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Regulatory Science in a Developing State: Environmental Politics in Chile, 1980-2010

by

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Professor David Winickoff, Chair
Professor Kate O'Neill
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Professor Alastair Iles

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Abstract

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Between 1980 and 2010, the Chilean state regulated the environment to meet local demands for democracy and more equitable development, as well as global demands for good governance. The 1980 constitution created a 'right to a clean environment' that came to life with the transition to democracy, first with a coordinating agency in 1994 and then with an Environment Ministry in 2010. One tool above all others was expected to put Chile on a greener development path: Environmental Impact Assessments (EIA). To meet demands state capacity also grew: government staff was hired and trained, consultants and scientists were enrolled to advise the government and rules were introduced to re-organize environmental regulatory efforts. With a history of strong institutions, Chile was well placed to succeed in this effort. In many ways Chile succeeded, and in 2010 it joined the exclusive club of developed nations, the OECD. But in others it failed: environmental conflicts are frequent, large investment projects with EIA approval are on hold, and environmental institutions face a crisis of legitimacy.

Combining approaches from science and technology studies and political science, this dissertation contributes to the literature on institutions and development. It explores the EIA's transit from bureaucratic formality to object of conflict through a qualitative comparison of three controversial projects (1998-2011) in the context of science-state relations and environmental politics from dictatorship through democracy. The longitudinal comparison allows for an analysis of how ideas about the need for "more science" versus "more politics" evolved over time. The first case is the Valdivia paper and pulp mill accused in 2005 of polluting a protected wetland and producing the mass migration (and death) of black-neck swans. The second case is the Pascua Lama gold mine, where the government and the company were forced to abandon plans to remove glaciers after major social protest in 2006. The third case is HidroAysén, a project to build five mega-hydroelectric dams in the Patagonia, that received EIA approval in 2011 in a highly contested evaluation process.

Technocratic solutions to large-scale environmental problems failed on the ground in Chile. Contrary to explanations that rely on stories of capture, this dissertation argues that disagreements over credibility have undermined the Chilean state's capacity to regulate the environment. These disagreements are expressed in two related sites: the boundary between political and technical decisions and disagreements over scientists and their proper role in society. Both disputes are about different visions of the state. Many in government believe good government means the state plays the role of a neutral broker that facilitates consensus and negotiation. Such a state has no tolerance for stubborn positions like those scientists or environmentalists might adopt, but a penchant for rules and regulations - its main job, after all, is to "draw the lines on the soccer pitch". Such a state, furthermore, is unable to cope with demands for accountability and thus faces a widening governance gap.

Dedication

Varias veces escuché decir a quienes estaban frustrados por la mala regulación que “Los chilenos no tienen conciencia de montañistas” o “aquí no hay cultura de mar”. Mal asunto para un país apretado entre el Pacífico y los Andes.

Esto va dedicado a todos los chilenos que sí tienen esta conciencia y cultura, y de sobra: los Huascoaltinos cerca de Pascua Lama, los Mapuche en Mehuín, los Patagones en Aysén, y todos aquellos que conviven con ellos en los valles y caletas, ganándose la vida a partir de y con la tierra, aire y agua.

Esto lo dedico también a los investigadores científicos de Chile que trabajan a menudo en laboratorios fríos, húmedos y débilmente equipados, y que con su trabajo tratan de acercarnos a la naturaleza que nos rodea para que juntos podamos compartir de esa cultura de mar y montaña.

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Glossary

Conama	Environmental Coordinating Agency
Corema	Regional Environmental Coordinating Agency
SEA	Environmental Evaluation Agency
EIA	Environmental Impact Assessment
DGA	Water Agency
Conaf	Forest Agency
Corfo	State Development Agency
SGA	Agriculture Agency
Conicyt	National Science Agency
Sernageomin	Geology Agency
CIPMA	Center for Research and Planning for the Environment
CENMA	National Center for the Environment
JICA	Japan Aid Agency
CEA	Consulting agency specialized on water issues
CIEP	Center for Ecology Research in Patagonia
EULA	Europe-Latin America project - Environmental Science Institute
CEAZA	Center for the Study of Arid Zones - U. La Serena
IFOP	Fisheries Research Institute
INFOR	Forest Research Institute

Political parties:

RN	National Renovation (ideological right, free-market and enterprise)
UDI	Independent Democratic Union (ideological right, conservative)
CD	Christian Democrats (ideological center-right)
PS	Socialist Party (ideological center-left)
PPD	Democracy Party (ideological center-left)
Concertación	Coalition of CD-PS-PPD and other parties
Alianza	Coalition of RN-UDI parties

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Regulatory Science in a Developing State: Environmental Politics in Chile, 1980-2010

Chile struggles with environmental degradation. The earthly Eden described by Jesuit priests and Alexander von Humboldt in the 19th century is today increasingly grey and desiccated. Mining, agriculture, aquaculture and hydroelectric power damage rivers and coastal marine systems. Climate change and mining accelerate the loss of glaciers. Petroleum coke and coal-fired power plants, open-pit mines and paper and pulp mills spew toxic chemicals on surrounding towns and ecosystems. All this may be the cost of development, as Chile is also one of a handful of countries advancing successfully on that path. Between 1990 and 2010, per capita income doubled and in 2010 Chile joined the prestigious club for wealthy nations, the OECD. Development was not achieved by supplying the world with copper, salmon, pulp, wood, fruits, wine and other minerals; any developing country can export raw materials well. Rather, development was achieved through 'strong institutions' and 'good government'. Without these, Chile would not have been able to join the OECD.

Large-scale environmental conflicts like those common in Chile today are often explained as cases of corruption or capture, where powerful companies prey on institutions too weak to enforce environmental regulations. These are institutions crippled by poorly trained and under-paid staff, asked to implement rules that are summarily ignored or not feasible in the circumstances, and beholden to illegitimate political or corporate pressures. Scholars and development practitioners often propose solutions that range from re-ordering the global market economy to technocratic policies guided by good government goals. Good government seeks to make institutions more efficient, effective and responsive through democratic values like accountability and transparency, and with investments in human resources, management and clear "rules of the game" (Grindle, 1997).

Between 1980 and 2010, the Chilean state regulated the environment to meet local demands for democracy and more equitable development, as well as global demands for good governance. The 1980 constitution created a 'right to a clean environment' that came to life with the transition to democracy, first with a coordinating agency in 1994 and then with an Environment Ministry in 2010. To meet demands state capacity also grew: government staff was hired and trained, consultants and scientists were enrolled to advise the government and rules were introduced to re-organize environmental regulatory efforts. With a history of strong institutions, Chile was well placed to succeed in this effort (Stein, Tommasi, Echebarría, & Lora, 2005). In many ways Chile succeeded, as attested by OECD membership. But in others it failed: environmental conflicts are frequent and tense, large investment projects are threatened by regulatory uncertainties, and environmental institutions face a crisis of legitimacy.

This dissertation shows that technocratic environmental management is failing on the ground and asks why this is so. Faced with disagreements about what makes environmental claims credible, how can the Chilean state know about possible risks and harms to effectively regulate them? In light of technocratic controversies, why do

Chilean politicians continue to promote technical solutions to political problems? Following global 'best practices', Chile built its environmental expertise with widely-used policy tools that try to integrate technocratic and democratic ideals. Only these tools were credible to all the actors involved: global trading partners, well-connected activists, and political leaders. Technocratic ideals include a belief in experts who can know the "right" or "best" policy. This is a form of consensus that can substitute for difficult negotiations. Democratic ideals, on the other hand, appeal to participation, representation and accountability. Democratic decisions are "right" only if politically legitimate. Governments need both types of "right" policies to govern effectively, and Chile's experience shows how difficult it is to combine these.

Political scientists have shown how democratic decision-making is more difficult in countries with high inequality, but focused less on how questions of knowledge shape democratic practices. Inequality produces diverse competing interests that are hard to integrate into shared decision-making processes (Fukuyama, 2007). Policy can be more easily destabilized where large social gaps exist between the poor voting majority and a wealthy influential minority (Levitsky & Murillo, 2012). But in trying to understand how institutions matter for development, political science has been too quick to point to technocrats - supposedly above the political fray - as sources of consensus and therefore legitimacy (Fukuyama, 2007). Rather than take technocrats' legitimacy for granted, science and technology studies (STS) finds that robust democratic government requires equally robust institutionalized channels for validating public knowledge (Ezrahi, 1990; Jasanoff, 2005). Not only must technocrats earn their legitimacy through politics like everyone else, but how this happens shapes the stability and adequacy of decision-making, representation and accountability. STS scholars have yet to apply these insights to study emerging democracy in a developing country.

Regulatory science is an STS concept that highlights how states combine technical and democratic demands when trying to regulate environmental risks and harms. Regulatory science combines "elements of scientific evidence and reasoning with large doses of social and political judgement" (Jasanoff,1990: 229). Successful regulatory science is credible and relevant, and results from institutional micro processes that delimit science from politics without insulating science so much that it ceases to be relevant or accountable. This balancing act relies on the participation of respected experts and communities that can criticize scientific claims. It is not a process driven by strict adherence to clear rules; rather, it thrives on debate, negotiation and the exercise of discretion to evaluate data (Farrell, VanDeveer, & Jager, 2001; Jasanoff, 1990; VanDeveer & Dabelko, 2001). Trained government staff and institutional capacity are necessary but not sufficient conditions for successful regulatory science.

To understand what makes for successful regulatory science, scholars often study it where consensus about science and its proper role in decision-making is most fragile. These moments expose the normally implicit conventions - informal institutions to political scientists - that give scientific and technical knowledge its appearance of solid determinacy and credibility (Jasanoff, 2012; Wynne, 2002). One such space is scientific controversies. Research into genetically modified foods, biotechnologies and life sciences has generated many insights into how liberal, advanced democracies

operate, and the values embedded in international treaties governing access and use of natural resources (e.g., Jasanoff 2005, Iles 2007, Miller 2007, Hayden 2003). Other scholars have looked to indigenous knowledges that contest Western scientific rationality and espouse entirely different ways of being in the world (Jasanoff & Martello, 2004; Leach, Scoones, & undefined author, 2005). And others have looked to global organizations like the World Bank that promote Western government practices in a top-down way (Goldman 2005, Miller 2007, Mitchell 2002). This research shows how ideas of 'good governance' and 'free market' are standardized and replicated around the world, often willingly or negligently blind to local conditions and helping to entrench existing inequalities.

Few however have explored regulatory science where scientific rationality is an aspiration. Since independence in 1810, Chile has aspired to liberal democratic development led by a modern and rational state. Progressive politicians advocated for "scientific government" as a means to a more egalitarian and meritocratic society (P. Silva, 2009). Obstacles to those goals have included deep inequality sustained by legacies of poor education, oligopolistic businesses and episodes of political disenfranchisement. In addition, there is a chronic sense of 'lacking' - money, talent, equipment, institutions, trust and power are always in short supply. Chile is not unique in these respects; many small and medium developing countries aspire to achieve good government with Western rational decision-making policies. In settings like these consensus about science and its proper role in decision-making is fragile because it requires reorganizing the rules of the game and reallocating public resources in ways that can threaten existing social hierarchies.

Furthermore, countries like Chile often have to adopt Western rational decision-making policies to participate in global markets. In doing so, countries face competing demands between good government and neoliberal policies that advocate for small, deregulated and heavily privatized states. They suffer from both "too little" and "too much" state (Grindle, 1997). Good government was supposed to be an antidote to technocratic, universal policy recipes and to the small states advocated by neoliberalism (Grindle, 1997; Stein et al., 2005). Although Chile is held up as an example of both good government (Fukuyama, 2007; P. Silva, 2009; Stein et al., 2005) and far-reaching neoliberal policies (Bosworth, Dornbusch, & Labán, 1994; Katler, 2004; Perry & Leipziger, 1999), its environmental regulatory debates show legislators struggling to reconcile competing neoliberal values with demands for equity, protection, justice, voice and growth.

This dissertation shows that through debates about capacity and information, global policies redistribute political power across state, government and civil society actors and thus reshape democratic practices. While policies may become universally adopted, sources of legitimacy most certainly are not universal. In Chile, disagreements over what counts as expertise and what makes claims credible are undermining the state's efforts to regulate the environment, despite relying on policies recognized world-wide as technocratic good government and the country's strong and orthodox economic growth trajectory. In other words, Chile's environmental and political conflicts do not bode well for widely-used global policy prescriptions about how to achieve sustainable

development. To recast traditional institutional challenges like capture, corruption or low capacity as problems of regulatory science points to the importance of credibility, relevance and trust, rather than rules and compliance, in regulatory politics. No longer is knowledge a solution to the problem of power, but knowledge and power together must meet needs for democratic and technical legitimacy. Legitimacy, like credibility, is in short supply in many developing countries like Chile.

Environmental regulatory politics takes many forms but one tool above all others has become the global standard: Environmental Impact Assessments (EIAs). Paradigmatic of rational decision-making, EIAs are used in all but two countries in the world to reduce, mitigate or compensate environmental damages caused by large projects like roads, factories or mines (Pope, Bond, Morrison-Saunders, & Retief, 2010). Often dismissed as a bureaucratic formality, as a policy instrument EIAs integrate expert and public opinion to assist the state in decisions about sustainable development. Like elsewhere, the EIA in Chile required expanding state capacity. But as the EIA grew in importance, so did environmental conflicts to the point that the EIA itself became the focus of conflict. Currently in Chile, projects valued at US$30 billion that won EIA approval in the last few years are paralyzed due to social opposition. This is a large figure; for context, in 2012 the EIA approved US$28 billion worth of projects.[1]

This dissertation explores the EIA's transit from bureaucratic formality to object of conflict through a qualitative comparison of three controversial projects that took place between 1998 and 2010 (listed in table 1 in blue). The longitudinal comparison allows for an analysis of how ideas about the need for "more science" versus "more politics" evolved over time and were used in the reform of the EIA in 2010. The first case is the Valdivia paper and pulp mill accused in 2005 of polluting a protected wetland and producing the mass migration (and death) of black-neck swans. The second case is the controversial Pascua Lama gold mine, where the government and the company had to abandon plans to remove glaciers after major social protest in 2006. The third case is HidroAysén, a project to build five mega-hydroelectric dams in the Patagonia, that received EIA approval in 2011 in a highly contested evaluation process. The cases involve different industry sectors, expert communities and government agencies, thus maximizing variances related to capture or corruption to yield insights about regular patterns in Chilean environmental regulatory science.

Environmental regulation today is a problem of equity. In an era of global climate change, intensified production and increasing population density, the potential for rapid environmental degradation is greater than ever. Many of Chile's worst environmental problems reflect this: minerals that were inaccessible can now be profitably mined and rivers that were too far away can now be profitably damed, in a context of a warming and drying atmosphere and of massive, less livable cities. More than half of Chileans live in cities that do not meet national air quality standards. Environmental conflicts in Chile are controversies over the type of development Chile seeks: whose livelihoods will be preserved? Who will be forced to move to find wage work, and who can stay and have access to land and resources? Chilean environmental politics between 1980 and

[1] Figures obtained from industry associations Sofofa and Cochilco, and from Centralenergia.cl.

2010 thus reflect classic struggles between those who push for progressive regulations and those who resist these; those who support expanding export-led growth, convinced by past successes and dismissing alternatives, and those who want more equitable, sustainable or ethical development; and those who want a nimble state adept at efficient decision-making, versus those who want to ensure fairness in the process and outcomes. This dissertation is about Chile's efforts to implement sustainable development policies using global best practices, and the findings are relevant to other small and medium countries that hope to replicate Chile's achievements.

Table 1. Timeline of events, institutions and conflicts covered in this dissertation
In blue: the three controversies covered here

1973	Military coup led by A. Pinochet against S. Allende's government.	
1980	New Constitution establishes right to live in a clean environment.	
1984	Inter-ministerial Ecology Committee is created.	ch. 2
1990	Transition to democracy begins under President Patricio Aylwin (CD). Environmental framework law (19.300) submitted to Senate.	ch. 2&3
1994	Environmental framework law is approved. Conama (*Comisión Nacional del Medio Ambiente*) is created and administers voluntary EIA process.	ch. 2&3
1994	President Eduardo Frei (CD) is sworn in to office.	
1995	CENMA (*Centro Nacional del Medio Ambiente*) is created.	ch. 2
1997	EIA becomes obligatory.	ch. 3
1998	Valdivia Paper and Pulp mill EIA submitted.	ch. 4
2000	President Ricardo Lagos (S) is sworn in to office.	
2000	Pascua Lama gold mine EIA submitted	ch. 5
2005	Valdivia Paper and Pulp mill conflict	ch. 4
2005	Pascua Lama gold mine conflict	ch. 5
2006	President Michelle Bachelet (S) is sworn in to office.	
2008	HidroAysén hydroelectric dam EIA submitted	ch. 6
2010	Environmental framework law is reformed (20.417). An Environment Ministry and autonomous EIA Agency are created to replace Conama.	ch. 3
2011	HidroAysén hydroelectric dam EIA is approved.	ch. 6

This introductory chapter provides a review of the relevant scholarly literature and introduces the themes and questions the dissertation will address. Chile is a developing country on the cusp of development so its struggles with the EIA bring needed nuance and depth to the study of institutions in development; this is discussed in the next section. The next four sections examine the literature on EIAs, regulatory science, science and democracy and science in Latin America to build an argument about the character of the relationship between science and the state in Chile. The final sections of this chapter describe the research design and anticipate results of the dissertation.

Chapters 2 and 3 set the institutional and historical context. Chapter 2 focuses on science in Chile. Like in other Latin American countries, science there has always been an engine for economic growth and had a tenuous relationship to the state. Chile's neoliberal-turn in the 1980s also created markets for science that have produced new opportunities and challenges for science. Chapter 3 focuses on the creation of Chile's environmental institutions: the coordinating agency (Conama), in charge of administering the EIA, in 1990-94; and their reform into a Ministry and autonomous EIA Agency in 2009-10. This chapter shows how central executive authority and bureaucratic capacity were strengthened in response to calls for "more technical" politics, and goes into detail about the EIA.

Chapters four, five and six each report on one of the three controversies of this project in chronological order. Chapter seven provides a brief conclusion. The major events covered in this dissertation are listed in table 1.

I. Chile: a brief introduction

The military coup of September 11, 1973 was unprecedented for Chile. The Military had a strong ethic as guardians of the constitution that crumbled during the increasing chaos of Salvador Allende's socialist government (1970-73) (Constable & Valenzuela, 1991; Valenzuela, 1978). For the first time, political parties lost capacity to govern and become increasingly radicalized, as did society in general.[2] The Military and ideological right feared civil war and communism, while the Christian Democrats - the ideological center - lost or abdicated from their capacity to negotiate with the parties of the Left. Allende and his group committed to a pacifist path to socialism became isolated. As Allende lost control, he tried to bring in neutral institutions, like the courts and military, for stability, credibility and legitimacy. But this split the Military and Navy. Moderate individuals resigned or were removed from their positions. Until a week before the coup, the few who had heard of Pinochet associated him with the conciliatory position of General Carlos Prats, whom he replaced just prior to the coup.[3] Pinochet's conversion into dictator was swift, unexpected and cruel.

[2] Unlike its neighbors, Chile lived just one short military government and period of unrest in the late 1920s.

[3] Former President Eduardo Frei, one of Chile's most respected figures at the time, reportedly said at the time of the coup: "Who is this Pinochet? I don't know him." (Valenzuela 1978)

Figure 1: South America & Chile

Information & Data

Capital	Santiago
Population	17.2 million
Urban population	89%
Population growth	0.88%

	Chile	OECD Avg.
Poverty (% that is poor)	19%	11%
"It is hard or very hard to get by on current income"	38%	24%
High levels of trust in others	13%	59%

Source: CIA Fact book & OECD

Seventeen years of dictatorship destroyed democratic institutions that had been evolving for 130 years. The dictatorship was brutal. Human rights abuses were massive; thousands disappeared, many were detained and tortured, and others left in exile. Institutions were destroyed: political parties dissolved or went underground; formerly independent courts were complicit in human rights abuses; Congress, formerly the forum for compromise and accommodation, was closed; university chancellors were replaced by generals. The economy was re-organized by the *Chicago boys,* a group of Chicago-trained economists, followers of Milton Friedman, who won Pinochet's ear and

together launched a neoliberal experiment. They were explicit in their hope to make history by implementing a deregulating, privatizing, free-market program.[4]

A new constitution approved by plebiscite in 1980 gave expression and longevity to this political program. Among other things, the Constitution expands private property and raises different forms of it to a constitutional right, and creates a right to free-enterprise. In sharp contrast with the regime's poor environmental record, it also grants citizens a "right to live in an environment free of pollution". A sign that Chile was "in tune with the times" (Nef, 1995), or an inadvertently forward-looking provision to protect nature for "man's integral development", the environmental right is subordinate to the right to free enterprise.[5]

Among the dictatorship's achievements were a drastic reduction in the size of the state, a re-concentration of wealth and a deepening of inequality. Prior to the coup, more than in other Latin American countries, the Chilean state made itself felt in citizens' and corporations' daily lives (Valenzuela, 1978). Pinochet eliminated subsidies and forced many industries to close. National companies were privatized, often hastily and rather cheaply (Constable 1991). Wealth re-concentrated around three traditional sectors - mining, agriculture and forestry - and around three large, diversified family-led groups - the Matte, Angelini and Luksic families (Khanna & Yafeh, 2007; Ross Schneider, 2004). Multinationals, which had always been important in mining, became important in other sectors too. This accentuated Chile's legacy of inequality. In colonial times, a feudal socioeconomic system existed where peasants relied on the local landlord for food, housing and work (*encomiendas*). Since independence in 1810, political life swung between demands for socioeconomic reform versus preserving the status quo. Periods of social, labor and educational gains were followed by roll backs; most notoriously gains won in the 1960s-70s were rolled back by the dictatorship (Constable, 1991). Chile remains among the most unequal countries in the world, and labor conditions for many have worsened since the "economic miracle" of the 1980s and 1990s (D. Contreras, 1998; Winn, 2004).

In 1989 Pinochet lost a plebiscite and Chile began to transition back to democracy in what is known as a "negotiated transition" (*transición pactada)* (S. Collier & Sater, 2004). The Concertación governments that governed Chile between 1990 and

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[4] See Constable 1991. Milton Friedman visited Chile in 1975 and met with Pinochet to persuade him to the neoliberal cause. Before the coup, the economists had been preparing an economic program in hope of a better future (from their perspective). They accepted the challenge of government and often adapted their program an ideas as needed. For example, after economic collapse in 1982 there was a shift towards Friedrich Hayek's ideas more than Friedman's. Hayek also visited Chile in 1983 and met with Pinochet.

[5] I have not found any good accounts of this. Senator Sergio Díez attributed responsibility for this article (19.8) to himself and to legal scholars Jose Luis Cea and Enrique Evans de la Cuadra and gives this reason during Senate discussions after 1990 (Legal History 19.300, quotes 115 and 308). Relevant rights that take precedence over the environment: the right to free enterprise (Art. 19.21), the "freedom to acquire control over all goods except those that nature has made available to all men or that should belong to the nation and the law identifies as such" (Art. 19.23), and the right to property, in its different forms, over all types of goods, both bodily and non-bodily (Art. 19.24).

2010 promised "growth with equity".[6] They have delivered growth, but not equity. Chile is just US$2,000 shy of its goal of US$20,000 per capita income, the level at which politicians said Chile would become a developed country (table 2**).** It is a hollow achievement when less than 10% of Chilean households actually earn this amount.[7] Less than 20% of the population is middle class or higher (ABC1 in marketing terms) (for a review of inequality statistics see, Barandiarán, 2012). As the first generation of students educated entirely since the 1980 reforms graduated, they found few jobs that pay well enough to pay-back their education debt and took to the streets in protest. The policies once considered models of neoliberal development - pensions, health, education - are are too expensive for families. However the accounting happens, less than 20% of Chileans can afford developed-country services. The rest bought into development on credit. The discussion, however, is no longer about poverty and sanitation but about access to quality education, health and jobs. In this sense, Chile has developed.

Table 2. Economic indicators for Chile and selected countries in the EIA literature Sources: CIA Fact book, World Bank, African Innovation Outlook Survey, Heritage Foundation

	Population (million)	GDP/capita	Gini Coefficient (higher is more inequality)	R&D expenditure as % of GDP	"Economic Freedom" (100 max. freedom)	Govt. spending (100 lower spending)
Chile	17.2	18,400	52.1	0.53%	79.0	83.7
Brazil	200.0	12,000	51.9	0.9%	57.0	54.8
Ghana	25.5	3,300	39.4	>0.48%	61.3	52.5
Vietnam	92.5	3,500	37.6	0.19%	72.8	37.3
UK	63.4	36,700	34.0	1.7%	74.8	27.7
Germany	81.1	39,000	27.0	2.3%	76.0	47.8
U.S.	316.7	49,800	45	2.7%	51.0	72.8

[6] The Concertación is an alliance or compact of the Christian Democrats, Socialists, Democracy Party (socialists) and other smaller groups that joined forces in 1988 to defeat Pinochet in the plebiscite that marked the beginning of the transition to democracy. The coalition represents moderate right to left-wing positions. The other main electoral force is the Alianza, a coalition of two right-wing parties: the conservative UDI party and the libertarian RN party.

[7] http://www.elmostrador.cl/opinion/2012/01/06/pib-per-capita-de-16-mil-dolares-%C2%BFnos-quejamos-de-llenos/

Some reflections on the quality of Chile's development

In what ways are developing and developed countries really different? Most emphasize income, absolute poverty, unemployment, stagnant agricultural productivity, country debt (imbalance of payments) and political and economic volatility, and assume some notion of "stages of development". These have been absent from Chile for twenty years, so is development a done deal? Income gains aside, Chilean development has not met expectations for better, more fair state capacity. This section reflects on some of the legacies that make institutions in developed and developing countries really different, and addresses arguments about Chile's neoliberal experiment. An ineffective and illegitimate EIA is not just a bureaucratic nuisance but points to the limits to growth imposed by low institutional capacity in a liberal democracy.

The transition from developing to developed is a question of income as much as one of identity, where under-development is an excuse and a way of doing things. Today Chilean politicians strategically compare Chile to OECD or Latin American averages depending on whether they want to tell a story of success or of need. After the 2010 earthquake former minister Sergio Bitar took the stage at an important academic conference and explained that "as a developing country" Chilean relief efforts had coped very well. A social scientist next on stage was less forgiving: "as a developed country, Chile needs to do better."[8] One of the best examples is the flurry of jokes elicited by President Sebastián Piñera's attempt to transform the idiomatic expression "the Chilean way" from a signifier of shoddiness to high-tech success. The phrase first emerged to describe Allende's (failed) Chilean way to socialism, was then recycled to mean ingenuity in the face of poverty during the Pinochet years, before coming to mean sloppy or 'cutting corners' under democracy. In August 2010 when 33 miners trapped underground were successfully rescued in a sophisticated operation, President Piñera hoped to inaugurate a new era of the Chilean way: this time to signify a modern and expert "Chilean way" at the service of the common man.[9] Those dissatisfied with Chile's inequitable and unfair development trajectory were quick to ridicule the attempted linguistic-turn.[10] This episode points to how central though subtle questions of capacity and quality are to development.

Institutions are different in developing and developed countries. In an analysis of the EIA in his native Ghana, scholar Seth Appiah-Opoku matches different theoretical policy models that underlie the EIA to operational requirements and conditions in developing countries (Appiah-Opoku, 2005: 28). Each form the EIA can take requires different Western-style "requirements" like analytical capacity, data, participatory

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[8] Special panel on the earthquake at the Latin American Studies Association meeting held in Toronto, Canada, October 6-9, 2010.

[9] Other Presidents have also tried to turn the Chilean Way around. Former President Ricardo Lagos used this to title his article in the Harvard International Review praising Chile's socialist democracy: http://hir.harvard.edu/the-united-nations/the-chilean-way. Chapter six has a longer discussion.

[10] The best example was the front page of *The Clinic*, a satirical paper, that read: "The Chilean Weá: the papelito a papelón". This is slang that roughly translates to "Chilean stupidity, from a little paper to a big mess" in reference to the note the 33 trapped miners sent up to communicate they were alive. "Wea" can be read in Spanish to say "way". Issue 28/10/2010.

democracy, and inalienable, well protected civil liberties. Legacies that hold developing countries back range from lack of capacity to lack of civil liberties. If the goal is to reach a legitimate result through a critical vetting of the alternatives, then small and under-funded expert communities are unlikely to pack much of a punch. If the goal is to reach a legitimate result through negotiation, compromise and consensus, then repression is likely to have taken the spirit and honesty out of dialogue. Appiah-Oppoku's analysis asks what conditions favor constructive debate? Developing countries with legacies of repression, inequality, weak civil liberties and fragmented expert communities differ in these respects from institutional legacies found in first world countries.

The global EIA literature has emphasized two types of lacking in developing countries. The first is a list of conventional lacking: if data, information and expertise are "limited" in developed countries, they are "severely limited" in developing countries (Lemons & Porter, 1992). If political will is weak and government agencies resource-constrained in general, in developing countries these are severely under-staffed, under-resourced, lack skills and training, and lack political will (Clausen, Vu, & Pedrono, 2010; El-Fadl & El-Fadel, 2004; Glasson, Therivel, & Chadwick, 2005; Kolhoff, Driessen, & Runhaar, 2013; Marara et al., 2011). Grounded in material constraints, these conventional 'lackings' assume that if remedied the country would progress through the 'stages of development', a thoroughly discredited notion (Germani, 1969; Hirschman, 1981). Following the tradition that "modernization" need not mean "Westernization", this dissertation examines how the Chilean state knows about environmental harms and risks so the Chilean citizens whom the state represents may better control their own development path (Raj, 2006). Following the anecdote with the 33 miners described above, to overcome 'conventional lackings' is not the whole answer to capacity and development.

The second type of lacking is a lack of power and voice, because policies are imposed on developing countries top-down to extend the interests of developed countries (Appiah-Opoku, 2001; Cashmore & Axelsson, 2013; Doberstein, 2004; Goldman, 2005). Resistance is required, either through local (indigenous) knowledge (Appiah-Opoku 2005), redefining power structures and relationships (Cashmore 2013), or abandoning neoliberal development recipes (Goldman, 2005; Tecklin, Bauer, & Prieto, 2011). Neoliberal policy recipes have indeed been bad for Chile's environment (Altieri & Rojas, 1999; Bauer, 1998; Budds, 2004; 2009; Carruthers, 2001; Ederington, 2007; Lata, 2010; Liverman & Vilas, 2006; Prieto & Bauer, 2012; E. Silva, 1996a; 1996b). But it is also the case that the environment was thrown under the development bus not just by Pinochet, but by all previous governments (Camus & Hajek, 1998; Nef, 1995; E. Silva, 1996a). Science has likewise consistently stayed below the government radar, as discussed in chapter two. Despite some recent growth, research and development spending is well below 1% of gross domestic product, compared to over 2.5% in the U.S. or Germany (GDP; table 3). Many faculty are employed part-time and many full-time faculty do consulting work to make ends meet. The bread and butter of

Chilean science - Fondecyt projects - are just around US$10,000.[11] These are historical shortcomings. Chile's neoliberal experiment does not account for all of Chile's current development failures.

Table 3. Indicators of science and university activity in Chile compared to other countries, and change over the last decade.
Source: elaborated from UNESCO data, accessed in 2008.

	Chile	Argentina	Brazil	Mexico	Spain
Number of researchers 2006 (in full time equivalent hours)	13,427	35,040	84,979	48,401	115,798
Change in researchers, 1996-2006	98%	41%	33%	143%	124%
Research expenditures 2006 (% GDP)	0.67%	0.49%	0.83%	0.50%	1.21%
Change in expenditure, 1996-2006	0.15%	0.08%	0.12%	0.19%	0.40%
Published articles 2003	1,500	3,086	8,684	3,747	16,826
Change in articles, 1996-2003	62%	40%	127%	76%	38%
University students 2002	451,872	1,269,239	2,150,659	1,521,536	N/A
Change in university students, 1995-2002	114%	71%	108%	70%	N/A

Rather than analyze what Chile is 'lacking' or the deleterious effects of neoliberalism, this dissertation examines the politics of knowing about the environment in Chile to reflect on the country's progress towards sustainable development through democratic means. Like many countries, Chile has historically modest levels of development and reasonable capacity, so what are the specific legacies of this trajectory? More specifically, how are claims made credible where the environment and science have been suspect but where technocratic government is valued? What consequences does Chile's small and fragmented expert community have for transparency and accountability? What kinds of data and scientific evidence are most trusted, where resources for data collection have been scarce? In Chile's highly legalistic culture, what role do rules play in shaping how environmental knowledge is

[11] This figure was reported by several scientists but may be an under-estimate based on official data. Fondecyt's budget in 2007 was about US$50 million and 4559 researchers obtained a grant between 2007-2012. The division results in about US$10,000, but this is inaccurate because the figure for researchers is presumably cumulative.

taken up by state bureaucracies? Many countries like Chile do not have institutions that produce a "scientific opinion" like the U.S. National Academy of Science or the British Royal Society. As knowledge-intensive policies like Environmental Impact Assessments proliferate, how do countries like Chile respond and with what consequences for democratic life? The answers to these questions lie in the micro processes of regulatory science, in things like how environmental baseline reports are delineated from impact assessments to protect the integrity of scientists or how different actors distinguish "technical" from "political" factors in decision-making.

Chile's development trajectory is on balance positive, with stable democracy, export-led growth and orthodox macroeconomics. In this context the EIA highlights the limits to Chile's democratic and neoliberal growth model: in a democracy, large investment projects like power plants, mines, and industrial facilities need to be made legitimate through agreed-upon procedures. New investments can not occur without EIA approval, and increasingly they can not occur even with EIA approval. This predicament reflects the need to shift Chile's environmental politics. Environmental protection can no longer be seen as an 'anti-development' luxury. Instead protection and development need to be reconciled; this is what Chilean communities want. In a documentary on the controversial mine Pascua Lama, the director reflects on her transformation from labor to environmental activism.[12] The community she was documenting, however, did not identify with an environmental cause. For them, protecting the glaciers was necessary to preserve their agricultural livelihoods. The community was demanding sustainable development, where environmental protection and development are compatible.[13] The real limits to growth Chile faces are less from natural resources and more from liberal democracy, as it is ill-equipped to cope with spiraling levels of inequality and injustice.

II. Environmental Impact Assessments and Western scientific rationality

As anticipated, Environmental Impact Assessments (EIAs) are a policy tool where scientific and technical methods are used to collect and analyze environmental information, use that information to evaluate the impacts a planned project may have, and connect this to decision-makers before a decision is made to authorize the project (Owens & Cowell, 2002). It is a technocratic environmental management tool based on the classic ideal of "speaking truth to power" where scientific knowledge is the "solution" to the "problem" of power, as discussed at length in chapter 3 (Cashmore & Richardson, 2013; Fischer, 2000; Jasanoff, 1990). EIA scholarship has focused on three topics: explaining the global spread of EIAs, assessing EIA performance against the theoretical linear model that privileges rational decision-making based on objective facts obtained through scientific and technical methods, and challenges to the linear model. Though ubiquitous, no two EIA systems are exactly alike. Countries have adopted different arrangements within the same overall framework and goals and yet around the world

[12] *Pascua Lama: Latin America's Treasure* (2010), directed by Carmen Castillo.
[13] For an eloquent statement of the community's position see this recent interview with an indigenous leader from the area: http://radio.uchile.cl/noticias/210043/

the EIA produces the same shortcomings Chile's environmentalists complain about. The transformative power of the EIA thus depends on how it is integrated into local institutional cultures more than in the specific rules that guide the process.

The global appeal of EIAs lies in the need for policies to achieve sustainability, through rationality and good government, as these became more pressing goals towards the end of the 1970s (Cashmore & Axelsson, 2013; Hironaka, 2002). Created in the United States in 1969 and required as part of that country's groundbreaking National Environmental Protection Act (NEPA), almost twenty years lapsed before EIAs were espoused by the European Union and the World Bank (Glasson et al., 2005). Through the 1980s use of EIAs expanded: first the European Union (1984) and OECD countries' international aid agencies (USAID used it routinely from 1979) started using it, and then it was endorsed by the Brundtland Report (1988). Through the 1980s U.S. environmental NGOs kept pressure on the U.S. government to force the World Bank to expand its environmental capacities in 1987 (Wade, 1997). The Rio Conference in 1992 endorsed EIAs and this swayed many still reluctant developing countries (Hochstetler & Keck, 2007; Kolhoff et al., 2013). In many cases, as in Chile, the World Bank followed with funding and technical support to help install the EIA (see also El-Fadl & El-Fadel, 2004). From its origins in the U.S., EIAs developed differently elsewhere. U.S. environmentalists and the courts used it to push for then radical environmental standards, while elsewhere EIAs arrived as a bureaucratic tool embedded in every day politics (Glasson et al., 2005).[14]

Resistance to environmental protection was strong within the World Bank and in developing countries. In their view environmental protection was expensive, an unnecessary diversion of needed effort and resources, and an incursion into national sovereignty (Wade 1997, Hochstetler and Keck 2007). The World Bank, along with some government agencies like the British Department of Environment, worried EIAs would be ineffective and cumbersome (Glasson et al., 2005), or would put a break on development (Hironaka, 2002). World Bank staff feared environmental concerns were too qualitative and would put up obstacles to their real objective: to fund development projects (Wade 1997). Though some World Bank leaders, notably Robert McNamara, had supported environmental protections in the 1970s, attitudes, behaviors and the organization changed much more slowly and in response to pressure from U.S. NGOs (who pressured Congress) (Wade 1997). Hironaka argues that the broad appeal of EIAs lay in that they seemed like a reasonable and flexible method to environmental governance. Reasonable because EIAs are founded on scientific and technical knowledge.

Scholarship has focused on assessing the performance of EIAs against a theoretical ideal that is very close to global notions of good government. EIAs are more effective where there is good governance. This includes an autonomous EIA Agency, low corruption, high levels of training and capacity, public participation and environmental standards are raised incrementally (Kolhoff et al., 2013; Pope et al.,

[14] The design choices of international aid agencies, including the World Bank, in this period merit further research. Was this a purposeful change or the result of different roles of the judiciary in the U.S. compared to everywhere else?

2010). Sometimes government employees who review EIAs need more training in the skills and knowledge to assess the assessment (Ahmad & Wood, 2002; Clausen et al., 2010; Lemons & Porter, 1992). Often government reviewers also need to be sufficiently empowered to overcome the pressures for capture, corruption or alternative political interests (Cashmore & Axelsson, 2013; Doberstein, 2004). The literature regularly critiques but relies on a "practice-theory gap" where the EIA falls short of the linear model's and environmentalists' expectations (Bina, Jing, Brown, & Partidário, 2011; Cashmore, Bond, & Cobb, 2007; El-Fadl & El-Fadel, 2004; Glasson et al., 2005; Holder & Lee, 2007; N. Lee, 2006; Mascarenhas & Scarce, 2004; Owens & Cowell, 2002; Pope et al., 2010; Richardson, 2005; Walker, 2010).

The practice-theory gap affects both developed and developing countries. As a result, EIAs around the world share a familiar list of shortcomings: environmental impacts are fragmented as cumulative or synergistic impacts are often unaccounted for. Alternatives to the proposed project, as required by the original EIA, are either not required or inadequately identified and assessed. EIAs often occur too late in project design and planning to significantly change a project. Owens (2002) points out how even in an environmental leader like the Netherlands assessments led to the "least cost accommodation of growth" around Schiphol airport. Rarely are EIA projects rejected, and even ideal public participation processes generate parochial notions of sustainability. Scholars highlight a lot of gains from the EIA, but struggle to produce evidence of substantive transformation of government values and practices towards sustainability and environmental protection (Owens 2002; Holder 2007; Cashmore et al., 2007).

The practice-theory gap is thus often explained as a problem of capacity, which harkens back to notions of good governance, leading to a somewhat circular argument. For example, Cashmore and co-authors find mixed achievements in UK assessments when they defined performance outcomes as learning, governance, attitude and value change, and development outcomes. These dimensions are all part of comprehensive notions of capacity, as defined by Merilee Grindle:

> good governance requires time, commitment, innovative ideas, consensus building, changed behavior and norms for those who work in the public sector, new rules of the game, efficient design and resource allocation in technical assistance . . . [B]uilding state capacity also requires effective efforts to develop human resource capacity, particularly among technical and professional staff; organizational strengthening initiatives, particularly those focused on incentive and managerial systems; and institutional reforms, particularly those that address underlying constraints on government to contribute more effectively . . . (cited in VanDeveer & Dabelko, 2001: 20)

There is a need to problematize the notion of capacity by calling into question the politics of information (VanDeveer & Dabelko, 2001). Many analysts reject the linear model but ultimately retain it by bracketing questions about credibility. For example,

Cashmore and his co-authors celebrate transparency standards in the UK EIA, although "there are obvious reasons why the objectivity and validity of the published information should be viewed cautiously..." (Cashmore et al., 2007: 522). In a large-scale study on good governance and assessment tools, Cash and his co-authors argue "one challenge is to produce information and technologies that meet the needs of decision makers and are thus seen as being salient." (Cash et al., 2002 5). The problem is that "salience" requires authorities who know their needs, can name them and can convince others these are legitimate. This is precisely part of the challenge in many countries: "so long as policy makers fail to notice what they fail to notice, there is little they can do until they realize how their failure to notice limits the success of EIA procedures." (Appiah-Opoku 2000: 32).

Another way to problematize capacity and good governance is to question those with power: whose capacity is being reinforced through global tools like the EIA? Scholars of international politics have studied how these policies are imposed on poor countries by global institutions and argue tools like the EIA help maintain the World Bank's dominant position as an expert on global development work (Cashmore & Axelsson, 2013; Goldman, 2005; 2007). Inefficient, uncooperative or "corrupt" institutions are marginalized and construed as an obstacle to development, and property rights and large capital projects are construed as the best way to both develop and protect the environment. Corruption is demonized. So the World Bank uses the EIA to promote its own notions of good government and environmental protection in a subversion of the rational decision-making process. This literature looks at countries where asymmetries are known to be great, as in Laos and Bangladesh.[15] But in countries that occupy a middle ground like Chile, are developing countries themselves using green science to redefine their own development expertise? Are countries like Chile using their positions to export models of development to poorer countries?

A third way to problematize capacity is to focus on scientists, consultants and experts. The global spread of EIAs relied on the appeal of rational decision-making, so who are these rational actors? This only surfaces occasionally in the literature (e.g., Lawrence, 2004; Owens & Cowell, 2002, Pope et al., 2010). In an introductory volume to the EIA, Glasson (2005) points out that the British EIA is criticized because the developer, with in-house or hired consultants, carries out the EIA (like in Chile; see chapter 3). Though Glasson says this is generally the case, the review of international practices is far more nuanced. In Peru the Ministry of Energy and Mining authorizes organizations to do EIAs. In Benin the Environmental Agency carries out the EIA drawing on a "forum of experts from public and private institutions" (Glasson et al., 2005: 297). Government authorities in China control the EIA: they determine if one is required, what to study and evaluate, draft the terms of reference, and license these to state-approved experts. In Poland the authorities make a list of appropriate consultants for each project. And in Canada the government at the regional and federal levels set up external review panels to evaluate projects at different stages of assessment. States

[15] Both are in the poorest 50 countries world wide measured as GDP per capita (US$3,000 and less), according to the International Monetary Fund. Chile's GDP is six times higher.

around the world use a range of methods to attempt to certify and control the credibility of information.

Furthermore, the literature takes for granted the role of consultants, but there are signs that all is not well in the global South. Scholars studying assessments in Middle Eastern, African and Asian countries call for local universities to be more involved (Ahmad & Wood, 2002; Doberstein, 2004; El-Fadl & El-Fadel, 2004; Glasson & Neves Salvador, 2000), but do not reflect on why this has not happened yet nor why this would be desirable. In a study of Brazil Glasson identifies that actors have "scathing criticism" of the "EIA industry" but the article does not explore what lies behind this (2000: 203).

Studies of EIA quality leave room to doubt the information in any given study. Quantitative analysis in the UK concludes that between one third and one half of EIAs are poor or unsatisfactory quality (Glasson et al., 2005). In developing countries local data is so limited that international databases are used to estimate local climate and ecosystem phenomena (de Eicker, Hischier, Hurni, & Zah, 2010). EIAs in the tropics are hampered because few models and data exist for those regions (Glasson et al., 2005). A study of Latin American EIAs found that just 22% of respondents found them to be good (Espinoza & Alzina, 2001). A study in Chile by the University of Chile of 100 large mining and energy EIAs found models to lack data and insufficient information in all of them.[16] All the above points to the need for analysis of how EIAs establish their credibility and legitimacy in different settings, and the frame of regulatory science provides a good guiding analytical template for this.

Relative silence on consultants and scientists contrasts to the steady stream of work that calls for increased public participation in EIA. Indigenous knowledges and other new voices would complement or substitute for Western science in assessments (Appiah-Opoku, 2001; Backstrand, 2003; Epstein, 1996; Iles, 2007; Rozema, Bond, Cashmore, & Chilvers, 2012; Wynne, 1996). The normative and political arguments for more participation are clearly strong, but only rarely has more public participation permanently altered regulatory science (e.g., Iles 2007, Epstein 1996). Furthermore, while in some areas there may be good reasons to advocate for the inclusion of important others, like indigenous groups, in many places like Chile most public participants will bring dominant neoliberal values and other parochial concerns to the forum (Owens 2002).

One other approach is to focus on the political uses of EIAs. For example, as an advocacy tool (Cashmore et al. 2007) or a communication platform to broker agreement between powerful actors (Richardson 2005). These uses appeal to complementary planning approaches that informed EIA design and that emphasize consensus, negotiation, and representativity (Lawrence, 2000; Owens, Rayner, & Bina, 2004; Rozema et al., 2012; Wesselink, Buchanan, Georgiadou, & Turnhout, 2013). Similarly, science scholars look at "models" of the science-policy interface: precautionary, demarcation, framing, extended participation and modern (Guimaraes Pereira & Funtowicz, 2009). The goal of these models is to identify some "right" amount and type of science to use under different conditions (Funtowicz & Ravetz, 1990). While many of

[16] Reported in *La Segunda*, 22/09/2012. I have not accessed the original report.

these findings resonate with Chile's EIA experiences (e.g., its use as an advocacy tool), this analysis seeks to assess the EIA as an expression of local governance and politics grounded in political science (Fukuyama, 2007; Murillo & Levitsky, 2009) and STS (Jasanoff 2005, Ezrahi 1990) literatures on institutions. Rather than bracket the political system as a "context factor" to be controlled for, this analysis seeks to engage with politics directly (Kolhoff et al., 2013).

The Chilean political context is generally favorable for the EIA. For reasons discussed in chapter 3, the EIA rose to become Chile's number one environmental regulatory tool. First administered by the National Environmental Coordinating Agency (Conama), and since 2010 run by an autonomous EIA Agency, the EIA has only grown in importance since it was first adopted in 1993. Chile is a unitary country with no decentralization of political power; citizens vote only for the national executive and legislative branches and for municipal representatives. The President, through his cabinet of ministers, is very powerful (Stein et al., 2005). Environmental authority first lay with Conama whose director was named by the President but answered to the Minister of the Interior. Since 2010 environmental authority lies with an Environment Ministry with a minister that forms part of the President's cabinet.

III. Regulatory science

Reflecting these tight linkages between Presidential authority and ministries, Chilean technocrats have a long history of successfully working within state bureaucracies and in response to executive demands. Patricio Silva (2009) documents Chile's penchant for technocrats in conservative and progressive, democratic and authoritarian governments from the 1920s through today. Thus it is a fiction to describe technocrats as insulated from politics and business interests, and therefore freer to take a long-term view against short-term interests (Fukuyama, 2007). The example of the Chicago Boys as supposedly sheltered and apolitical technocrats is not just false - they were part of a thoroughly political project (Constable & Valenzuela, 1991) - but misleading. Technocrats draw their authority not from being sheltered from politics but because they offer the illusion of consensus by virtue of being "right". The lens of regulatory science asks: how do they convince citizens and colleagues that they are right?

Regulatory science requires a delicate balance: experts too exposed to political, social or economic interests risk being distorted or marginalized, but if too insulated experts might become irrelevant or unaccountable (Jasanoff, 1990). Striking the right balance can yield great institutional rewards. Expertise is stabilizing, particularly if it is external to the organization, because it raises the costs of challenging the decision. Expertise that is vetted and disputed can improve the quality of a decision. And recognizing the political needs of expertise can help state bureaucracies harness the power of science. Studying the U.S., Jasanoff argues the real puzzle is that the negotiation between science and policy does not break down more often. By creating alliances, zones of contact and investing effort into preserving or moving as the need may be certain boundaries between science and non-science, fact and belief,

supposition and certainty, the actors who participate in regulatory science vie to make certain claims, organizations and people credible and others refutable (Wynne, 2002). This section introduces these concepts which guide the analysis in this dissertation, and concludes by juxtaposing this analytic approach to others that emphasize goals like consensus.

Regulatory science works through two micro-processes of negotiation and boundary work. Negotiations shape the direction and content of regulation. Jasanoff finds that in U.S. regulatory politics, incremental reductions in risks and a slow raising of environmental standards is most effective (Jasanoff, 1990). Boundary work, the careful delimiting of science and non-science, is the "casing that gives the result legitimacy" in large part because it shapes what science is seen as relevant and integral (Jasanoff, 1990: 236). U.S. regulatory science decisions are more legitimate when science is "closed" from policy, incorporated early into the process and when outside experts participate (Jasanoff, 1990). Compared to their colleagues outside state bureaucracies, state-employed scientists closer to setting regulation and therefore to political power are forced to maintain a stricter - and more artificial - distinction between scientific facts and social values to defend their integrity from suspicion (Keller, 2009). To protect their integrity, U.S. government regulatory scientists may have to sacrifice on relevance and abstain from working with certain groups. Their colleagues outside of government organizations, however, can act like advocates with more freedom to embrace the causes of their choice.

One of the major changes to occur in Chile since the military dictatorship and the transition to democracy is that technocrats left government and universities to work in private think tanks (Levy, 1996; P. Silva, 2009). Following Sheila Jasanoff's and Ann Keller's analysis, there are multiple implications for Chile. Technocrats who work outside state institutions have more freedom (less accountability) to propose policies as they choose. Those who work inside state institutions - more often called *técnicos* - implement policy and are closer to state power, more accountable to citizens and more constrained by the need to protect their scientific credibility from political demands. Técnicos should not be confused with bureaucrats who apply laws without questioning their legitimacy or effectiveness. Compared to technocrats, bureaucrats and técnicos have tended to be less educated than technocrats in Latin America, often only with high school degrees or diplomas, and work as tenured civil servants. Técnicos traditionally were specialized in specific areas like health or agriculture (P. Silva, 2009).

Rather than attempt to classify the multiple technical and political actors that participate in environmental regulatory policy, this analysis approaches this as a problem of boundary work, that is, as political processes subject to change. Science is malleable, a *terra incognita,* onto which actors invest effort and political capital to move and police the boundary between science and non-science (Gieryn, 1999). The objective is not to erase or overcome false dichotomies, but to understand the motivations, interests, identities and framings at stake. Whereas in the U.S. the great site for boundary work is the science/non-science boundary, in Chile it is the technical/ political boundary. The above classification between technocrats, bureaucrats, and técnicos (to which we have not yet added politicians, law-makers, experts or scientists)

often involves the same individuals who assume different identities depending on their place of work at that moment, the issues at stake, or the political juncture. And as identities change, so will bureaucrats' reasoning and discursive practices.

There is more at stake in this process of boundary work than a question of job titles. Attribution of integrity, relevance and credibility are on the line. Whereas many scientists and scholars assume that credibility results "naturally" from knowledge, STS scholars have shown that credibility results from social and political processes which can often be highly idiosyncratic and contingent. Above all credibility is a social phenomenon: it depends on relationships, familiarity and shared beliefs (Alagona, 2008). Sometimes shared beliefs include beliefs in certain quantitative tools, like cost-benefit analysis (T. Porter, 1995), or in specific methods for generating observations and clinical proofs (Epstein, 1996). Integrity and relevance are sub-sets of credibility; both are necessary but not sufficient conditions for there to be credibility. Given the importance of markets as the favored way of producing knowledge in Chile, integrity is often under suspicion by many who see bought science as dependent science.

Chilean scientists face the same trade-off between relevance and integrity described by Jasanoff and Keller, but the options facing Chilean scientists are much starker. Relevance means being capable of providing salient knowledge or useful answers to the questions being asked (Cash et al., 2002). Relevance requires that scientists participate and engage with others. Chilean scientists face two problems. First, often only industry provides them with opportunities to participate, creating a problem of integrity. This dissertation shows that just the perception of conflicts of interest is enough to undermine a scientist's credibility. Second, the state offers few opportunities for scientists to participate. As discussed earlier in reference to Appiah-Opoku's work on the EIA in Ghana, and in chapter 2 specifically for the case of Latin American science, developing states often do not know what to ask for from technical experts (Appiah-Opoku, 2005; Vessuri, 2007).

Another important site of boundary work lies in the technical-political distinction. Nearly everyone in Chile advocates for politics to stay out of environmental decisions; they advocate for technocratic "right" answers. Many frustrations are embedded in these appeals: technocratic solutions are imagined as ways to hold the state and politicians more accountable, to increase the voice of communities affected by large projects, and to achieve more stable, consensus-type decisions less prone to adversarial challenge. Not just in Chile, around the world many see consensus as the only true legitimate result of a decision-making process (Irwin, 2006; Mascarenhas & Scarce, 2004). Scholars, likewise, argue for broad participation in collective decisions with the goal of consensus both for normative (Lawrence, 2000; Owens et al., 2004; Rozema et al., 2012) and instrumental reasons (Fukuyama, 2007; Levitsky & Murillo, 2012). From an instrumental perspective, broad participation can raise the costs of protesting a decision, particularly if everyone agrees.

Consensus and technocracy both have their pitfalls, however. First, the technocratic tide can turn; in the U.S. technocracy is championed by those who want to restrict environmental regulations (Jasanoff, 1990). This is a key reason for favoring democratic decision-making that prevents the process from being held captive by small

minorities. Second, participation can be mere greenwashing if actors are invited to participate to obtain their approval under false pretenses, as many communities in Chile complain. Finally, consensus can also be an excuse to stifle dissent, marginalize alternative truths and create conditions for more conflict (Owens, 2002; Persson, 2006). In Chile, the boundary between the technical and political reflects efforts to promote consensus and stifle dissent.

Contra consensus, regulatory science emphasizes institutionalized forms of skepticism through "critical communities" (Jasanoff, 1990; Miller, 1998; VanDeveer & Dabelko, 2001). Meaningful participation must include critical communities empowered to challenge, protest and propose alternatives, a sort of bureaucratic organized skepticism (VanDeveer & Dabelko, 2001). In this view, conflict is an opportunity to change policies and values, discourses about resource distribution, considerations about environmental and procedural justice (Cashmore & Axelsson, 2013; Levitsky & Murillo, 2012; Sairinen, Barrow, & Karjalainen, 2010; Walker, 2010).

IV. The "special authority" of science in liberal democracy

The contrast between consensus and adversarial forms of decision-making, and between appeals to technocratic "right" answers and democratic participatory "right" answers, can be projected to the state level through the work of Yaron Ezrahi (1990). Ezrahi's main argument is that liberal democracies use scientific and technological knowledge instrumentally to depersonalize knowledge and constrain freedom of action. Under the attestive gaze of the liberal viewing citizen, liberal democracies use scientific and technical knowledge to communicate to citizens the rationale for choosing certain policies over others in the language (or theatrics) of statistics, reports, proofs, assessments and the like. Expert knowledge expressed in publicly available proofs constrains the range of legitimate actions a state can undertake. Scientific and technical knowledge thus is a disciplining force through accountability. In the language of regulatory science, liberal democracies have traditions of 'organized skepticism' and structural critical communities (Merton, 1973; Price, 1965).

Writing in a Cold War context, Ezrahi contrasted liberal democracy to totalitarian and monarchical states. In monarchies, hierarchy and social "heterogeneity" produce invisibility. In totalitarian states, despite the rhetoric of an attestive visual culture, "centralized control over the acts of seeing and displaying" distort this culture (Ezrahi 1990: 93). Authoritarian, totalitarian and monarchical states in these ways prey on inequality and its power imbalances.

Ezrahi's findings resonate with work in political science that argues that instability is more likely in democracies where a majority of poor citizens hold political power through the ballot box, but a few with economic power hold influence over Congress (Levitsky & Murillo, 2012). It is easy to imagine that in such a democracy, the powerful interests in and near Congress have no interest in producing "public proofs" of accountability or in being disciplined by scientific and technical rationalities. Research into firms' innovation practices indicate that in countries like Chile companies in fact have few incentives to invest in scientific and technical knowledge (Ross Schneider &

Soskice, 2009). Schneider argues powerful firms, many of them multinationals, have little incentive to invest in innovation and training where the state is pervasive but erratic and inequality so high, helping to produce what he calls a "hierarchical market capitalism". Authoritarian governments have also imposed disruptive and violent projects on poor populations, where science and technology blind the state and global institutions to local realities, often condemning interventions to failure (Mitchell, 2002; J. C. Scott, 1998).

These cases of authoritarian, hierarchical and liberal governments all highlight - by its absence or presence - that public knowledge used for accountability shapes the public sphere. In authoritarian governments like those described by James Scott, the public sphere is excluded and passive, and suffers from great inequalities. Ezrahi in contrast describes the U.S. as having developed a relatively flat and inclusive public sphere, where every citizen was imagined capable of accessing education, culture and freedom. But liberal democracies can vary - the UK for example had a hierarchical and unequal public sphere, where culture and freedom were reserved for the upper classes. Scientific and technical knowledge were seen as a threat by upper classes who wished to keep lower classes in check. In the UK public proofs become credible through the English aristocrat with a strong vocation for public service.

Ezrahi's description of scientific and technical knowledge in the UK would have sounded familiar to Chilean politicians of the 19th century who, reacting against the conservative, oligarchic and Catholic elites of the time, advocated for a scientific politics to challenge the status quo. In contrast to positivist ideals in Brazil or Mexico that were closer to August Comte's ideal of order, in Chile technocracy was reformist and middle class (P. Silva, 2009). Significantly, one of the Chilean technocratic leaders, José V. Lastarria, led the Radical Party and called it an "instrumental party". Lastarria and Ezrahi used the same word - instrumental - to denote the ideological use of scientific knowledge to depoliticize power. For Chilean leaders like Lastarria and Valentín Letelier, however, "science" was about internal logic and a secular humanism rather than empirical observation. It is noteworthy too that early Chilean technocrats appealed to scientific positivism as a social equalizing force much like some of their colleagues in the U.S. (Kettl, 2000).

The instrumental use of scientific and technical knowledge in collective decisions today faces two challenges: from publics and markets. Many scholars advocate for a participatory-turn in science-based decisions to improve legitimacy and lead to socially better decisions (Frickel & Moore, 2005; Iles, 2007; Kinchy, 2010; Nowotny, Scott, & Gibbons, 2001). Too often scientific and technical knowledge are uninformed or dissociated from local realities and thus promote policies that disenfranchise local actors. Michel Callon calls us to "democratize democracy" through new forums of participation and governance that challenge the two great monopolies of Western society: production of knowledge and representation (Callon, Lascoumes, & Barthe, 2012). These monopolies do not apply where the scientific community is small, so the state never had much of a monopoly on knowledge, and inequality is high, so representation is highly contested. Furthermore, in states like Chile, multinational and large domestic companies and other global organizations have always been powerful

challengers to the state. As good and important as more participation is, it alone will not make institutions more accountable without sacrificing stability in countries like Chile.

Markets are also challenging the state's capacity to instrumentally use science and technology. Neoliberal values and policies have further privatized scientific and technical knowledge production, changing how prestige and credibility are communicated to non-scientific audiences and how scientific practice is organized and funded (Lave, Mirowski, & Randalls, 2010). Ezrahi sees the market-turn from the perspective of government: he argues faith in science and technology are falling as information proliferates through surveys, public opinion, and increased recognition that knowledge is limited and uncertain. Furthermore, knowledge production is fragmented into many different laboratories and scientists, each competing for funds. The "Great Society" of before, led by a state confident of the knowledge at its disposal, is ceding to a "Facilitator State" whose task is to manage a cacophony of informed voices. In other words, this may be an era of increasing relative ignorance as actors loose confidence in what they know while facing increasingly complex issues (LaPorte, 1994).

These points are taken up in chapters 2 and 3 that discuss democratic and technical fantasies in Chile as solutions to continued problems with environmental information, legitimacy and accountability in the context of the EIA. One of the findings of this dissertation is that, despite the historical role of technocrats in Chile and the findings of STS scholars linking liberal democracy to the instrumental use of scientific knowledge, scientists in Chile are more or less marginal to power for a number of different reasons.

V. Science does not have "special authority" everywhere

Whereas scientists in the U.S. are regularly called to Congress to give opinions and share data, and in Germany are invited to participate in regulatory commissions (Keller, 2009; Jasanoff, 2006), in other countries scientists are not usually invited into government decision-making. For example, Hayden (2003) finds that Latin American scientists are weak middle men between local Mexicans who hold knowledge about plants' therapeutic properties and Northern pharmaceutical interests. As the Latin American scientists pass information on to the laboratories in the North, they often erase both the local roots of the knowledge that the international agreements seek to protect and their own scientific contributions. Science is "in no way a self-evident or clearly valorized concept" among locals (Hayden, 2003: 142). Wilkening (2004) finds that in Japan scientists have low prestige compared to political leaders. It took decades for atmospheric chemists to build a data set robust enough to support "bridging objects" to translate concepts like acid rain the public and government. In Peru, glaciologists were challenged by local elites, central government, foreign scientists and multinational energy companies, through periods of democratic and authoritarian rule (Carey, 2010). Scientists in Bolivia pioneered conservation policies by acting as "bilateral activists", a status they enjoyed by virtue of their foreign training and connections (Steinberg, 2001).

In these countries like in Chile, science does not have as consistent a presence as in the U.S. or European countries. Western science in Japan started in the late 19th

century. Though in Latin America it started earlier - usually during colonial times - its institutionalization has been haphazard. In all these countries science is seen as an imported activity.[17] Furthermore, these studies of scientific authority in non-Western countries highlight challenges to scientific authority not from indigenous groups but from multiple other sources, many of them thoroughly "Western", like local elites, economic and political interests, and the market. In Peru as in Chile market reforms have privatized, fragmented and further undermined scientific authority.

These challenges can be illustrated for Chile through the biography of Hector Croxatto, an accomplished biomedical researcher (Roblero, 1995). His university salary was too low to maintain a middle class living in the 1940s and 1950s; laboratory equipment and resources were scarce and dependent on political favors; academic rivalries between the University of Chile and the Catholic University interrupted his career and research; and his success got him invited to lead a project to reform university education. Croxatto had to answer to: "how could so many people and resources be dedicated to one laboratory, to study a substance that has never been found in nature, only in the lab in artificial conditions?" (Roblero, 1995: 89). In Chile, government and science administrators play the role of Bruno Latour (1979).

While scientists were called on to be "agents of modernity" and development, Latin American states have been fairly disinterested in science most of the time. Hebe Vessuri argues science was a poor means for controlling the population and could not be evaluated by government, and so was best left alone. "The state was not interested in the type of science offered by the small scientific community, and this community did not have the political, technical and cultural capacities to offer solutions or alternatives of practical and symbolic value that respond to the state's needs." (Vessuri, 2007: 345). These sentiments were echoed by a former Chancellor of the University of Chile: "Biomedical research is decisive to the country's health. Many doubt this statement. In particular, different governments and health administrators have behaved, and continue to do so, as if they did not believe this." (Lavados Montes, 1990: 113). Science has been small, elite, foreign, and irrelevant to local issues for states to worry much about. This is the main topic of chapter 2.

A Chilean civic epistemology?

If science is so marginal, yet important for accountability in liberal democracies, how does the Chilean state know about environmental risks and harms? The analytical framework civic epistemologies integrates the multiple elements that together produce regular "ways of knowing" in a society (Jasanoff, 2005). Civic epistemologies guides the study of a dynamic political culture as it resides in bureaucratic procedures. Political culture here refers to flexible categories like frames, boundaries, reasoning and discourse, and identities, that are both informed by and shape formal institutions.

[17] See forthcoming book by Eden Medina, Ivan da Costa Marques and Christina Holmes (eds.) *Beyond Imported Magic: Studying Science and Technology in Latin America.* MIT Press.

Understood like this political culture is critical for understanding how institutions function (Fukuyama, 2007).

Sheila Jasanoff developed civic epistemologies to synthesize observed differences in how advanced liberal democracies like the U.S., Germany and the UK come to know about the risks and harms of new life sciences (Jasanoff, 2005). Whereas the U.S. tends to adversarial forms of knowing, with an open contest of quantitatively expressed ideas, the UK and Germany have more tightly managed institutions for validating public knowledge. Consensus obtained through collegiate bodies that represent different stakeholders - including NGO and activist groups - is preferred in Germany. A communitarian approach where public figures of renowned prestige and merit - often together with a certain lineage - is preferred in the UK. These institutional channels include fora and mechanisms for critical communities to vet and challenge proposals, and produce alternatives, leading to a more legitimate process overall.

Civic epistemologies built on previous work, including Ezrahi's discussed above, as well as multiple other scholars who have remarked on the U.S.'s adversarial character (Jasanoff, 1990; Miller, 1998; Weber, 1998). Another influence was Theodore Porter's (1995) work on quantification. In the U.S.'s fragmented bureaucratic map, quantification was a useful way to convince other government agencies of proposed policies. France and Britain, with more centralized political authority and clearer hierarchical order, relied less on quantification. French engineers had sufficient autonomy and credibility to refuse to be held accountable to Parliament through quantitative analysis, and British actuaries could resist government efforts to regulate them through standards. In both European countries, social relationships and shared values among those with similar training maintained trust among institutions. Thus quantitative methods can replace trust where it breaks down and, as in Jasanoff and Ezrahi, provide a form of accountability in a depersonalized setting.

Chile is very different from these countries, despite some similarities. In the realm of similarities, Chile too has been since its independence a liberal democracy and has struggled with many of the same challenges: inequality, education reform, participation, and economic growth. The realm of differences is greater: Chile has been much poorer and constantly exposed (or subject to) foreign institutions. The legal code is largely from Spain, universities are a modified version of French Napoleonic universities, teacher training was modeled on the Prussian system, the Catholic Church was always a formidable power - and this is all before 1890. Professionals are trained in Chile, the U.S. and many European countries, and so do not share exactly the same ethic. Like the UK, Chilean elites remained a fairly small group bound by personal ties (Stabili, 2003). Authority remains hierarchical and centralized (Ross Schneider, 2009). So a Chilean civic epistemology would be closer to a British model, with comparatively little use of quantitative tools and more reliance on ad hoc expert bodies were experts are sustained by traditions, relationships and conventions.

Unlike Britain, Chile also has a strong "legalistic" culture with an attachment to bureaucracy similar to that found in other countries with legal and political traditions that link back to Spain. This tradition may have been accentuated by good governance notions that emphasize rule-following as good government, ignoring the importance of

bureaucratic discretion that is common in advanced, liberal democracies (Levitsky & Murillo, 2012). In the context of the EIA, for example, discretion to prioritize, evaluate and assess impacts is weak, and faced with ambiguous rules bureaucrats react by striving to be "hyper exhaustive" and produce information for every possible event (L. Contreras, 2000; la Maza, 2001). This dissertation observed these practices.

These observed practices do not result from bureaucratic stubbornness or curiosity, but from a civic epistemology that privileges reasoning and discursive techniques that appeal to narrow interpretations of procedural and substantive rules and regulations. This idea is developed throughout this dissertation, but it is worth noting certain similarities with findings from scientific forestry in Mexico. Mexican bureaucrats perpetuated certain statistical myths to protect themselves from being held accountable for processes they do not control (Matthews, 2011). To a certain extent, Chilean bureaucrats behave similarly; they protect themselves by sticking narrowly to the rules and shape knowledge to fit the rules. Future research should examine if countries with a Spanish colonial past share civic epistemology traits.

VI. Research design and methods

This dissertation analyzes three environmental conflicts as if each was an experiment in civic epistemology: the Valdivia paper and pulp mill whose pollution allegedly provoked the disappearance of hundreds of black-neck swans (2005); the Pascua Lama gold mine that threatened glaciers in the dry central Andes (2005); and the proposed construction HidroAysén, a project of five mega-dams in the Patagonia (2011). As experiments in civic epistemology, each case is very different. The Valdivia mill case generated an adversarial, court-room based conflict in an attempt to use the EIA to hold the company accountable for alleged pollution. The Pascua Lama mine case had a difficult EIA evaluation and required a political resolution. This occurred through negotiation, where glaciologists participated for each side rather than as mediators or brokers. Finally, HidroAysén's EIA had a difficult EIA evaluation through a highly bureaucratic procedure. Adversarial, negotiated and bureaucratic epistemologies are represented in chapters 4, 5 and 6, respectively. Unlike the situations described in the EIA literature, this analysis shows how the EIA itself becomes an object of controversy: it fails to legitimate projects, as in the gold mine and the Patagonian dams, and it fails to exercise accountability, as with the black-neck swans.

Studying controversies comparatively

Social controversies are "laboratories for studying how science and technology work in society" (Jasanoff, 2012: 439). Moments of controversy reveal the flows of trust and credibility that are normally implicit and hold relationships together so collective decisions can be made. Controversies then represents moments of overflowing, when the normal institutionalized channels of collaboration are not sufficient to broker an agreement. To study controversies is a political act, not because the researcher will know better whether a project should be built or if pollution occurred, but because the

researcher will hopefully make a statement about the cultural conventions and rules that hold our political lives together. Controversies challenge actors. Identities, rationales and discourses all need to be sharpened or redefined to respond to the challenge.

To study how technocracy contributes to good and democratic environmental governance this dissertation focused on one case, that of Chile, that seemed a least likely place for technocratic environmental governance to fail. As discussed above, Chile has succeeded in many conventional ways: it has steady economic growth and good institutions. And yet the frequency and intensity of environmental conflicts tell a different story. The technocratic approach failed often and visibly but led to calls for more not less technocratic government. How could this be? Newspapers and local actors tended to attribute failure to corruption and capture; these are large, powerful companies that the Chilean state relies on for money, jobs and growth. Chilean political elites are notoriously close to business elites (Ross Schneider, 2004). To study the causes of technocratic breakdown three moments of controversy were selected to maximize within case variation (Brady & Collier, 2004).

The controversies thus differ by industry sector (forestry, mining, and electricity) and business structure (Chilean family owned, multi-national and joint ventures). Compared to the U.S. or Europe, life in Chile is dominated by the influence of multinational companies and large diversified family-owned companies (Khanna & Yafeh, 2007). Different types of companies, in different industry sectors, relate to the state in different ways - there are different legacies of industry associations, collective bargaining, connections to regulators, etc. (Ross Schneider, 2004). Likewise, the controversies were chosen because each enrolled different expert communities - water chemistry, geology, glaciology, ecology - that reside at different universities (U. Chile, Catholic U., Austral, Concepcion), research centers, and regions of the country. If this is a story of capture, it involves capturing hundreds of professionals employed by the state, universities and private centers, at quite an expense in terms of time and money. Furthermore, similar patterns are observed across the three controversies, and it is unlikely such different companies would independently choose to capture the state in such similar ways.

The controversies also allow for a longitudinal analysis that reaffirms the general, bureaucratic lessons over circumstantial, capture aspects. The experiences of the earlier conflicts at Valdivia and Pascua Lama shaped the reforms of environmental institutions, including the EIA, in 2010 (chapter 3). HidroAysén's EIA process was finished up under the reformed system, so allows for some conjecture about the character of things to come.

Data collection

Data collection took place between November 2010 and July 2011 and proceeded similarly in each case. Data proceeds from interviews with participants in each controversy; EIA documents; and supporting documents from Congressional and Senate debates, legal histories and newspaper reports and opinion columns. Data was collected mostly in Santiago, reflecting Chile's high degree of centralism, as well as over

5 weeks in Valdivia, 6 weeks in Aysén, 1 week in Concepcion and 1 week in La Serena and Huasco. I also attended a number of workshops and meetings, some of them private, that inform the analysis. Data collection was informed by the civic epistemologies framework. This identifies six pathways through which public knowledge is generated: (1) who participates in producing knowledge claims, (2) what is the basis of trust, (3) what is considered a well demonstrated proof of concept, (4) what are the "registers of objectivity" in a society, (5) what are the foundations of expertise, or the relative importance given to formal qualifications versus different forms of experience, and (6) how visible are expert bodies to the public. For each controversy I looked for each of these things.

Respondents signed informed consent letters which require anonymity. Chile is a small country where "everyone knows each other", particularly in the environmental field. To protect anonymity equally, some genders have been changed and some institutional affiliations made ambiguous. Directors of government agencies and of research institutes participated gladly but often issued a disclaimer: "I can only give you the official line". Employees in government offices (e.g., reviewers) and in some companies were sometimes reluctant to participate; several asked that I not record the interview and wanted assurances that responses would be anonymous. The great majority of respondents participated gladly and many took several hours out of their day to talk to me. Companies were accessible and open once the right contact was made. More than 80 interviews were conducted with:

- Each of the three companies involved (Celco Arauco, Barrick Gold, and Endesa); including the directors for environmental issues, public relations and communications, and close collaborators who helped during the controversy.
- Consultants who prepared EIAs for each of the controversies.
- Academic scientists (employed at universities or research institutes) who worked on EIAs for each of the controversies or contested these.
- Government employees who worked in the review of each EIA or in managing the fall-out of the controversy after this occurred.
- Activists who led protests and opposition to each project.
- Environmental leaders who shaped Chilean environmental politics since the 1980s, including some of the architects of the EIA and of environmental science laboratories.

VII. Summary and outline

Chapter 2 and 3 build on the themes raised in this introduction about the role of scientists in politics and the appeal of technocratic politics for the specific case of Chilean environmental politics between 1980 and 2010. Chapter 2 focuses on scientists and their transit from engaged scholars in the 1980s to experts-for-hire after the transition to democracy. Chapter 3 focuses on technocratic politics and the need for legitimacy based on some form of consensus. It also provides details about the Chilean

EIA and how it operates. Together these chapters show that Chilean politics has changed towards more not less technocracy, combined with direct public participation, in ways that marginalize forces that seek to represent local communities and local versions of nature. Despite the appeal of technocracy or technical politics, the "technical" has nothing to do with the "scientific". So what does the "technical" mean? There is subtle yet persistent disagreement that reflects disagreements over what counts as expertise.

Chapters 4 (Valdivia paper and pulp mill), 5 (Pascua Lama gold mine) and 6 (HidroAysén dams) recount each conflict in chronological order. Rich descriptions of each socio-technical dispute are used to illuminate broader political processes.[18] The analysis is organized into four themes that reflect the civic epistemologies framework, defined below. These themes narrow the analysis - for example, the remarkable social movements that pushed these controversies are not the focus here - and treat the EIA as a "register of objectivity", where "objective knowledge is by definition reliable public knowledge, for such knowledge looks the same from every standpoint in society." (Jasanoff, 2005: 282). The EIA transforms disparate information about local ecologies, past conditions and expected change into official knowledge. Through the EIA environmental knowledge becomes permanent and, hopefully, useful to hold the state and companies accountable.

In contrast to registers of objectivity that rely on numbers and risk assessments, as in the U.S., or on balanced and representative inputs, as in Britain or Germany, the Chilean EIA registers objectivity defined by rules and regulations. Environmental impacts are not defined by statistics, probabilities, or estimates of risk but by article 11 of the environmental framework law (law 20.417). Not one piece of data is needed to determine if a project will have an environmental impact. Respondents agreed that in Chile, "the state can only do what it is explicitly allowed to do by the rules, while companies can do anything not explicitly forbidden". This is a rule-bound epistemology, and this dissertation seeks to document the negative impacts this has on democracy and environmental politics. Each chapter is organized as follows (table 4):

Stakes: this section narrates the main controversy and its broader political significance. Chilean actors still believe there is a trade-off between growth and environmental protection. Each controversy thus pits different views of development against each other, where communities are fighting to preserve their local livelihoods from national interests.

Participants: this section identifies the consultants, scientists, and government knowledge actors involved in each controversy. Expert participation is shaped by the market, and in each case participants were subject to different suspicions of conflicts of interest which drive distrust in the results. The authority and remit of science was often narrowed down by scientists who were quick to put limits on the capacity of science to

[18] Interviews were coded using Atlas.ti according to pre-defined categories informed from the civic epistemologies framework.

generate valid knowledge. New research institutes that tried to participate in these issues of public interest were usually expelled: their reputations were too weak, the threats of public participation too strong or their funding too erratic to participate in a meaningful way.

Illegibility: this section is about the conditions for participation. It is common for EIAs around the world to lack sufficient data. This section in each chapter tries to illustrate what this means in Chile. The lack of data was "a conversation stopper", according to an observer. Weather and water stations are few and far between, access is difficult and even simple census data is contested. Data has often been privatized with other formerly state-owned assets.

Standards of proof: how does the EIA close debates? In Chile, through bureaucratic necessity rather than with numerical proofs. Rather than decide on impact estimates, the Chilean EIA is decided on the baseline. These record existing ecological conditions (prior to the construction of the project) and have become the most effective way to exercise accountability. This raises difficult questions about accountability, a distinct and much more important practice than transparency.

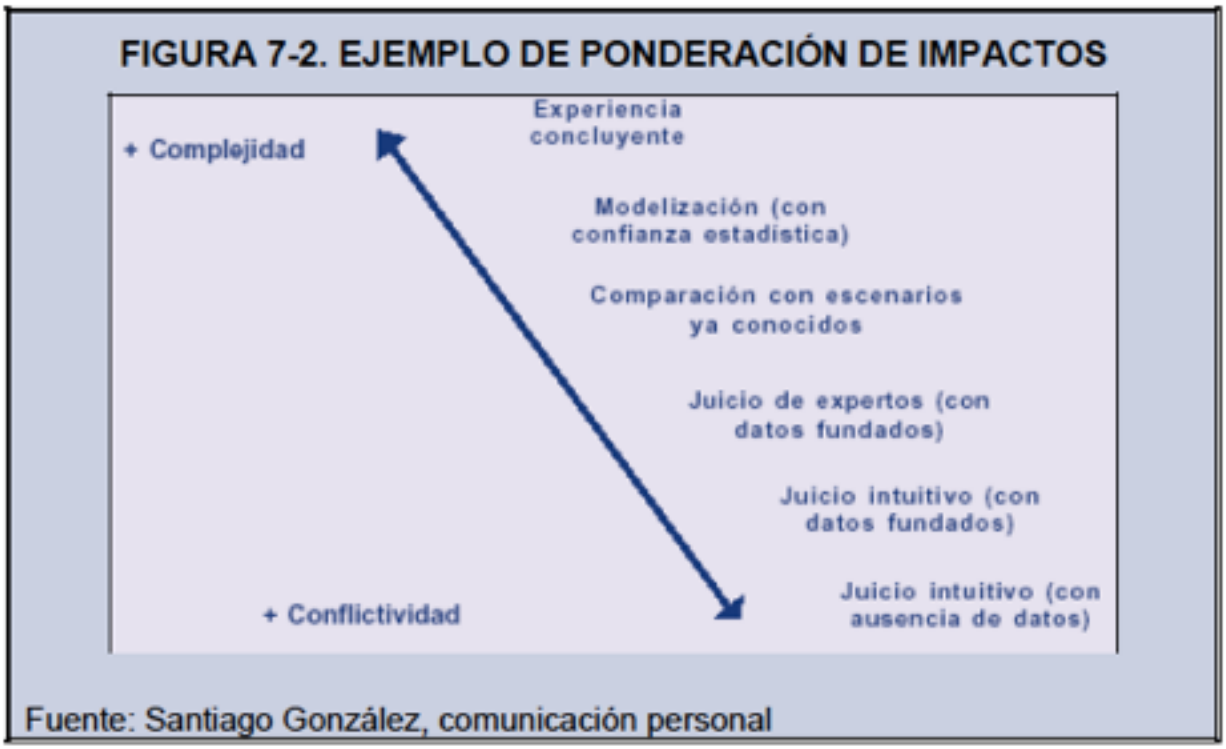
Table 4. Four dimensions of Chile's civic epistemology

	Chapter 4: Valdivia Paper and pulp mill	**Chapter 5: Gold mine**	**Chapter 6: Dams**
Who participates in producing knowledge claims?	Local & foreign, academic & consultants. Public lab excluded.	Academic and consultant glaciologists; many "burnt" by experience.	Consultants and academic scientists but local experts had to be excluded.
What is proof?	HIghly contested; proliferation of names and hypothesis.	Highly contested; resolved through political negotiation.	Highly contested; disputes spill out of the EIA process into the media.
What are foundations of expertise?	Very different expert groups called by different "sides".	Very different standards applied by each "side".	University affiliations, free from "conflicts of interest".
How visible are expert bodies?	Variable	Variable	Variable

Despite the predilection for technocratic environmental governance, scientists are not the preferred messengers of technical rationality. Respondents who consumed expertise - individuals in government or industry - could often not remember the names, areas of specialization or university affiliations of the scientists they worked with. When asked "who are the experts", responses ranged from silence to a list of Chile's important

universities. Some would say “we became experts as we went along”, and others would say the companies were the experts because they had data and field experience. Many in industry would say they had worked “with the best” or “an important scientist from [the U.S., Canada, Norway, France or Argentina]”. Figure 2 reflects the opinions of two architects and long-time participants of the Chilean EIA (Guillermo Espinoza and Santiago González). Increasing conflict is associated with expert judgement (bottom right corner). Increased complexity (presumably of the EIA or the impacts) is associated with quantitative models and “definitive experience” (top left corner). The figure helps confirm the trends described in this dissertation: expertise is difficult to demonstrate and experience is valued over credentials, but is hard for scientists to obtain because industry controls access to data and nature.

Figure 2. Example of how to weight impacts
Source: Espinoza (2007) *Gestión y Fundamentos de Impacto Ambiental. Axis not labeled.*



Studying the EIA

The EIA’s strengths are also its weaknesses. Set up as an administrative ‘single window’ the EIA is an easy target for protest because no other opportunities to contest the government’s development policies exist. As one government employee dedicated

to environmental issues said: “the EIA works too well” because it is the only reliable space for direct public participation into public policy on issues. It is also one of the few regular channels for scientists and experts to participate in collective decision-making, hired through the market. The EIA is thus a battle ground between two versions of global policy advice for developing countries - neoliberal, small state, free-market policies versus good governance, capable, strong institutions policies - just as it mediates between two constitutional rights - to free enterprise and to a clean environment. How the EIA resolves these tensions shapes under what conditions Chile will participate in global markets. Will it be a source of raw materials, or will it transition to produce quality products certified by credible institutions that promote good conditions at home?

Hebe Vessuri once juxtaposed First World “moral concerns” with the role of experts in frontier science projects that redefine our notions of life - like genetic modification or nuclear power - with Third World “anxiety” to use knowledge to climb out of poverty (Vessuri, 1987: 533). Such a contrast reflects a belief or tradition where countries like Chile received policies digested and tried by developed countries that had already worked out any moral reservations for us in the Third World. The moral implications of genetic modification may be more obvious than those posed by a bureaucratic quagmire like the EIA, but both seek to regulate nature and our access to it and therefore pose moral concerns. This is particularly so where poverty, inequality and disenfranchisement in multiple forms are at stake. Vessuri’s comment goes a long way to explain the marginalization of science as an issue of public concern in Chile.

This dissertation argues it is necessary to examine the role science in policy in Latin America. Scientific and technological knowledge is mobilized by different actors to produce public proofs that citizens can use to hold decision-makers accountable. Expertise can help avoid conflict by contributing to more stable and legitimate decisions. Scientific and technological knowledge is ultimately a forum for local representation: in this case, ecological conditions, potential impacts, and risks are supposed to gain institutional visibility. The experts who produce EIAs represent nature; ideally, they represent local versions of nature and have enough discretion to adapt rules to local demands. Throughout this dissertation what is at stake is the local and who is allowed to speak for the local. Increasingly, only the central government can do this as ministries gain new faculties and state employees are pushed to act more like bureaucrats and less like *técnicos* with discretion, following the reforms of environmental institutions in 2010.

Global policy recipes that focus on good governance or technocratic solutions fail on the ground with bad consequences for emerging democracy. Discontent and disbelief in the authorities seem to grow as steadily as the economy. Evidence lies not just in the demonstrations of the past few years, but in the calls for more technocratic government among young and progressive legislators (chapter 2), the feeling that each reform was a “missed opportunity” for something greater (chapter 3), falling voter turn out, and low levels of trust in surveys (figure 1). Capacity building, training, technocracy or clear rules do not transform decision-making without understanding the conditions that make scientists, experts and public knowledge credible.

Scientists' relationship to the state reflects dominant notions of the state. In Chile where the state is seen as a neutral broker scientists are asked to participate either as one more input nominally equal to others or as hands for hire for each side. Rarely do scientists have their own voice, and rarely is there any estate who speaks up for the common good. Scientists could be a voice for alternative ways of doing things. They could speak up to show environmental harms, biodiversity losses, risks and other problems. One of the most difficult questions to answer is why prestigious scientists participate in controversies through a system that constantly undermines them. Why do they hold environmental protection up to standards of proof and accuracy they know to be impossible? And why do they narrow down the scope and power of their trade, to survey landscapes before they are destroyed or work as the apologists of large companies that face piddling fines for environmental harms? The answers come back to a culture where rule-following is praised and discretion is frowned on, and where environmental harms are defined by legislators in a cavernous room rather than by scientists in the field.

Chapter 2. Science and Environment in Chile in historical, transition and democratic perspective

In the inauspicious context of the dictatorship, with the military in control of universities, scientists spoke up in favor of greater environmental protections. Every three years through the 1980s an academic think tank, CIPMA, organized large town hall style meetings about the environment. This space shaped Chile's environmental democratic transition as CIPMA members went on to lead the creation of Chile's first environmental institutions, including the new National Center for the Environment (CENMA). Created with aid from Japan, CENMA was created to advise the state on environmental issues and became "the best atmospheric science laboratory south of the Rio Grande". As the transition to democracy of 1990 approached, CIPMA members had a hopeful vision for an engaged science and a vibrant democracy that would awaken Chile's environmental awareness.

Yet as the transition progressed the market increasingly regulated scientific participation. Legislators felt different concerns had to compete "on equal footing" so no special place could be given to environmental science and research. As a result, academic titles were extended to consulting companies, scientific notions of pollution and nature were left aside, and funding for environmental science was left small and competitively disbursed. Even the smallest amounts of research money have to be publicly tendered through competitions decided only on price. Market-organized science like this is fragmented, discontinuous and unproductive, as best observed in CENMA's ups and downs.

Though very much a product of market-oriented policies, CENMA's trajectory is also typical of historic patterns in Chilean science. Universities in Latin America have survived major political storms but never really flourished - in institutionalist terms, they are both strong and weak. Latin American science has grown in what Hebe Vessuri described as a *coup d'accordeon* pattern: like an accordion, an influx of resources, enthusiasm and vision force scientific effort to swell. Equipments are bought, new buildings are dedicated to science, students sent abroad to train, foreign experts arrive for workshops and extended stays, and new longer-term research projects are laid out. Political change, events or personalities will then cause the effort to deflate. Activity falls to a minimum and scientists wait for the next *coup* - it often comes swiftly, unexpectedly and for reasons seemingly beyond the laboratory's control. For fifteen years CENMA has grown and suffered like this.

This chapter traces a brief history of science, particularly environmental science, in Chile from landscape surveys in the 19th century to the re-organization of universities and research institutes that began in 1973. Focusing on science, Chile is a colonial country where ideas have always come from abroad - first Europe, later the U.S. too- and faced the challenge of local adaptation. In contrast to policy analysis that attribute explanatory power to the foreign origins of policies like the EIA or environmental protections (Tecklin, Bauer, & Prieto, 2011), this chapter shows that these policies and ideas were not the only ones to be imported to Chile; rather, most ideas are imported.

The question is how technocrats, scientists, professionals, communities and leaders adopt and adapt these to local needs and goals.

With regards to scientists, the question of adoption and adaption remains unresolved. Specifically, for the better part of its history Chile has struggled to satisfactorily answer for itself how and why scientific and technical knowledge are useful where poverty dominates. Despite Chile's impressive growth, poverty persists and so too do questions about what scientists' proper role should be in Chile's development project. Whereas before 1980 the state had significant control over this debate - and as a result the fate of science reflected larger debates about secularization, education and economic growth - since the deregulation of higher education in 1980 the state has less control. On the one hand, the comparative evolution of different environmental science laboratories inside and outside state institutions highlights how commitments to a small state and low-cost markets undermine the production of credible public knowledge. On the other hand, the historical perspective this chapter adopts highlights that neoliberalism alone is not at fault; a state indifferent to scientific advisors is traditional in Chile. This chapter begins to explore what kind of good governance and development is possible without the participation of scientists.

This chapter begins with a theoretical and contextual exploration of the creole scientist, that person called on to apply his or her specialized knowledge to decipher local problems in universally recognizable ways. This serves as an introduction into Chilean scientific history - a sparsely documented field of inquiry - to illustrate how science was an engine of economic growth the state nonetheless kept at arm's length. This chapter then examines environmental science first during the 1980s at the CIPMA meetings, then as an input into the legislative processes that created and then reformed environmental institutions, and finally in the attempts to create environmental science laboratories. Since 1990 Chilean universities have grown tremendously but science less so. The chapter ends with a map of Chilean science: despite a lot of experimentation with market forces and new funding programs, its the same group of five universities that lead the country's research efforts. Scientific institutions like the National Academy of Science remain as marginal as always. Instead, a group of regional research institutes show more dynamism and engagement. Introduced here, several of these regional research institutes are protagonists in the controversies that follow.

I. The Creole scientist

Scientists have played an array of roles in environmental politics around the world. Scientists have sometimes rang the first environmental alarm (Hochstetler & Keck, 2007; Liftin, 1994), put issues on the policy agenda (Keller, 2009), or provided resources useful to marginalized groups (Kinchy, 2010; Martello, 2008). They have been activists (Steinberg, 2001) and helped shape environmental regulations at the international (Liftin, 1994; Ringius, 2001; VanDeveer, 1998) and domestic levels (Keller, 2009; Wilkening, 2004). Sometimes charismatic scientists like Jacques Cousteau carry the weight (Ringius, 2001), but more often communities must be built (Wilkening, 2004) and organizations – like the National Academies of Science or government research

labs – mobilized (Keller 2009). Often scientists are mediators. Their data, concepts and equipment produce bridging objects that actors in government, industry and civil society can agree on and recognize (Wilkening, 2004). They sustain negotiations among interests in conflict (Carey, 2010). And in Chile technocrats have acted as buffers between competing political parties (Silva, 2009).

In Chile scientists have not played these roles. Scientific organizations are few and relatively weak. Scientists themselves see the Academy of Science as an Ivory Tower. The Association of Research Universities (CRUCH) that lobbies for researchers and universities is a political body. Neither the Academy nor CRUCH emit reports that represent "scientific opinion", like the National Academies of Science do in the U.S. or different foundations do in the UK (for U.S. examples see Guston, 2000; Hilgartner, 2000). Furthermore, scientists usually get involved in controversies as hired hands on behalf of government or industry. Thus they enter a conflict on a side. Only EULA - introduced at the end of this chapter - has broken some of these tendencies. And Chilean scientists rarely have privileged access to data: traditionally intellectual activity was preferred to empirical work, and more recently privatization has raised barriers to access of data, equipment and field sites, as discussed in the following chapters.

Beyond the instrumental roles scientists play outlined above, scientists represent nature in ways that become universally valid and mobile. Science gives a particular kind of voice to local communities and their use of space, land, air and water that is recognized by others far removed from that specific place (Knorr-Cetina, 1999; Latour, 1983). In this way, scientists bridge local and universal spheres. Since independence from Spain, in Latin America science posed a special challenge, for in addition to making local natures globally legible, scientists were asked to do so in ways that made the new nations independent of the colonial power despite relying on colonial methods and tools. Like the creole leaders of the revolutions against Spain, the creole scientist integrated his European roots and training with a local outlook. In a sense the term creole science is redundant because all scientific activity is about this same process of reconciling local goals, needs and practices, with appeals to universal values, rights, and ways of doing and knowing.

Historians have described creole science as a distinctive form: "transnational or hybrid in its form and practice but as distinctively local in its goals" (McCook, 2002: 5). More recently, this notion was challenged by emphasizing the context that allowed this kind of science to flourish: creole science refers to "…a specific geopolitical context in which systematic knowledge of the natural world provided a basis for Americans of European and mixed ethnicity to assert their own authority and dominance over regional environments and their residents while living under colonial rule." (Cushman, 2011: 23). In both visions creole science is creative of a new order formed out of two old ones, the indigenous and the colonial. The creole represents, furthermore, an opening for a new identity and a space for new actions. This was the space occupied by new, Latin American elites and middle classes, including scientists.

Creole science is a useful analytical lens that will be used to highlight the negotiation and political use of foreign credentials and local identities. More so than alternatives like hybrid (e.g., Medina et al forthcoming: 21), creole is grounded in Latin

America's violent history between the West and something else. Criticized as Eurocentric, creole underlines science at the service of the also Eurocentric state. Latin America sits uncomfortably in the West. The discomfort results not only from the ever present lack of resources, modernity, development and power, but also from the lack of alternative identities. Increasing recognition of indigenous voices is welcome and overdue, but is unlikely to replace the West from Latin Americans' identities. Creole science is used to continue a tradition in STS work that has found that the "social" is much more than "interests" and the "local" is more than "indigenous" (Jasanoff 2004; Hayden 2003; Matthews 2011).

The approach in this dissertation seeks not to do away with binaries like local/ universal but to understand the political work invested by different actors in maintaining them. Following McCook, creole science involves certain practices and goals which may be distinctively local, different from the universal accepted practice. Creole science also calls attention to the geopolitical context that allows it to flourish, as Cushman emphasizes. Recent developments in Bolivian plant biology are an excellent example where biology is being enrolled to defend the nation's patrimony from foreign interests, as part of both a scientific and nation-building project (Centellas, 2010). Finally, this dissertation strives to look also at the use of creole knowledge (Edgerton, 2007). Looking at technology from the point of the view of the user, Edgerton illustrates that new technologies rarely helped a country develop. Adaptation matters instead, as technologies are introduced by foreign experts and made durable through creole adaptations. The challenge of the creole scientist is to mediate between these alternative identities, needs, and hopes for development, to reconcile them into a workable set of practices.

II. A legacy of science as an engine of economic growth

Initially part of a nation-building project, science has been seen more as an engine for growth in Latin America throughout the 20th century. Science is part of the development project both as an agent for economic growth and as an agent for modernity. This has led to two legacies: a weak institutionalization that reflects changes in economic policies and a troubled relationship to foreign ideas. These are explored below in relation to Chile in a Latin American context. This brief historical review indicates that science in Latin America still has not found its 'proper place' in part because it has not been considered an advisor to government or provider of public goods. The creole scientist has been asked to provide local responses to local problems although the institutions, funding and context for this to happen do not exist. Part of the challenge lies with accountability: for creole science to address the problems that affect most of society or of those most in need, as opposed to the problems of an elite, requires for stronger mechanisms for accountability than have existed in the past.

Science in Latin America is linked to old notions of modernity, cultural change, civilization and progress, where the Latin American is a little backward and has planted in his midst a "seed of inferiority" (Mignolo, 2005). The local and foreign are not equals and resulting tensions between foreign credentials and local identities are still important.

Latin American scientists can quickly become suspicious of foreign credentials, even among groups that worked together for years or among local scientists trained abroad (Lahsen, 2004). Scientists can also easily be aloof to local realities, because channels to exercise accountability often do not exist in Latin America, neither at the domestic nor international levels (Miller, 1998; 2004). Perhaps as a result of these deep suspicions and lack of mechanisms for control, scientists who participate in global environmental negotiations seem to confer greater legitimacy on decisions made through an adversarial process that generates more information rather than a consensual one (Andresen, Skodvin, Underdal, & Wettestad, 2000). In historical perspective, the World Bank is just the most recent source of foreign ideas to arrive in Chile.

During the 19th century the Chilean government made strides towards modernity by creating the University of Chile (1843) and executing large landscape surveys. Foreigners were protagonists in these achievements: Andrés Bello was from Venezuela and Claudio Gay and Amadeo Pissis from France. Gay and Pissis returned to France after their expeditions, taking their knowledge and experiences with them. Local actors like state agencies or the military gave erratic support to these expeditions and thus learned little from the experience (González Leiva, 2007). Chile was also lucky to receive two hard-working scientists in exile: Rodolfo Philippi from Germany and Ignacio Domeyko from Poland. Philippi made the Natural History Museum a world referent through his friendships with natural scientists in Europe, including Charles Darwin. Domeyko founded the Geology department at the University of Chile and pioneered studies of new minerals and mining technologies. Important as these achievements were, state funding dried up after Philippi and Domeyko passed away and the achievements of these institutions fell accordingly (Villalobos, 1990).[1] Even in the 19th century academic prestige required publishing abroad and foreign scientific cooperation did not always lead to lasting, institutionalized new practices.

Then as now, publication abroad is both a requirement and a threat for Chilean scientists. The number one way to demonstrate prestige and credibility for Chilean scientists is to publish in largely foreign, peer reviewed ISI indexed journals. However, it is difficult to gain and retain recognition abroad. This is illustrated by the experience of Hector Croxatto, a renowned biomedical researcher, that Chilean scientists today reported to be common: theft or lack of recognition of ideas and achievements (Roblero, 1995).[2] Croxatto published his most important research results in a Swiss journal; his biography regularly holds this up as the measure of his success and prestige. Just a few months after his publication a group of U.S. researchers published similar results and

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[1] The career and successes of Philippi are the subject of an upcoming book by Patience Schell, *The Sociable Sciences: Darwin and His Contemporaries in Chile.* Palgrave Macmillan, 2013. Domeyko's successes are chronicled tangentially in Villalobos (1990). Personal communication with Schell confirmed there are no monographs on natural science history in Chile. Schell finds that after Philippi's death the Museum quickly went into declined.

[2] Between 2009 and 2011 I conducted over 50 interviews with Chilean scientists in different areas (ecology, biology, chemistry, astronomy, geology, etc.). I didn't ask about these kinds of experiences but episodes like this were mentioned regularly. Two had personal stories about "theft" of work and ideas by foreign colleagues. A few others complained of "theft" of ideas by Chilean colleagues through the peer review process for research proposals. And several others had hear-say experiences similar to these.

kept the international credit over the Chilean. Though in this case the U.S. researchers issued a note recognizing Croxatto's prior authorship, the episode highlights that even if no bad intentions are involved Chilean scientists have a harder time raising their voice internationally.

Domestically, science and education in Chile are intimately related and have a long but small history. Between 1850 and about 1900 education was one of the battle lines between the Catholic Church and secular political forces. The ideology of positivism was used to counter the Church's control over the curriculum (Jaksic, 1989). As secularization progressed, after about 1900 scientific activity became professionalized. Engineering, law and medicine grew, but education and particularly higher education remained accessible to just a few. Education expanded dramatically only between 1950 and the coup of 1973, prompting concerns about the "mass university". Juan Gómez Millas, chancellor of the University of Chile and twice Minister of Education, led the expansion: new campuses of the University of Chile opened in regions across the country, biomedical laboratories were built, and new teacher training programs set up. Public centers of excellence that were accessible to middle class students existed (the Instituto Nacional, the Pedagogical Institute), but these were too few to provide opportunities for the majority of Chile's middle and poor classes nor to significantly change society towards more liberal and secular values (Silva, 2009; Vessuri, 2007; Villalobos, 1990).[3]

Science in Chile has also been tied to debates about economic growth. Areas like engineering and biomedicine flourished under import-substitution policies after about 1940, and then floundered as skepticism of import-substitution set in during the 1960s (Adler, 1987; Berrios & Saldivia, 1995; Vessuri, 2005; 2007). Since the free-market turn in the 1980s, countries are returning to science as innovation policy after a hiatus during the military governments of the 1970s and 1980s (Conicyt, 2001; Ministerio de Economia, 2009; Nelson, 1993; Schwartzman, 2008).[4] This contrasts with U.S. and European practices, where science recently came to be seen as an "engine for growth" (Etzkowitz, 2008; Popp Berman, 2012).

The challenge for 'science as an engine for growth' however is how to prove its usefulness to society. Hebe Vessuri recognized that governments in Latin America were largely ill-prepared to evaluate the results of science and often left this task to foreign foundations with different conceptions of merit, justice, relevance and scientific critique (Vessuri 2007: 231, 222; Cueto, 1994).[5] Yet without good evaluation, it is impossible to hold science accountable for its economic impacts. Scientists thus have a difficult time proving their relevance, at the same time that they have little autonomy because their funding is closely linked to development policies (Vessuri, 2007). In response scientists

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[3] More historical research is needed to disentangle the relationship between science and elitism. Chilean scientists do not come from Chile's "aristocracy" (Stabili, 2003). Nonetheless, scientists and intellectuals have argued for both keeping science as an elite pursuit and expanding social mobility through education.

[4] A well studied example is Brazil where the military government of 1964-1985 supported science and universities.

[5] Measuring the economic impacts of research and development is difficult, as the U.S. government is finding today as it struggles to implement the STAR metrics program.

themselves have argued their relevance to economic policies, though the generally low levels of funding for science in the region indicate scientists were only partially persuasive (Schwartzman, 1991). Both scientists and society in Latin America have not adequately resolved a question that has plagued us for a century: are science and technology relevant where poverty dominates?

Scientists and society generally replied in the negative. As a result scientists often retrenched into their disciplines and specialities (also called professionalization). Seeing themselves as agents of cultural more than material change scientists avoided empirical work (which was also hard to publish and fund); the continent has produced more intellectuals than scientists (Jaksic, 1989; Kreimer, 2007; Schwartzman, 1991). In the ideologically polarized context of the 1950s to 1970s, left-wing scientists replied to this question with arguments for locally appropriate, pro-poor science and technology, as opposed to foreign, Ivory Tower science (Kreimer, 2007). Visionary and critical, Argentinean scientists like Oscar Varsavsky, Amílcar Herrera and Jorge Sábato argued that science is a cultural and social practice so countries will have different 'development styles'. Scientists have a special responsibility to overcome poverty and under-development, they argued, until they were persecuted and forced out by Argentina's military governments. In Chile, biomedical scientist Humberto Maturana developed similar arguments but took them in a different direction by developing a biological theory of knowledge (Maturana, 1993; Maturana & Varela, 2009). Maturana taught many young scientists at the University of Chile to be aware of the social practices that underpin claims to objectivity. His work continues to be influential - several biologists, geographers and agriculturalists cited Maturana when asked about the public credibility of scientific knowledge, saying "objectivity does not exist".

The other source of skepticism in science came from right-wing government and business elites who argued it was cheaper to import science and technology than produce it locally. In this view, national scientific infrastructure and talent are so far behind the global scientific frontier it will be impossible to "catch up" by investing in research and development (Maloney, 2007; Nelson, 1993). This policy led to very low investments in research and development and to privatizing science and technology: each company must provide for itself. Not only do multinational companies have an advantage in this context, but the local government is left with no scientific or technical capacity. Another result of this policy is periodic booms in certain scientific areas, in the belief that strong investment in just one area will help the country "catch up" in that aspect. This policy continues to be very influential.

These debates, along with the growth of universities during the 1950s through the early 1970s, ended abruptly with the military coup of 1973. Destroying the University of Chile and private universities with a "public vocation" like the University of Concepción and Austral University was a strategic objective of the military government (Constable & Valenzuela, 1991; Jaksic, 1989; Monckeberg, 2007). Like in other countries, universities had been hot spots of left-wing activism of the kind most feared by the military government. Army generals replaced academic Chancellors and student places fell from 146,000 to just 27,000 seats, and 25% of staff were expelled (Brunner, 1986). Furthermore, under Pinochet's neoliberal, free-market policies, university policy

became a question of finance. The Higher Education Law of 1980 reduced funding, downsized universities and lowered hurdles for the creation of private universities. Supporters of reform argued competition would improve quality at no cost (Bernasconi & Rojas, 2004; Brunner, 1986).

During the dictatorship scientific activity was extremely low (Constable 1991, Brunner 1986, Jaksic 1989).[6] Academics turned to narrow, reductive and "safe" areas of research. Geography departments left human geography to focus on rivers and mountains. Historians focused on colonial times. Philosophy turned to the classics. Sociology practically disappeared. Demand for science within the military government was ostensibly very low. In contrast to the U.S., Soviet Union or Europe, weapons were bought from abroad rather than developed locally, so a "military-industrial complex" never developed (Graham, 1993; Price, 1965). In contrast to Brazil and Argentina, the Chilean military did not develop local computer, optics or material sciences (Adler, 1987; Hurtado de Mendoza & Vara, 2007; Schwartzman, 1991).

The trajectory of Chile's nuclear power program is illustrative: by the mid-1970s the Chilean government was ready to implement nuclear power, but Pinochet's military government canceled the program arguing it required too much state involvement (Tironi and Barandiarán, forthcoming). For twenty years the state had trained nuclear engineers, chosen a site for the first power plant, and negotiated contracts for technologies and materials with the U.S. and UK. This may be a unique case of a military organization rejecting a most coveted and difficult to obtain technology just when it was within reach. The episode is evidence of the strength of Pinochet's conversion to neoliberal arguments in favor of a small state where "low-cost" defined the social good. It also provides evidence that science and the military were not embedded with each other; if the government did not demand this kind of science, it would have no interest at all in ecology or water chemistry. There was just one partial exception that merits further research: Antarctica, where Chile has land claims. The military, along with geologists and glaciologists at the University of Chile, sent some research campaigns to the frozen continent, though these were sporadic after 1976 when a global moratorium on mining in Antarctica was passed.[7]

Finally, ecology did not exist in the 1980s. The first Chilean to receive a PhD in ecology was Juan Gastó, in 1969 from the University of Utah. He taught Agriculture at the Catholic University of Santiago from 1977 onwards, and there quietly trained a number of future environmental activists. Gastó also participated in the regime, heading an inter-ministerial Ecology Committee that left such a light imprint on politics that the only self-identified history of the environment does not mention it (see also Camus & Hajek, 1998; Nef, 1995). No one had much to say about this committee and its work. In sum, though under the dictatorship universities and scientists came under attack, there

[6] There are no known studies of laboratory sciences during the dictatorship.

[7] Interview with glaciologists, July 2009. See also chapter on Pascua Lama for CECS' program on Antarctica research with the military today. Very few studies of science and universities under dictatorship exist. See Constable 1991 for a gripping depiction of university life during dictatorship.

was also some continuity with Chilean science prior to the coup: neither the civilian nor the military states were very interested in using science for their own purposes.

III. Scientific environmental activism: the CIPMA meetings

In this rather desolate context where science was small, unappreciated and even persecuted, one forum emerged where scientists became active voices in favor of environmental protection and scientific participation: the *Centro de Investigación y Planificación del Medio Ambiente* (CIPMA). From 1983 and every three years, CIPMA held large town-hall style meetings about the environment.[8] Remarkable for the breadth and depth of participation, the CIPMA meetings were sites of activism in the midst of dictatorship. Voices from academia, civil society, business and some government participated. Three-hundred arrived to the first meeting in La Serena (1983), then 500 attended the second meeting in Talca, and more than 600 went to the meetings in Concepción (1989) and Valdivia (1992). The CIPMA meetings were probably the largest civilian gathering allowed at the time. Activists interrupted the 1986 meeting to protest the disappeared, with the U.S. Ambassador present, landing the meeting on the front page of the New York Times as a sign of possible cracks in Pinochet's government.

CIPMA's founders hoped for scientists to become active participants in the country's environmental policies. CIPMA's origins lie in a group of urban planners trained in the U.S. in the 1960s, including at Berkeley.[9] In the U.S. they learned about the environment, civil rights and justice, and returned to Chile during the reformist and revolutionary period of Frei and Allende wanting to apply those ideas. One such planner, Guillermo Geisse, took a position at the Catholic University and, after the coup, led those like him who were allowed to stay (because they were at the Catholic University and/or had family connections) to CIPMA. So CIPMA's origins are much like those of other academic units founded by scientists forced out of the university but allowed to operate from small, private academic organizations that later became think tanks (Levy, 1986; Silva, 1991). It was a tiny organization built around a handful of academics who turned towards the environment - rather than social issues - because it was below the government's radar and scientific. Similarly, Osvaldo Sunkel, an important progressive economist, reportedly considered the environment "safe" in those repressive times (Nef, 1995). Arguing they were "just scientists" interested in natural resources, CIPMA's researchers passed military control and got needed visas to travel abroad for conferences.

With universities under military control, CIPMA asked the Academy of Science to support its meetings. These were likely the largest, best attended public meetings the

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[8] This section draws on articles published in CIPMA's journal *Ambiente y Desarrollo* and interviews conducted in November 2010 and April-May 2011 with three individuals who participated in CIPMA's founding and in these meetings in the 1980s. In addition, I attended CIPMA's most recent meeting in Santiago in March 2011.

[9] See forthcoming work by Andra Chastain for more about urban planners prior to the coup.

Academy of Science was ever involved with.[10] Prestigious scientists gave keynote addresses, including physicist Igor Saavedra, ecologist Adriana Hoffman and Juan Gómez Millas. Igor Saavedra called on scientists to make science relevant to Chile's social needs through the environment:

> The inter-disciplinary discussion of Chile's environmental problems should serve to formulate concrete solutions to the problems that affect us, and who else but [scientists] to detect and solve these. If this occurs we will show the man on the street the value of science and technology, its capacity to solve problems and direct quality of life. A social consensus will emerge with respect to the importance of science and technology, indispensable to make these activities permanent and significant in the country. (Keynote address delivered in 1983 and published in *Ambiente y Desarrollo*, vol. 1, no. 1, pp.15-18, december 1984: 15).

The environment provided a special opportunity for the creole scientist of 1980s Chile to integrate the local and the universal, and prove his relevance to the man on the street, in terms reminiscent of the appropriate technology movement of the 1960s discussed above. Saavedra further warned the "Third World scientist" that he must make complementary two seemingly contradictory goals: to produce universal, excellent science, and to produce locally-relevant science. Whereas in the First World, two scientific communities exist, one dedicated to universal and the other to applied science, in the Third World each scientist had to fulfill both roles simultaneously. Third World scientists must have "audacity, a certain dose of imagination and a great generosity" (Saavedra 1984: 16). In essence the creole scientist has to be a little subversive in his attempt to turn science and technology away from its European associations towards a new local development and identity.

In addition, the creole scientist of 1980s Chile could not expect help from the dictatorial state, as Ernst Hajek - a prominent biologist - noted:

> Who can ask questions of and make relevant demands on the scientific community? Traditionally, few people with technical training work at decision levels where they can formulate demands on the scientific community. …Often scientists are accused of being stuck in their ivory towers, facing the Academy and with their backs to the country's real problems…. But scientists could also ask, and how do you enter that other ivory tower, the organizations where decision-makers work? Where are decisions made? Greater integration and closeness among these groups is required and desirable: those who generate basic research…, and those who apparently could know what the country needs to develop.

[10] No one was available for interview at the Academy of Science. Respondents generally did not have much to say about this organization.

(Address delivered in 1986 and published in *Ambiente y Desarrollo*, vol. 3, no. 1-2, 1986: 13).

Hajek's comment highlights the disconnect between science and the state, where the state does not call on scientists to participate as advisors to government. In referring to both science and the state as Ivory Towers, Hajek is raising a deeper question about who then represents local natures, needs and interests.

The CIPMA meetings provided such a space to express different and sometimes contradictory representations of nature, sustainable development and progress. While some scientists spoke of the joy, harmony and symmetry in nature, and admonished Chile to recover its image as "the happy copy of Eden", an allusion to the national anthem, other scientists admonished: "Scientists are expected to deliver an objective diagnosis of the key problems and ways to solve them."[11] Several scientists concerned about the environment argued scientists needed to help overcome the crippling "knowledge deficit" by identifying a portfolio of sustainable projects for different industry sectors, producing theories and methods to integrate universal and local concerns, and defining notions of quality of life. Thus scientists expressed two different visions of their role in society. One group reflected a Humboldtian tradition of natural virtues, listed as discrete elements of beauty in harmonious relationship - flower-covered prairies, snowy peaks, the ocean, blue skies, while the other was concerned to connect science to policies that would alleviate poverty and produce growth (Cushman, 2011; Nef, 1995).[12] These alternate visions are grounded in the yet unresolved question about the proper role of science where poverty dominates, and contribute to the controversy around the dams of HidroAysén that is partly animated by this Humboldtian environmental nostalgia (chapter 6).

But what credibility did Chilean scientists, stuck in their Ivory Towers as Hajek argued, have to deliver policy promises or represent a harmonious nature? This is difficult to answer because the government's view is not well represented at the CIPMA meetings. Business interests seemed more interested in listening to the scientists, as long as they provided clear answers: "Once society knows what it wants, it needs to send us a clear signal."[13] Industry and some scientists did not want environmental concerns to go too far. Ecology in particular was criticized as a poor tool to know nature. Business representatives argued science had a mandate to provide objective information, in contrast to ecology-infused activism. Scientists given the stage and room to publish in *Ambiente y Desarrollo* criticized ecology as too new and plagued by methodological disagreements to usefully interpret nature, and associated it with activism, calling this "too ecological" and "passionate". Finally, scientists undermined themselves by preferring foreign credentials to local ones. An article titled "The opinion

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[11] The first comments were made by Hector Croxatto and Adriana Hoffman at the 1986 meeting, and reported in *Ambiente y Desarrollo* in 1987 (no. 1 & 2). The longer quote is from *Ambiente y Desarrollo*, vol. 4, no. 3, pp.7-86, 1988: 77.

[12] The Chilean national anthem lists these elements - prairies, oceans, snow-peaked mountains. The full text in English is available here: http://en.wikipedia.org/wiki/National_Anthem_of_Chile

[13] *Ambiente y Desarrollo*, vol. 4, no. 3, pp.7-86, 1988: 83.

of a Chilean scientist from Harvard about the first Scientific Meeting about the environment" illustrates the multiple and not-so-subtle ways in which foreign credentials are preferred to local ones, raising the bar for local legitimacy.[14]

As the transition approached, the unexpected activity and sense of community created by the CIPMA meetings faded. Scientists withdrew from the public sphere and from positions of environmental responsibility. No scientist delivered another keynote address at CIPMA meetings after 1990; the 2011 meeting was dominated by legislators, industry and a few activists. The Academy of Science became an invisible sponsor of the event; again in 2011 industry sponsorship dwarfed the Academy's tiny logo on the large screen behind the stage. A proposed joint industry-academia journal never took off and, as this dissertation shows, industry continues to have inaccurate expectations of science. The democratic swell of support for environmental causes that CIPMA's founders expected never materialized.[15] While CIPMA's leaders attribute this to multiple causes - poor education, fragmented and depoliticized citizenship, inattentive political elites - it may also be because the promises of environmental reform transformed into a less than inspiring technocratic environmental management. CIPMA's 1992 meeting adopted this theme. Previous ideals like quality of life were abandoned and new ideals that could have been adopted - like environmental citizenship to underscore the reclaiming of rights under democracy - never made an appearance in public debates. Instead, "environmental management" was the chosen rallying cry for the 1992 meeting.

This was a technocratic turn because reform was led by lawyers and engineers, Chile's traditional technocratic professions, rather than scientists or activists. In effect a small group of policy entrepreneurs formed around Rafael Asenjo, a lawyer, and Ricardo Katz, an engineer who led a group of atmospheric engineers (Kingdon, 1995; Sabatier, 1988).[16] It was also technocratic because CIPMA transitioned from town-hall style debates to political party think tank, a role it still fulfills. In 1986 CIPMA began reviewing foreign experiences with the EIA, and in 1989 both presidential candidates addressed the CIPMA meeting. In 1986 the World Bank had less than five people employed in its environmental office and several years would pass before it embraced the systematic use of the EIA (Wade, 1997). In this new role, CIPMA sought to propose the right mix of policies to solve environmental problems. Ecologists, biologists and other natural scientists never again publicly participated in environmental policy debates.

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[14] *Ambiente y Desarrollo*, vol. 1, no. 2, pp.123-27, 1985.

[15] *Ambiente y Desarrollo,* vol. 20, no. 3 - vol. 21, no. 1, pp. 35-45, 2004-2005.

[16] Asenjo and Katz formed a group of policy entrepreneurs because they shared core ideas, policies and values to react to external events. Twenty years later they remain active; Asenjo has just been named one of the first ministers to head Chile's new Environment Tribunals along with Juan Escudero, an old and close collaborator of Katz. A question for further research is how clear the notion of "the problem" was in this case.

II. Environment and science in the democratic legislature

Post-dictatorship, Chilean law-makers had rather superficial ideas of nature and science, based on anecdotal personal experiences and informed by a strong commitment to the market as the best way to organize and distribute goods, including knowledge. Over time, legislators learned about nature through the EIA, but less so about science. This section integrates legislative debates in two periods - 1990-1994 and 2009-2010 - to examine changes and continuities in ideals about nature and science.[17] The analysis is organized into three thematic sections. The first recounts how nature was introduced into government and translated into a matter of concern through the law, not science (Latour & Weibel, 2005). The second focuses on the introduction of markets as the best way to produce environmental knowledge, and the marginalization of scientific experts. And the third reports the brief appearance of "academic" as a title of distinction.

Overall, between 1993 and 2010 the EIA transformed legislators' ideas about nature and the environment, from superficial ideas about billboards and litter to deeper concerns about equity and access to a clean and healthy environment. Legislators, however, did not draw on science in this transformation. Each time science was eschewed for other processes - the law, markets - so that questions about the appropriate role of science in society remain as relevant in 2010 as they were under dictatorship, the socialist turn of the 1960s and previous eras.

Rendering nature legal to make it tractable

"The difference between the earthly paradise of Adam and that of Chile is that in this country there are no venomous snakes."[18] The opinion of Spanish Jesuit colonialists was evoked by Senator Eugenio Cantuarias, in May 1993, to lay out what was at stake in the approval of the environmental framework law. Cantuarias was a university professor in chemical engineering and appointed mayor of the industrial port city of Talcahuano by Pinochet in the 1980s. As one of the few legislators with scientific training, he had a particularly scientific view of pollution problems in the early 1990s:

> I would like to mention a situation that is rather shameful. Talcahuano has long been recognized as a heavily polluted city with very unpleasant smells. Everyone knows the smells are produced by the fishing industry. But – and this is incredible – only ten years ago could we determine the name of the element that generates these odors and its physicochemical properties. Before this discovery, despite all our efforts, from a strictly technical perspective, a real solution was impossible. (Legislative History 19.300: quote 80)

[17] Material and quotes in this section are from the Legal Histories of laws 19.300 (1994) and 20.417 (2010) that create and reform the Chile's environmental institutions. Legal histories are compiled and distributed by the Chilean Congress. Quote numbers correspond to my Atlas.TI database.

[18] Legislative History 19.300: quote 70

This is the most specific personal experience with pollution and science raised in the early debates. Other examples include air pollution in Santiago, a landslide that occurred as Congress was in session, and issues related to landscapes: billboards by the roadside, trash on beaches, and dams flooding waterfalls.[19] A few non-personal experiences were mentioned: industrial disasters like Bhopal and Chernobyl, an inventory of 180 environmental problems across Chile compiled by urban planners from the Catholic University, and the Pangue hydroelectric dam that was then displacing indigenous communities in southern Chile.[20]

Poverty, indigenous communities and justice were rarely mentioned, in contrast to an emphasis on the moral duty to have "respect for others" and assure the fundamental "integrity" and development of man.[21] The Senate resisted adding "equity" to the definition of sustainable development, as proposed by Congress. Senator William Thayer, a collaborator of Pinochet and former Chancellor of Austral University, claimed "…I do not see how improvements in quality of life, if they are rational, can be inequitable."[22] Bruno Siebert, also a Pinochet-era politician, nostalgic for the lost waterfall at Pilmaiquén he visited in his youth before a dam flooded it, argued that "To educate in environmental values not linked to the moral notion of respect for others can lead us to extremes and to distort young people's values, placing environmental protection over other goals like economic development, overcoming poverty, and improving people's quality of life."[23] Although equity was finally added to the law, the notion failed to change attitudes. For example, then Senator Sebastián Piñera argued that no one thought it desirable to legislate air quality standards in response to the needs of people with lung disease.[24] Any notion of environmental justice was absent from political debates.

Instead, environmental harms were rendered legal to make them objective. Relatively unconcerned by equity but very concerned with economic growth, representatives on the ideological right successfully argued that pollution should be defined according to legal emission standards rather than "subjective" notions of human health and quality of life. Cantuarias, the same representative that spoke of the need to know about toxicity to manage pollution, defended this legalistic vision:

> A polluting substance or element, in the literal sense, is everything that alters natural environmental conditions. For example, our breathing is, obviously, a form of pollution, and those who smoke double or triple it. But what does the Constitution guarantee? Not that we stop breathing or smoking, but the right to live in an environment free of pollution, that is, an

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[19] Legislative History 19.300: quotes 216, 465, 90.
[20] See chapter three for more discussion about these.
[21] Recent public opinion research by sociologists shows that environmental protection is still seen as a need for greater mutual respect by most Chileans. Personal communication with Manuel Tironi.
[22] Legislative History 19.300: 525
[23] Legislative History 19.300: 222
[24] Legislative History 19.300: 224

> environment that does not alter natural life conditions. What will signal those limits? The law. And when the limits are exceeded, we will be in the presence of pollution. (Legislative History 19.300: quote 205)

Another legislator argued that to define pollution on subjective notions of quality of life offered "a very perfect definition from the scientific perspective of what a pollutant is…if we use this as the basis for legislation, we enter the world not of ecology but of ecologism", that is, environmentalism.[25] Representatives wanting to restrict environmental protections argued only the law was objective.

Legislators also marginalized science when attempting to define "natural patrimony". Protected by the 1980 constitution, this definition would have many impacts over what aspects of nature would receive protection. Scientific definitions grounded in economics or science were finally abandoned in favor of ambiguity. Senators on the ideological right, including Sebastián Piñera, first argued that "natural patrimony" should be defined through a region-by-region inventory of places that are "unique, scarce or representative". But these adjectives elicited enormous disagreement and some anthropomorphism that merits further investigation: some non-endemic trees like the poplar and willow had gained "citizenship rights" long ago, though they are not unique, scarce or representative of Chile as are endemic species like raulí, coigüe, mañío, radal, peumo, quillay or boldo. Senators Nicolás Díaz and Sebastián Piñera replied these trees are "original ethnicities" and "that is what the indigenous law is for", and went on to advocate instead for replacing the contentious adjectives with "valuable".[26] Piñera's definition of value was straight from an economics textbook: scarce and useful goods like diamonds are valuable, but not air. Piñera did not prevail and Senator Jaime Gazmuri dismissed the discussion arguing that the suggested inventory of places was "scientifically and technically impossible" because beauty is subjective.[27] In this way, an ambiguous patrimony was clearer to legislators than a messy discussion about scientific notions of value and scarcity.

By 2010 legislators had more personal experiences with environmental conflicts in their districts: energy projects at Los Robles, San Pedro, HidroAysén, Villarica, Castilla, Guacolda, Campiche, and La Higuera; threatened rivers like the Copiapó, Caren, and Choapa; mines and industry at Los Pelambres, Tocopilla, Chañaral, Chuquicamata, Ventanas, Puchuncaví, Antofagasta, and La Calera. The absurdity of the EIA system was repeatedly denounced. For example, a park with native trees was built in Buin, a town south of Santiago, to mitigate environmental costs from a project, as negotiated through the EIA. One month after the park's inauguration, the city government sold it to another company to be used as a waste dump. The cases examined in this dissertation – Pascua Lama, HidroAysén, Celco Valdivla – were repeatedly mentioned during the 2010 legislative debates.

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[25] Legislative History 19.300: 208
[26] Legislative History 19.300: 460
[27] Legislative History 19.300: 498

Producing environmental knowledge through markets and politics

Just like science was not a foundation for legal concepts, neither did it serve as an input to learn about nature. In the early 1990s scientific research informed legislators on rare occasions. The most specific example was this experience reported by Senator Ortiz:

> In my office I spoke with professors from the Department of Geography of the Catholic University of Valparaíso, who did a very important study of the environmental impacts produced in [Aysén region] by the eruption of the Hudson Volcano[28]. They delivered relevant data, such as data on water contamination, loss of useful lands, destruction of flora and fauna, etc.
> Given the seriousness and importance of this research, I attended a meeting with his Excellency the President of the Republic (together with professors Victor Constanzo and Felipe Guerrero), to deliver to him the technical data and photographs. I took advantage of the opportunity to ask the President for aid for the region, suffering under the terrible effects of the volcanic eruption. The Head of State, after this visit, has requested important studies from the Catholic University of Valparaíso. (Legislative History 19.300: quote 101)

The Senator's comments illustrate a weakly institutionalized science that is produced on political demand without much regard to institutions like scientific autonomy.

The market for environmental knowledge production had to be free and fair: the environment could not be prioritized over other goals. Congress proposed a new Fund for Environmental Protection to support projects "relevant to the environment". But representatives on the ideological right - including now President Piñera - opposed it because projects with environmental and non-environmental goals would not be competing "on equal footing."[29] Though the fund was approved, it was very small - enough for two to three projects per region per year - and the Director of Conama can only approve projects of less than US$22,000 (500 UF). Any project over this amount must be publicly tendered and supervised by a higher authority. Yet this Fund for Environmental Protection was the only measure taken to reinforce the role of science in environmental management. Other proposals were discussed and rejected, including: to encourage the national science agency to fund environmental projects; to create national environmental accounts; and to create an "Institute of Environmental Quality" to integrate public and private research and strengthen the state's technical capacity.[30] Generic statements in favor of "incentives to rationalize in a scientific way stages of production" or the need "to educate the community based on some scientific information" were occasionally spoken but rarely picked up.[31]

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[28] Hudson erupted in 1991 with a volcanic explocivity index of 5 (the largest recorded is 8).
[29] Legislative History 19.300: 149
[30] Legislative History 19.300: quotes 367, 405, 113
[31] Legislative History 19.300: 90 and 381

How to produce information for EIAs was not an issue at this time. In a legislature where most representatives agreed that a market was the best way to produce environmental science, and that no steps had to be taken to improve the nation's environmental science capacity after twenty years of dictatorship, whether and how to regulate consultants for the EIA was not a question. Twenty years later concern about information and science had grown, but still then just a few Congressional representatives raised questions about Chile's market for environmental consultants: "I don't think it is reasonable that the same company call and hire whoever they want, because in this way the consultant is captive, on its knees, and can not generate an independent report, that looks out for the common good because it must look out for the company, that it gets its project approved."[32] Though a number of legislators in 2009-2010 advocated for scientific and technical voices to play a greater role in environmental politics to counter partisan politics, the term "science" was used rather superficially because with few exceptions legislators did not question the conditions of knowledge production.

Giving and withholding academic titles

In 1993 as the debate over the environmental law began scientists were portrayed as silent heroes but then little was done to give them a special role. "From the beginning of our history there have been in Chile men and women who have alerted us of the fragility of our land and who protected our natural resources. Many worked in silence, often misunderstood and with little support, studying the resources of the nation and deciphering her riches. Most of society, however, lived with their back to our own land and the opportunities it offered."[33] President Aylwin, here addressing the Senate in 1992, invoked classic struggles of the creole scientist - misunderstood and isolated in a context of indifferent people. An Advisory Council to Conama was supposed to help remedy this situation.

Participation and representation were central to the original proposal for the Advisory Council, with two members each from academia, environmental NGOs, business organizations, labor unions and a representative of the President. Proposals were made to increase private voices on the Council. Senators proposed additional representatives from "private entities dedicated to research on environmental issues", meaning environmental consulting companies, and from the Armed Forces, even in replacement of NGO representatives. In 2010, new private interests - this time from private universities - were proposed. The Advisory Council finally did not include Armed Forces or private universities, but includes consulting companies. The vision for the Council is that of a Noah's Ark that "balances out different estates of society".[34]

In contrast, the role of scientists generated little debate. Congress considered it "unnecessary" to specify that academic representatives should be "scientists

[32] Legislative History 20.417: quote 916
[33] Legislative History 19.300: quote 9
[34] Legislative History 19.300: quote 158

specialized in the environment" and extended the title "academic" to consulting companies.[35] Political representatives in government and the Association of Research Universities (CRUCH) appoint scientists to the Council; no one is concerned about scientific autonomy. After all the debate, scientists do not see the Council as a very relevant institution. Few want to participate and the same individuals take turns to sit on the Council. Engineer Ricardo Katz, a CIPMA participant and policy entrepreneur during the transition, has often been on the Council representing consulting companies. Though it is important in rule-making, where it can cause delays by failing to muster sufficient quorum at meetings, the Advisory Council has not lived up to expectations.

Furthermore, legislators rejected a proposal to allow individuals who hold a masters or PhD degree, but not a professional degree, to be employed at the environmental agency. Chilean law requires civil servants to have a professional degree. Academic degrees were rejected because these have no legal recognition to certify their credibility: "If tomorrow someone appears with a degree from the University of Paramount, Vernon North or whatever else, who would be able to evaluate that?"[36] Whatever practical effects this modification might have had on employment, the two debates point to how flexible and undefined the academic title is in Chile. "Academic" was extended to consulting companies to include them in environmental institutions and used to exclude others (those with PhDs but no professional degree) due to unexpected concerns about quality. No other concerns about certifying the quality or credibility of knowledge were raised by legislators throughout these proceedings.

In 2009-2010 the question of the appropriate role of scientists in decision-making again split legislators, this time on along generational lines. Legislators under age 50 who began their careers during the dictatorship as government employees or in business advocated for more scientific/technical views than those who began their careers before the 1973 coup. The generational divide overwhelms party-differences. Young legislators on the left and right agree on "more technical" politics, and older legislators of any party agree on "more politics".[37]

By 2010, many considered the political subversion of technical assessments as the root cause of environmental conflicts. "No more politicians in charge of exclusively technical issues! …The usual thing is for a technically trained person to [revise and approve EIAs], with knowledge and skills, and who is also committed to defending our natural patrimony and good living conditions."[38] The EIA process "erases with the elbow what was written with the hand" as projects are approved, under political or business influence, despite observations to the EIA. A legislator from the conservative UDI party

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[35] Article 76, Law 20.427 specifies members of the Advisory Council. Numeral (a) "two scientists, proposed from a list by the Association of Research Universities"; Numeral (c) "two representatives of independent academic centers that study or work on environmental issues". Numeral (c) means consulting companies. Numeral (b) adds NGOs; Numeral (d) adds business; Numeral (e) add labor; and Numeral (f) adds the President's representative.

[36] Legislative History 19.300: 348

[37] Of the young congressional representatives cited here three are from left-wing parties and one from a right-wing party.

[38] Legislative History 20.417: 348

argued for raising the standards of evidence: "No one can act according to impressionistic criteria, typical of chileans: 'I'm surprised by… I believe that…'. No, here is pure science put at the service of the nation."[39] Ideologically left-wing legislator Guido Girardi claimed he was even nostalgic for the dictatorship because then technical reports were respected, and Marco Enríquez-Ominami hoped the environmental authority would have autonomy like the Central Bank.[40]

Seasoned senators on the left and the right could not disagree more with their younger colleagues. Andrés Allamand, of the libertarian RN party, replied to Girardi that:

> In the "technical" realm there are no absolute truths. And given this reality, what is the only forum that can distinguish between right and wrong? Obviously, a political forum...To subordinate political decisions to technical expertise is absurd. (Legislative History 20.417: quote 316)

On the political left, two influential politicians - Jaime Gazmuri and Camilo Escalona - argued that:

> A completely autonomous environmental authority … would negate the principle of a government's political responsibility.… I am very critical with what we have done [with environmental policy], but that does not lead me to think that complex problems should be handled by organisms autonomous from political power. That was already tried and it corresponds to Plato's old idea of 'government by experts'...It is not practical." (Legislative History 20.417: 319)

> Economics is too delicate to be left to economists…The point is to vindicate the role of politics and the politicians. Because it is very difficult to conclude that the affairs of a society, involving the interests of millions of people, of the State, of countries, can be solved within the narrow boundaries of a specific profession. And there is a specific area of political responsibility, which is the concern for the common good or national interest, as Rousseau said. (Legislative History 20.417: quote 327)

Finally, from the ideological center, then Secretary of State Edgardo Boeninger shed further light on the administrative relationship of science and politics:

> Many things can not be defined with absolute precision. In these cases, we draw from procedures that guarantee that different opinions will be heard and that the criteria [for decision-making] will result from a certain amount of consensus, that assures decisions are not arbitrary. The only way to achieve this, when there is no precision that can be summarized in

[39] Legislative History 20.417: 344
[40] Legislative History 20.417: 311

> one number, quantity or indisputably clear concept, is through a procedure that gives maximum assurances [of consensus]. (Legislative History 20.417: quote 230).

Legislators who began their careers before 1973, on the left and the right, advocated for politics over technical or scientific rationality. Above all they reject the idea that immutable, knowable, unique truths exist. It is important to emphasize that these politicians - Allamand, Escalona, Boeninger and Gazmuri - are among Chile's most influential politicians. In contrast, those closer to age 40 than to age 70 advocated for more scientific and technical rationality. Ominami makes an almost ironic neoliberal environmental plea: an autonomous Central Bank is the epitome of technocratic politics and a core demand of neoliberal economists. Does this reflect a stronger democratic commitment among those legislators who lived the coup and its aftermath? Does it reflect how neoliberal ideas of good government have permeated even the most progressive and environmentalist positions?

In addition, it reflects different ideals of science among generations - in one case as unreliable and authoritarian, in another as enlightened and effective. It is an ideal of science where scientists do not figure prominently. Instead, the enlightened and effective alternative is ambiguous, linked to state institutions, and rather divorced from concerns about how knowledge is generated. For example, one young legislator diagnosed the problem thus: "The [Environment] Ministry must distribute and generate more research. On environmental issues, often we do not have bibliography of research conducted in our own country,"[41] and the adopted solution focused on giving the Environment Ministry the faculty to collect, organize and store information. As discussed further in chapter 3, the production of knowledge was left to the market as before.

III. Environment and science in the laboratory: the pitfalls of neoliberal science

Outside the legislature, the newly democratic Chilean state met efforts to create new environmental laboratories with skepticism. Instead of building a national laboratory to provide the state with credible scientific advice, the state channelled these efforts towards the market. Publicly tendered science, however, proved to be an unreliable advisor to government. This is the experience of CENMA, the National Center for the Environment (*Centro Nacional de Medio Ambiente*). A project of the Japanese Aid Agency (JICA), CENMA was supposed to produce official information for the government on the model of Japan where central and regional environmental agencies have in-house scientific capacity. JICA aspired to demonstrate that government data is useful, and replicated the experience in Mexico, Indonesia and China.

In Chile, a commitment to a small, competitive state not allowed to privilege any source of information hurt CENMA's fortunes and illustrates the *coup d'accordeon* pattern typical of Latin American science (Vessuri, 2007). Publicly tendered science selected only on price has produced a fragmented and superficial expertise that does

[41] Legislative History 20.417: quote 233

not add up to robust notions of public proofs. This is an example of neoliberal science because research projects are chosen by public tenders that use very narrow market criteria to select projects: cost or price, rather than experience, prestige or the goals pursued. Even when financial resources were not a constraint, the Chilean state preferred a small market-oriented laboratory to a specialized advisory one. CENMA's politics show that the market can not generate official statistics or publicly credible expertise, and without these the state has little capacity to know or control nature. As a result, the once carefully tended Japanese garden at the center of the CENMA buildings today is a dried out mass of grasses (figures 1 and 2).[42]

Figure 1. CENMA's garden in winter 2011
Photo by the author

[42] This section is based on interviews conducted in March-May 2011 with past CENMA and EIA directors, JICA staff, and two current CENMA scientists, as well as documents about CENMA from the Environment Ministry's library. Records, including annual reports, were incomplete. JICA declined to give me access to documents, except for an evaluation of the program found through the internet.

The origins of CENMA

CENMA is potentially the best funded and longest-lived of a few efforts in the 1990s and 2000s to produce "science in the public interest". Other examples include research institutes in productive ministries like Economy and Agriculture, and the State Development Agency (Corfo), like: fisheries (IFOP), soils (CIREN) and forestry (INFOR). Corfo, for example, recently launched a new public tender to support "public goods science" to address market failures necessary for regulation. Recognizing that tenders is not enough, however, Corfo is also identifying labs' base funding needs so they may better accumulate data and experience. This shift reflects a changing understandings of U.S. practices: according to an economist and government advisor, Corfo's program for public goods science reflects a realization that the U.S. government funds science generously, although they and the World Bank then tell "the little indians in South America" to shrink their states. The trajectory of CENMA and the University of Chile, detailed below, indicates that notions about U.S. government spending may be changing faster than ideas about the role of science in society.

The initiative to create CENMA came from a group of technocratic engineers involved in environmental politics during the transition. Through the dictatorship they had worked on air quality monitoring, and under democracy decided it was time to set up a more permanent monitoring capacity to support decision-making. They looked to international aid agencies for funding, and JICA responded quickly with a broad vision and a generous plan. JICA donated scientists' time and equipment to build the "best air and water quality laboratories south of the Rio Grande." Although the Chilean contribution was built on shaky foundations - the buildings are old and still subject to land disputes[43] - between 1995-2000 CENMA became Santiago's official source of air quality information, advised Conama on a number of issues and trained hundreds of government staff in environmental impact evaluation. CENMA was playing its public function, even if somewhat skewed towards one issue, Santiago's air pollution problem.

Reluctantly, JICA agreed to create CENMA as a private foundation within the University of Chile, not within Conama. This ran contrary to JICA's experience - science for government advice should be within the government - but they were told (and believed) that Chilean state institutions can not legally house their own research facilities. Not only is this not really true, in light of the existence of public research institutes like IFOP, CIREN or INN, but it created a permanent source of tension. The University of Chile names CENMA's director from among professors, who have every incentive to steer CENMA towards academic science and away from government information. CENMA's annual reports provide evidence of this tension; the 1999 report mentions the University just once and Conama five times, whereas the farewell speech

[43] CENMA is located at the University of Chile's La Reina campus. The lands were confiscated from poor communities and given to the University of Chile to relocate humanities departments there, outside the city center, following the coup in 1973 (Jaksic 1989). The communities still protest their land rights, while urban growth has raised the value of these lands significantly.

of CENMA's second director in 2003 called on CENMA to look to its "fundamental entity, the University of Chile."[44]

During these years several environmental conflicts showed a need for greater scientific participation on environmental questions of social relevance. CENMA may have been too new and confused between its different missions - public or research lab, environment or just Santiago's awful air quality - to be involved, but many scientists participated on behalf of the environment in these cases. Their credibility was somewhat suspect among the broader community and many felt "burned" by the experience - several never again participated in EIAs and others worked on environmental issues from abroad or far-away regional universities. Many hoped the EIA, CENMA and the new democracy would be better equipped to deal with these controversies in the future.

The first early controversy was Alumysa, a Canadian project to install an aluminum smelter in the Aysén, Patagonia. Aluminum smelting produces fluoride wastes, among

Figure 2. Signs of development? The welcome sign at CENMA.
Photo by the author

others, and is a large industrial intervention in contrast to Aysén's deep rurality (chapter 6). Environmental NGOs, together with biologists, ecologists, and water chemists, mobilized to successfully oppose the project (Camus & Hajek, 1998). Another was Trillium, a project to harvest a native *lenga* forest in Tierra del Fuego, Chile's extreme south. Seeking to use "the best available science" for sustainable forest management,

[44] http://www.uchile.cl/acerca/rectoria/noticias/02abril2003.html. The archive at the Environment Ministry did not have many CENMA documents. Only a few annual reports exist and JICA declined to give me access to their documents.

the Seattle-based company created an "Independent Scientific Commission" with Chile's top ecologists, including Mary Kalin and Claudio Donoso (Kalin Arroyo et al., 1996). The commission supervised consultants and scientists could speak openly to the press about their findings. They made many pro-environment recommendations, including leaving forests on gradients 40% or over untouched. Scientific integrity was supposed to be protected through a public Charter, signed by the company's chairman and president. But the agreement failed. Environmentalists were not convinced by the show of scientific integrity and the scientists were strongly criticized for collaborating with industry. Kalin, who directs Chile's largest network of ecologists, never again participated in EIAs.

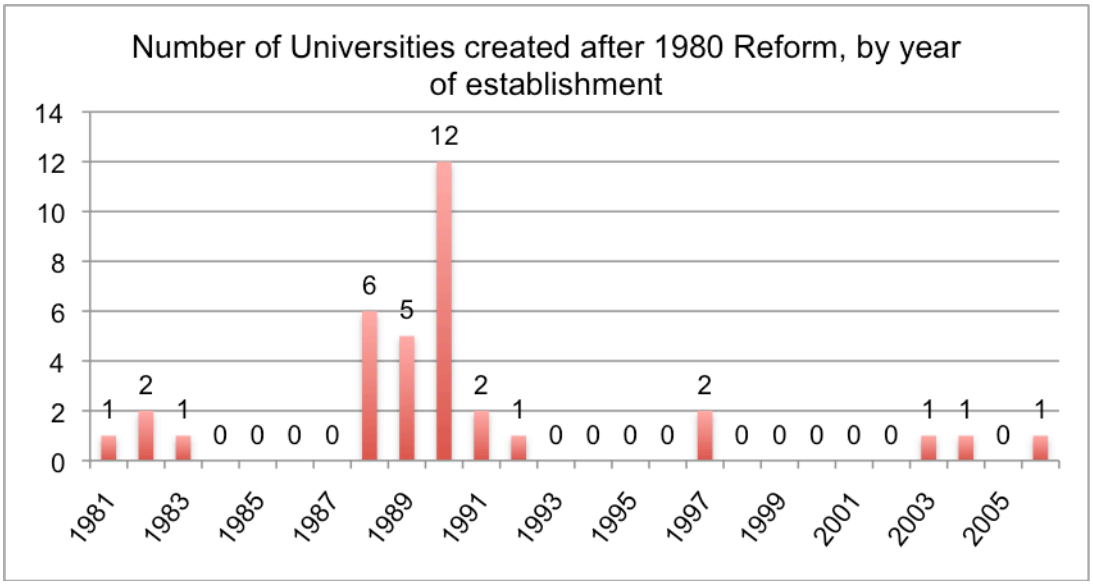
The two most dramatic conflicts were over two large hydroelectric projects, Pangue and Ralco, on the Bío Bío river. Both projects forced the relocation of several indigenous *Pehuenche* communities and split the country; these projects dramatized the ethical choice between different visions of development. Scientific groups like EULA raised the alarm saying the projects threatened water quality and quantity in one of Chile's most industrial areas. The Bío Bío sustains communities including subsistence indigenous groups to large forestry industry further downstream and the large city of Concepción. Many actors at the time called for "neutral" voices to assess damages and hoped that tools like the EIA would in the future avoid such confrontations (Camus & Hajek, 1998).

As these scientists were participating in environmental controversies under a new hopeful democracy, the state-funded universities where they worked were rapidly changing. The military dictatorship hollowed out Chilean universities: some faculty went to academic groups protected by the Church that then became think tanks or grew into new Catholic universities, others went into consulting and some never returned from exile (Jaksic, 1989; Levy, 1996). New universities were easy to create following the 1980 Higher Education (discussed in section II). Public figures from the regime had few public positions they could occupy, so many turned to the new universities. In the last three months of Pinochet's government twelve new universities were created (figure 3). Many of the new universities packed their Boards of Directors with conservative political, religious and industry elites (table 1). Run as businesses, these new universities invested little in the conventional indicators of academic prestige: faculty, books and research (table 2). After twenty years of experimenting with new forms of organizing universities and science, just a handful of traditional universities continue to account for the vast majority of Chilean science: University of Chile, Catholic University, Austral U., and Concepción (Barandiarán, 2011).

The technocrats that created CENMA are participants of this privatizing trend, as they shifted from positions in government and the University of Chile to positions in consulting. The key figure behind CENMA's origins is Ricardo Katz, an engineer active in CIPMA who collaborated with Rafael Asenjo (lawyer) in the drafting of the original environmental framework law. While Asenjo defended Conama in the Senate, Katz worked to build a scientific laboratory ostensibly to support the new institution. Katz began his career in Pinochet's Ministry of Planning. There he cooperated with engineers at the University of Chile on air pollution measurements. Since the transition, he directs

the environmental consulting company he founded (GAC), works for a think tank for the Christian Democratic party and frequently sits on Conama's Advisory Council. His employees at GAC have occupied important positions, including the first director of CENMA, Juan Escudero, and the current Environment Minister, María Ignacia Benítez.[45] Katz's career is paradigmatic of the inner workings of Chilean technocracy and the movement of individuals between the public and private sectors and between political parties (both Christian Democrats and right-wing parties).[46] These individuals have generally favored the expansion of markets and privatization of government functions, and have worked in the public sector to make it happen.

Figure 3. Universities created after 1980 by year
Source: elaborated from data from Monckeberg 2007. Reproduced from Barandiarán 2011.



[45] Juan Escudero was named in December 2012 as one of the first five ministers on the new Environmental Tribunals.
[46] These engineers had support from Eduardo Arriagada, also an engineer and influential within the Christian Democratic party. Arriagada owned the engineering firm that built Santiago's subway system. I was unable to interview Katz or Arriagada (deceased).

Table 1: Ownership interests of Universities established after 1981 and still operating in 2006
Source: elaborated from data from Monckeberg 2007. Reproduced from Barandiarán 2011. Total Universities: 35. Numbers do not sum 35 because some universities present interests in more than one category. Excludes universities created by the State or the Catholic Church post 1981.

Business	24
Politicians linked to Pinochet Government	10
Elite religious groups (Opus Dei, Legionaires of Christ)	5
Military	5
Academic groups	3
Jesuits, Salesians and traditional Catholic orders	3

Table 2: Characteristics of universities by type
Source: elaborated from data from Monckeberg 2007. Reproduced from Barandiarán 2011.

	State universities	Non-profit universities	Private universities
Avg. Students/ University	8,520	10,231	5,640
Total students (% of total)	136,327 (31%)	92,082 (21%)	205,536 (47%)
% Poor students (students from public schools)	88%	79%	60%
*% Top students (students bringing variable funding)	8%	11%	3%
Avg. Library holdings/ Univ.	94,000	246,000	26,000
Books/students	11	24	5
*Avg. Fondecyt/ Univ.	11	20	0.7

* Top students are defined as those that receive variable funding as defined by the state (AFI). Fondecyt projects are the “bread and butter” of Chilean science; these are small individual research grants given to academic scientists.

Neoliberal science is produced through public tenders

Like in other countries, research funds are disbursed competitively in Chile. But Chile's public tenders for science are different because even the smallest amounts are tendered, there is very little base funding and cost-criteria dominate over considerations of quality. The formal operation of these public tenders and respondents' statements all point to a very low willingness to pay for science in Chile. For example, by 2002 as funding from JICA was about to expire and under a university-oriented director, CENMA's funding from Conama fell to less than 300 million pesos (less than US $750,000) or just 2% of Conama's expenditures in this period. Conama had no interest at all in maintaining a national environmental research capacity and a new director was named to dismantle CENMA. On assuming his position in 2003, however, he saw a need for a public laboratory like CENMA and negotiated five years of base funding of 1,600 million (US$2.9 million) a year, in addition to funds won through public tenders (about another US$1.7 million). After 2008 a new university-oriented director came in and base fund commitments were again under threat.

The primacy of cost considerations in public tenders is critical and reflects Chile's brand of neoliberalism. Economists eager to dismantle Chile's plans for nuclear power in the 1970s persuasively argued that to maximize social benefit is to reduce overall cost (Tironi and Barandiarán, forthcoming). The Environment Ministry, for example, tenders about US$2 million annually in studies to support their regulatory efforts. These go through an online platform called *ChileCompra*, "the public market", that coordinates all government acquisitions, from pencils to laboratory analysis. Many respondents declared they are required to choose the lowest cost offer; the cheapest always wins the tender. As a result, scientific information is either cheap or expensive - there are no evaluations of credibility, reliability or experience.

Staff committed to the idea of a public laboratory in JICA, Conama, the University of Chile and CENMA agreed that to tender research projects destroys the government's capacity to maintain reliable, usable data. For example, CENMA offered to provide an official assessment of pollution effects at a wetland in Valdivia (chapter 4), only to be told by the minister in charge that the issue would be put to public tender. Seven years later, a fierce scientific dispute over this case continues. Frustrated by this experience, the respondent, an economist by training and advisor to then President Sebastián Piñera, went on to say: "Hayek would understand me well. What [the economic right] is doing is anti-liberal because it is destroying any government capacity. Small government does not mean good government." Public tenders are "the greatest imbecility the world has ever seen", he concluded.

Respondents criticized that the tender process produces information that is superficial and has low credibility. A former director of Conama and today a professor of public policy went so far as to say: "I do not know where to get information on HidroAysén that I could base my opinion on", in reference to the controversial dam project (chapter 6). The tender process spreads knowledge production out in a subversion of the notion of participation and transparency; experience becomes

fragmented and expertise can not accumulate. Knowledge transmission remains embedded in a few people rather than in institutions.

CENMA's contributions to environmental politics

In 2010 CENMA suffered a series of losses. The earthquake of February 2010 damaged the second floor and forced the relocation and closure of several labs. Prior to that a number of labs closed as specialists left, equipment broke, and competitors arrived. Worse, CENMA lost for the first time the public tender to measure Santiago's air quality. There was a slow decline in capacity: from 24 air monitoring stations in 1997, only 13 were left in 2011 (ten of these are online, which is an improvement; these stations cover a population of over 5 million). Stations were lost to theft, interference from antennas, and maintenance costs. The tender process chose the cheaper option, though there is also debate about what air quality model to use.[47] So capacity will decline further: CENMA's air quality database that contains daily measurements from 1997-2010 will be interrupted. Instead, a new scientific project using balloons to measure ozone depletion in the stratosphere was launched. This is characteristic of the *coup d'accordeon* from public interest to academic science and back again.

CENMA also made an expensive investment into ISO certification to become a national center of reference, with support from Canada's Environmental Agency. The objective was to be both an intellectual center of reference with experience in interpreting and using environmental information, and a technical center of reference to calibrate instruments across the country. The Canadians' standards, however, were too high for the Chilean market for credibility; corners had to be cut to save costs. Clients in government and commercial labs were unwilling to pay for quality and CENMA fell into the irony that as it invested in ISO certifications it became increasingly like any other commercial laboratory, losing any special status it may have had as a public organization.

The scientific community too contributes to CENMA's fragmented and weak influence. In all the potential forms CENMA took - as university research center, as government laboratory, or as a commercial lab - it never aspired to be a public-interest, environmentalist laboratory at the service of civil society, communities or NGOs. A CENMA report on indoor pollution caused by heating systems published in early 2011 was cited as a rare example of its capacity to play this role. A scientist now working in the Environment Ministry said scientific opinions like this report are rare because scientific voices are reluctant to address policy-makers. Scientists often cowered before industry and political figures: scientists involved in Conama's Advisory Council would say to him things like "what could we [scientists] have to say to them [industry]" and "what if they get angry or upset". In sum, scientists do not embrace a role as public experts. Their institutions like CENMA, the Academy of Science or the University of

[47] http://diario.latercera.com/2011/07/10/01/contenido/pais/31-75944-9-el-nuevo-modelo-para-santiago-es-totalmente-objetivo.shtml

Chile are constantly under political and economic assault and have not formulated visions for a public science.

Finally political figures in the ideological center and right frequently attack public scientific institutions as "decontextualized" Ivory Towers. One respondent criticized that scientists might suggest to solve Santiago's air pollution problems by proposing to move industry out of the city, something that is just not feasible or desirable, from a technocrats' point of view. The cash-starved and politically crippled University of Chile is a common target of criticisms; many advocate privatizing it because they favor more markets and a smaller state, without recognizing how these trends are the cause of many of the University's troubles (for example, even pencils have to be bought through *ChileCompra.* The University has no bureaucratic autonomy) (Barandiarán, 2011). Many of the technocrats that originally created Conama, the EIA and CENMA today blame CENMA's failures on University of Chile.

This chapter argues CENMA was placed within the University of Chile out of a commitment to small government and markets. The state turned its back on scientific and technical knowledge. In a twist of James Scott's famous book, the Chilean state prefers "not to see like a state" (Scott, 1998). More privatization, as many advocate, would only further weaken the state and increase conflict in environmental politics as disagreements over the credibility of environmental expertise would rise. Throughout all these years many efforts have been made in different sectors of the state to increase public science (e.g, at Corfo), but these always fail because funding is publicly tendered and the cheapest option - not the experienced, credible, or cohesive team - is preferred. So continues the sad tune of the *coup d'accordeon*.

"Chile thinks Chile": With what capacity?

CENMA's relative failures are evident in contrast to EULA's relative successes. These two environmental science laboratories were set up around the same time, both with foreign funding, but EULA has benefited from steady, visionary guidance and being far from Santiago's politics. Housed at the private but state funded University of Concepcion, EULA enjoys state funding for science along with much more bureaucratic autonomy than the University of Chile. In both cases these are relative successes and failures because environmental science as a field has advanced little within Chile's broader science efforts.

In the 2000s the Chilean state began experimenting with new forms of funding science. New programs to support PhD students abroad, fund research teams rather than individual researchers, fund applied work, revitalize development through clusters of innovation and decentralize scientific capacity were adopted. A National Accreditation Agency was created to certify the quality of universities and degree programs. Science as an engine of economic growth has benefited: in 2007 37% of science funding went to basic science (Fondecyt, Fondap and Astronomy) while 49% went to applied or commercially relevant research. The bread and butter of Chilean scientific funding (Fondecyt) was 10% smaller in 2007 than in 2004 (Barandiarán, 2011; table 4). Criticized as a "national policy of little examples", these programs have yielded many

positive results but are falling short of some of their targets. Chile's science policy is pushing scientists further into global science, with rather demanding publication, patent and outreach counts where anything foreign carries a premium or bonus, and to collaborate with industry. But industry seems uninterested in working with scientists, as testified by respondents and as documented elsewhere (e.g., Benavente, 2006). This does not make scientists' quest for social relevance any easier.

In this context, and as a science manager said, ecology has been surprisingly successful at winning new funds from different programs. One of these programs sought to increase regional scientific capacity and several new research centers now exist on issues related to environment, like CIEP and CEAZA, protagonists of the controversies discussed in chapters 5 and 6. Likewise, the number of researchers in oceanography, glaciology and geology is growing (table 5). But environmental science as an inter-disciplinary pursuit has had a harder time winning these funds and no new programs have been established since the creation of EULA in 1989. EULA's PhD program, created in 1990, was only accredited in 2010 because the National Accreditation Agency thought "it was too inter-disciplinary".

EULA stands for "Europe-Latin America" and was a project supported mostly by the Italian government to commemorate 500 years since Christopher Columbus landed in the Americas. The Europeans provided almost US$15 million to fund research of the Bío Bío river's watershed. Thirty-six students were admitted to the country's first environmental science PhD program that first year, with scholarships to complete part of their studies in Italy. The PhD program dovetailed well with the theme of CIPMA's 1989 meeting: "*Chile piensa a Chile"* (Chile thinks Chile).[48] Five hundred years later Europeans were still helping Latin Americans how to "think" about themselves.

EULA and CENMA are characteristic of a creole science where foreign funding and know-how sought to create a new capacity to govern and think about the newly democratic local society. CENMA, housed at a public university in Santiago, became a victim of the Chilean government's commitment to the market and a small state. The state - the intended user of the new knowledge - did not know what to with the new laboratories. EULA was more successful, in part because it enjoyed the best of both private and public worlds. It receives public funding but is a private organization with bureaucratic autonomy (Barandiarán, 2011). EULA could look for users widely rather than rely on a narrow-minded state that until 2010 did not see the value of an inter-disciplinary environmental science.

Among Chilean research institutes EULA alone walks a fine line between relevance and integrity. EULA has a strong academic reputation and participated in many controversies of public interest. It monitors water quality for Arauco's paper and pulp mills but has also been critical of HidroAysén and other dam projects.[49] Those who applaud EULA's model attribute success to the leadership of Oscar Parra, EULA's

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[48] Gyhra Soto, A. "Universidad, Medio Ambiente y Desarrollo" in *Ambiente y Desarrollo*, vol. V, no. 1: 79-83. April 1989.

[49] Of course, this does not mean environmentalists or communities have always like EULA's positions. Its collaboration with Celco Arauco is particularly suspect among many. See chapter 4.

director of twenty years. While CENMA's fortunes changed with each new director, EULA flourished under one particularly competent director. Are more EULAs the solution to Chile's lack of credible and official environmental knowledge? Its successes aside, in twenty years EULA as an organization has not been replicated, environmental science remains somewhat suspect as a field of inquiry and education, and the Bío Bío river watershed can hardly be described as environmentally sound. Furthermore, EULA too is criticized and many are fearful of how it will fare with Parra to lead it. The criticisms of EULA again harken back to disputes about the proper role of science in society. Some say EULA "over-stepped its boundaries" by taking positions against some projects. Others that it operates like a consulting not a research institute. Many scientists continue to feel tormented about their proper role because poverty *still* dominates in many ways. Like in the 1960s, some feel a need to be socially engaged while others could joke about their social irrelevance by referencing a common Spanish language expression - "to think of a crab's immortality" - to mock science.

Conclusions

In contrast to literature on science and the state in advanced liberal democracies (e.g., Callon, 2012), the Chilean state never had a monopoly on the production of knowledge. In an economy dominated by large firms, many of them multinationals, science as an engine of economic growth was a marginal interest of the state (Maloney, 2007; see also Vessuri, 2007). In addition, since 1980, the state is blinded by an exaggerated allegiance to the market. A "competitive research market" in an "efficient state" meant to Chilean legislators that no area of knowledge can be privileged, grants must be small and the lowest-cost bid must win. Michael Goldman coined the term "green science" to describe a hybrid form of environmental knowledge, between conservation and development goals, generated through policy tools like the EIA. In Goldman's account, the World Bank has successfully accrued green science to extend its governance reach (Goldman, 2005). The Chilean state is struggling to do the same, as the next chapters show, but it is building on weak foundations, as this chapter shows. The weak position of public experts has both historical and recent roots; neoliberalism alone is not to blame.

Currently, despite the growth of universities and organizational experiments, Chilean science is plagued by an unwillingness to pay for knowledge. Public universities have seen their funding fall while private universities invest little in books, research or full-time faculty, and are often led by conservative ideologues with powerful business and political connections. University students paralyzed the country in 2010-2011 to protest these conditions, and have continued to keep up the pressure. As of writing in April 2013 the Education Minister was forced out of his seat for alleged wrong-doing (of the same kind all his predecessors are guilty of: ignoring universities' illegal for-profit ventures). Not only are there limits to how much personal debt students can shoulder, but as this chapter shows there are also limits to how a university can perform under a bureaucratic and ideological stranglehold. Often blamed for ruining CENMA, this

chapter argues the state's commitment to the market is ruining both the University of Chile and CENMA.

FInally, legislators still do not find ecology and environmental science useful as means to represent nature in the public sphere. In the first legislative period (1990-1994) things like pollution and the national patrimony were defined based on legal standards while science was kept at arm's length - it was too subjective, ambiguous and messy compared to intuitive categories like beauty or objective legal standards. Ecology was associated with "ecologism" to imply it was part of a passionate, zealous, anti-development, and environmentalist world-view. Technocratic solutions like those proposed by the policy entrepreneurs that emerged from CIPMA were preferred, as will be discussed in more detail in chapter 3 that focuses on technocracy. Twenty years later this only changed somewhat. Though ecology has been successful as a science, environmental science was capped by the accreditation agency.[50] By the second legislative period (2009-2010) visions of nature had changed into visions of conflict. During this whole period, "environmentalism" continued to be a "bad word" in Chile and a label anyone who wants to work in government, industry or scientific research should best avoid. In 1984 Igor Saavedra, physicist and President of the Academy of Science, recognized in the environment a special opportunity for Chile's creole scientists to prove their relevance to the man on the street. The debates around CENMA, EULA and the state's changing science policies - including attempts to create "science in the public interest" - indicate that the appropriate role of the creole scientist in society remains in question.

[50] I have not compiled data about this yet, but the field is dominated by environmental "engineering" rather than "science". Further research should examine the cultural differences between the two in Chile.

Data appendix

Table: Conicyt funds in 2007: Total US$171 million (expressed in 2009 US$ by program)		
Basic	**US$**	**%**
Fondecyt	$ 51.4	30
Fondap	$ 9.7	6
Astronomía	$ 1.1	1
Applied/ Economic competitiveness		
Bicentenario de Ciencia y Tecnología	$ 37.3	22
Fondef	$ 24.2	14
Financiamiento Basal para Centros Científicos y Tecnológicos de Excelencia	$ 18.0	11
Regionales de Investigación Científica y Tecnológica	$ 4.7	3
Public outreach/diffusion and Scholarships		
Becas Nacionales Postgrado (scholarships)	$ 16.6	10
Explora (public education)	$ 6.4	4
Departamento de Información Científica (journals, access to data bases)	$ 0.3	> 1
Departamento Relaciones Internacionales	$ 0.7	> 1

Table. PhD graduates per million residents Source: Kawax, data calculated following Frascati Manual			
	1998	**2001**	**2004**
Chile	6	6	15
Mexico	7	11	19
Brazil	23	34	48
Finland	331	346	356
New Zealand	107	125	153

Table. PhD programs and graduates in Chile by selected disciplines
Source: Academy of Science census (2005). If no data is reported then no data was available.

	Year of first PhD program	No. PhD programs	No. scientists (2005)	No. scientists (1995)
Biology		11	424	
Biomedicine		9	504	
Chemistry		18	390	
Mathematics	1968	5	169	93
Physics	1968	5	205	70
Astronomy	1999	3	42	(approx.) 20
Agriculture & Forests		14	206	ns
Environmental sc.	1968	14	170	102
Engineering	1990	17	254	
Earth sciences	1968	3	155	
Ocean sciences		8	157	

Chapter 3. Environmental Regulatory Politics, 1990-2010

In 1993 and 2010 Chilean environmental regulatory institutions were created and then reformed. To import "the most modern policy tools" to Chile, as the Environment Minister called it, required local adaptation. Initially the new National Environmental Coordinating Agency (Conama) faced a classic capacity challenge focused on human resources and training. Over time Conama proved capable but not very effective at producing and controlling environmental information, leading to a crisis of legitimacy and the 2010 reforms. Throughout appeals to technical politics - used interchangeably with technocracy - were a source of legitimacy to Chilean actors. Through the lens of regulatory science, this chapter problematizes 'capacity' by paying attention to the politics of information, expertise and power, as discussed in chapter 1. Whose capacity do tools like the EIA improve? Given that EIAs are predicated on a rational, linear model driven by experts, who are these experts? Chilean scientists do not play the role of public experts, as shown in chapter 2. If not science, then what is meant by "technical"? The three environmental controversies discussed in chapters 4 through 6 find a range of meanings of the "technical", but first this chapter focuses on the meanings state and government actors attach to the "technical".

The transition from military to democratic rule was an opportunity to create new environmental institutions unconstrained by past organizational practices. Of many possible options, law-makers opted for a coordinating office (Conama). A full-fledged Environment Ministry - with more legal standing than an office - was rejected by law-makers who feared this would become a "Ministry of No" that derives power from blocking projects and "opposing progress". In contrast a "transversal" office would bring environmental concerns to the agendas of different sectoral ministries and agencies, promoting the environment through negotiation and persuasion across different interests. Conama as a transversal office mirrored President Patricio Aylwin's "transversal party". This reflected a commitment to technocratic, consensus politics in the spirit of a democratic government for all Chileans, not just the supporters of the new governing Concertación parties (P. Silva, 2009).[1]

Fifteen years later transversality was in question. Chile's first Environment Minister Ana Lya Uriarte argued an Environment Ministry was needed because "experience had shown that transversal coordination in a vertical political hierarchy was difficult. Politics kept interfering in technical decisions. Asymmetries of information are plentiful. And there has been an unbalanced use of environmental policy tools, with too much EIA and too few norms."[2] Whereas President Aylwin's transversal party was the reconciliatory alternative to divisive partisan politics, Bachelet's government represented

[1] This chapter is based on material from the Legislative History from Congressional debates in 2009-2010 and interviews with government employees involved in Conama, EIA Agency and the new Ministry. Quote numbers reference my Atlas.ti database.

[2] Legislative History 20.417: quote 9. At the time Ana Lya Uriarte was a minister without a ministry.

the best effort since 1990 to democratize technocracy through expanded participation. This was the spirit of her campaign promise "no to the technocrats, yes to the people".

Nonetheless, Bachelet's government also retained a technocratic politics. In the case of the environment, this meant increasing technical politics through more control by ministries. Patricio Silva (2009) argues that in Chile technocracy and party politics are opposite forces, one the antidote to the other, where technocrats buffered conflict between competing parties. The boundary between these groups shifts in response to political priorities. Bachelet, in trying to both reinforce technocratic and democratic politics, was trying to shore up the legitimacy of Chilean institutions and increase accountability. Interestingly, her government pursued an environmental reform that increased the power of the central executive government (through the ministries) at the expense of local elected government.[3] In this way, embedded in appeals to technical politics are contentious visions of how state power should be distributed in Chile's modern democracy.

From a global perspective appeals to technical politics highlight Chilean law-makers' struggle to reconcile neoliberal values like a 'small state with little regulation' with a 'capable state that can compete in global markets'. "Market-enabling" environmental regulations prevailed (E. Silva, 1994; Tecklin, Bauer, & Prieto, 2011), and this required cutting "good government". Thus how to regulate the environment was a debate about the conditions under which Chile should participate in global markets and institutions. The Organization for Economic Cooperation and Development (OECD) urged Chile to strengthen environmental institutions to join its exclusive club of first world countries. According to the OECD, development understood as "good government" and not just exports required a more capable state. The EIA certifies environmental production concerns and thus signals to international markets and Chilean citizens that Chilean exports are good enough to compete globally. Technical politics made it possible to achieve this with a nod to the small, neoliberal state.

Domestically, appeals to the technical represent power shifts from the executive government to the "technical" state, where the boundary between politics and the technical shifts around ministries. In contrast to classifications of public sector workers as technocrats, bureaucrats and *técnicos* (P. Silva, 2009), discussed in chapter 1, this chapter uses boundary work to find that the closer these individuals are to executive power the more they work like bureaucrats who unquestioningly apply the rules than technocrats who exercise discretion. Actors contest ministries' technical status, so agencies - semi-autonomous organizations within ministries - ground their technical status in appeals to rules. This is very different from the U.S., where government scientists ground their integrity in a strict delineation of science from non-science (Jasanoff, 1990; Keller, 2009), and the UK or Germany, where experts in ad hoc committees ground their integrity in thick traditional social conventions (Jasanoff, 2005).

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[3] As of writing in April 2013, events of the past two years confirm the dangers of this course of reform as some regional movements have gone on strike to paralyze government and business in demand of more decentralized political power. Conflicts have increased under Sebastián Piñera's government, and this analysis indicates this is not only the result of his administration's unpopular policies or coarse style. In other words, conflicts with an environmental core are likely to continue.

The EIA improved between 1993 and 2010 to have more public participation, better guidelines, subject to more rules and administered by more experienced and trained workers. Concerns about information however persisted. Legislators proposed different forms of control over information but at no point discussed changing the conditions in which knowledge is produced. The first part of this chapter covers this discussion in the democratic legislature as it discussed the creation of Conama and then of an Environment Ministry. The second half of this chapter covers this discussion in its technical details: in how the EIA operates where the EIA is seen as a registry of objectivity (Jasanoff, 2005). One of the central concerns of this analysis is accountability, a democratic value that is intimately related to information (Ezrahi, 1990).

I. Transition politics and the Environmental Framework Law

The transition from Pinochet's military dictatorship to President Aylwin's center-left coalition government in 1990 was a "negotiated transition" (*transición pactada*) (Collier & Sater, 2004). Guided by the twin goals of "growth with equity", as Aylwin's platform promised, the new democracy also had to answer to demands for greater environmental protections. A coordinating office best expressed the spirit of negotiation. Technocratic policy entrepreneurs like lawyer Rafael Asenjo and engineer Ricardo Katz, introduced in chapter 2, favored a coordinating office because "the environment is a transversal issue". They argued an environmental ministry risked irrelevance as a "Ministry of No"; it would just put obstacles and breaks on development projects and risked being excluded from negotiations. A transversal organization instead could be conciliatory and bring environmental concerns to different tables. A transversal environment office dovetailed well with Aylwin's transversal party, used to project a party that governed all Chileans, not only the majority who had voted for the Concertación parties in 1989 (P. Silva, 2009). Transversality represented values like consensus, compromise and negotiation, all the sources of legitimacy among Chilean politicians usually anxious to avoid conflict or destabilizing disagreements (Carruthers, 2001; E. Silva, 1996; P. Silva, 2009).

A transversal Conama was the technocratic alternative to a political Environment Ministry. Those who supported a ministry argued a coordinating office would lack sufficient legal authority to significantly change environmental practice, but their criticisms were dismissed because they were too political. Legislators and advisors who supported a ministry were largely on the ideological left. Many had worked with poor rural communities during the dictatorship. They were geographers, agriculturalists and biologists - not lawyers or engineers. Their leader was Luis Alvarado, a geographer and President Aylwin's Minister of Public Lands, that administers state-owned lands and had housed Pinochet's Inter-ministerial Ecology Committee.

Conama was presented as a transversal, technocratic office, but was preferred over a ministry for political reasons. The left-wing geographers advocated transforming the Ministry of Public Lands into a new Environment Ministry, so those on the right suggested placing Conama within the Ministry of Planning, a pivotal ministry under

Pinochet's government that would likely smother the new environmental office.[4] Conama was placed within the Ministry of Interior (*Secretaría de la Presidencia*) as a compromise. The negotiation took place off-the-record, before the project was submitted to the legislature for discussion. A note on translation, here Conama is an "office" to underscore the difference with a "ministry". Though in both cases the President selects the top authority - Minister or Director - Conama's Director answers to the Interior Minister. The term "agency" is reserved for autonomous or semi-autonomous organizations within ministries, offices or departments; agency directors are named by Ministers with less Presidential involvement than in the case of an office like Conama.

The new Conama was justified in the Senate not by appealing to political goals like a clean environment or quality of life, but to technocratic ones like "correcting market externalities". In 1993 two days before the Senate began discussing the environmental framework law that creates Conama and the EIA, a mudslide killed 26 and left eight wounded in the poor neighborhood of Macúl, near Santiago.[5] Heavy rains were the immediate cause but bad infrastructure, erosion and deforestation were the real causes, as the city crept up the Andes without much regulation. Discussions on the new law was thus preceded by an appeal for personal donations to aid victims, and several Senators demanded government help for those outside Santiago also affected by the heavy rains. Thus several of the grievances the proposed law sought to solve marked the beginning of Chile's first Senate debate about the new environmental law: development that ignores environmental realities, environmental harms that devastate the poor, and regional inequities. Few Senators linked the human causes and consequences of the mudslide to the purposes of the law to be discussed; neoliberal orthodoxy and technocratic objectives like the gradual raising of environmental standards prevailed.

"…The 'invisible hand' of Adam Smith does not conduce, on its own, economic activity aligned with harmony and protection of nature. Real sustainable development requires political power, the State, to set limits and regulations that respond to the common good, which today has a core ecological component."[6] So President Aylwin addressed legislators in 1993 to convince them of the need for the future Conama. He blamed the "catastrophic" state of the environment on Chile's 718 "incoherent, fragmented and inorganic" legal texts. These needed to be replaced by a law based on principles: gradualism, realism, polluter pays, and participation. Gradualism and realism responded to a common Latin American malady: "In Latin America there are abundant environmental laws and codes, almost perfect from an ideological and theoretical point of view, that are inapplicable because of the disjuncture between the institutions

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[4] By 2010, the Ministry of Public Lands had been completely sidelined because "what can Public Lands do with a project that occurs on private lands?" This was one statement by an official who argued for excluding government from decision-making as much as possible. More research is needed to understand the role of Public Lands in Chilean politics today.

[5] The mud slide was May 3, 1993, and Senate discussions began May 5, 1993. This was a one year and a half after the President first announced the proposed law, in September 1992. About the mud slide see: http://es.wikipedia.org/wiki/Aluvi%C3%B3n_de_la_Quebrada_de_Macul

[6] Legislative History 19.300: quote 4

responsible for those laws and their content."[7] This malady is neither unique nor unexpected. The global development community often admonishes Latin America for violating the rules in its books. Good government and global markets prefer the certainty of following the rules.

Conama was approved not to herald a new era of environmental stewardship, but to redress a problems with externalities caused by export-led growth. And it would do this not through the overhaul of the country's environmental laws but through gradual improvements. Few legislators were openly critical of the Pinochet government's environmental legacy or lack of "political will" to enforce those 718 incoherent laws. Most legislators agreed: they needed feasible, implementable laws, within the restrictions of existing administrative capacity. A coordinating office responsible for implementing a fairly lax set of environmental standards was the best way to achieve this. Two legislators, José Antonio Viera-Gallo and Andrés Palma, questioned the neoliberal logic of the future environmental institutions and anticipated many of the problems the EIA came to have: projects are approved because they meet the existing standards, but are still environmentally bad projects. In this way, environmental politics was defined as a problem of rules that raised questions about institutional capacity: would Conama have sufficient capacity to propose, implement and enforce these rules?

A Problem of Capacity: how to be small yet capable

To calm fears about capacity, President Aylwin assured legislators Conama would be "small but well qualified".[8] He identified sources of capacity that would strengthen Conama, including complementary laws that would be passed soon - like one to protect native forests -, participation from academics, and a "clear and objective" EIA process. Of these promises, only the EIA was made "objective", while environmental rules and standards were painfully slow in coming and spaces for participation by academics largely disappointed. These are promises about capacity and the distribution of power: who is asked to take on different tasks and is equipped to do so? Who gains capacity for what? All three promises appeal to the participation of different groups - scientists, legislators, and industry and civil society groups. So each promise speaks to the ideals that guided Chilean legislators through the transition. Ideals that included belief in broad participation, negotiation, and strong and clear legal structures to improve environmental management. Each of these is reviewed below, but first some words about Conama.

Conama was kept small, but it also grew quickly as it attracted many young, idealistic professionals who hoped it would alter Chile's inequitable development trajectory through a defense of the environment. In 1993 legislators largely agreed on the need to send "a signal" that no large, sprawling bureaucracy would be created. Presumably the signal was oriented at business interests, both domestic and foreign, but legislators on record were not explicit about who their audience was. The Treasury capped Conama at 62 employees, of which 25 would be professionals and 21 directors

[7] Legislative History 19.300: quote 62
[8] Opening speech on the environmental framework law by President Aylwin to Senate, May 1993.

with at least professional degrees. Some even proposed that Conama be staffed only with civil servants whose previous position in another ministry, like Health, be annulled after their transfer to Conama. Commitment to the small, deregulated state was so extreme that some legislators even defended a kind of governmental *Hunger Games,* with self-defeating competition among agencies.

Nonetheless, many current and former Conama staff remember the 1990s as a good time. The idealism of young professionals was guided first by Vivianne Blanlot, steeped in international good governance practices. Conama's director from 1995 to 1997, Blanlot came from ten years working for the Inter-American Development Bank. Conama's most important period, according to former staff, was under its second director, Rodrigo Egaña, an expert in public policy. His tenure is remembered as "the peace of Egaña" and the period when public participation was institutionalized taking as expansive a role as possible within the legal limits. The 1990s was marked by anxiety over Conama's capacity: "would we be able to do all this? To implement and administer the EIA? Analyze all that information?", remembered one Conama employee of the time. There was no precedent for the EIA in Chile, no other policy that required such extensive and well-timed public participation, nor anything that required government staff to collect, read, understand and evaluate so much information. Conama's archives are testament to this anxiety: countless studies were commissioned in the mid-1990s on capacity. One led by Ernst Hajek - the biologist who in 1984 saw in the environment a special opportunity for scientists to prove their social relevance, as discussed in chapter 2 - found that each agency had about 10 to 20 people with relevant advanced training, leaving about 2,000 staff in need of capacity building. The challenge of capacity was indeed daunting but successfully resolved.[9]

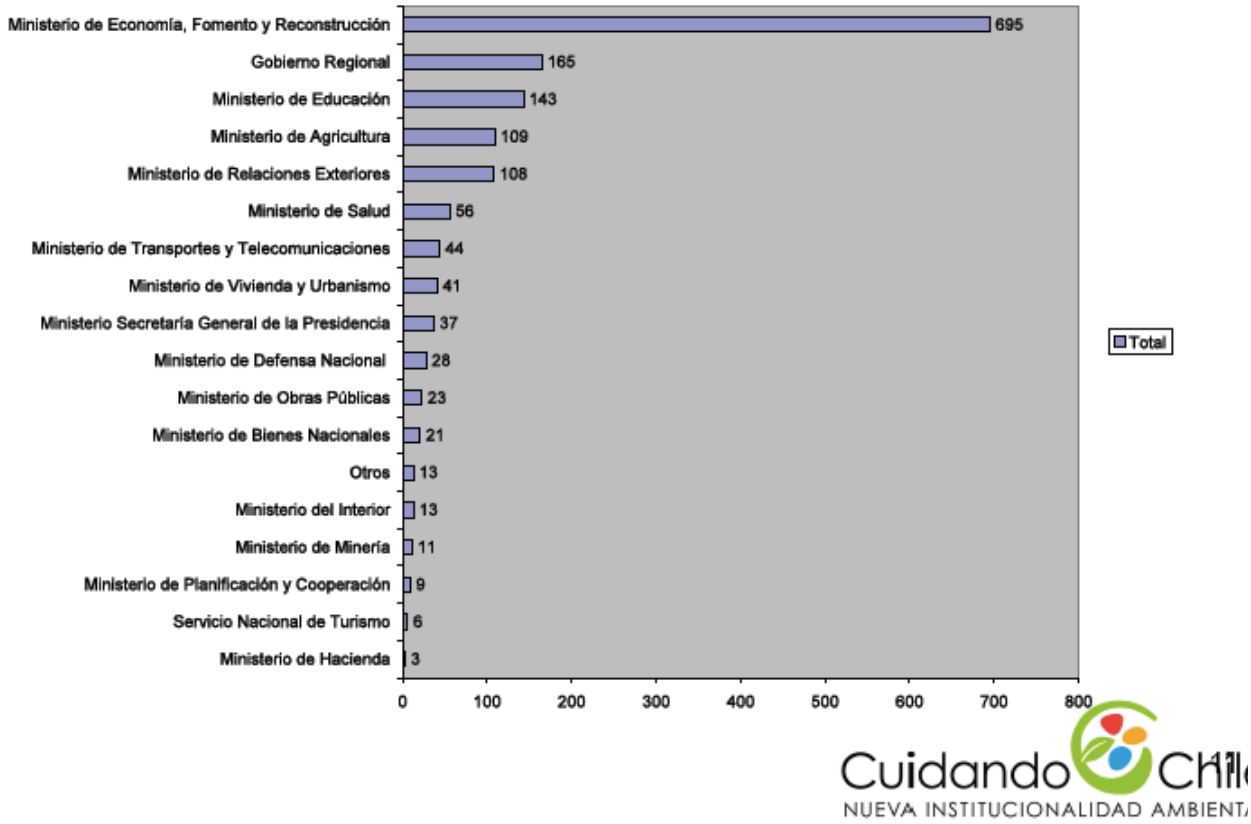
Of President Aylwin's promises in 1993, the most disappointing has been the slow pace for setting environmental quality and emission standards. While the EIA grew, standards floundered. In twenty years, the legislature approved only five environmental laws of 68 that were submitted.[10] Other laws with environmental consequences have often dragged out in legislative discussions. The native forest law President Aylwin said would strengthen Conama took fifteen years to be approved, 1992-2008.[11] Less than a third of laws to change regulations for fisheries and water have been approved. And the first law imposing obligations on mining companies to clean up mining wastes after production ceases was passed as recently as 2011.

Worse of all is the slow pace of approval of environmental emission and quality standards by Conama. Since 1994 31 have been approved and 34 were in discussion as of mid 2011. Most standards regulate air quality (n=20), particularly vehicle emissions (n=12), because Santiago's urban air pollution is seen as the nation's number

[9] CENMA, discussed in chapter 2, played a critical role in training all these government employees.
[10] This includes the original framework law and its reform. The other approved laws are: one approving a grant from Germany, one introducing the Minister for Foreign Affairs into Conama's inter-ministerial council, and one limiting the Military's autonomy to produce environmental harms. This information was listed on the Congressional Library's website in 2010.
[11] For more background see: http://www.ecosistemas.cl/1776/fo-article-78337.pdf

one environmental problem.[12] Approval of standards is incredibly slow. On average it took nine years to approve the five standards adopted since 2007.[13] For eleven years Conama tried to regulate airborne particulate matter to 2.5 levels, the globally accepted threshold! The law requires a revision of standards every five years but Conama takes longer to revise them. Water quality standards were supposed to be revised in 2005, and seven years later the revision is still in discussion (chapter 4). Those who defend Conama's standard-setting legacy point out that the actual number of standards is higher because other ministries also pass such rules (figure 1). But almost half of these were passed by Economics (n = 695), while Health passed quite few (n = 56). These numbers do not convince most respondents who complained that "Chile has few environmental norms". On the contrary, the role of Economics confirms the power of industry in environmental politics.

Figure 1. Census of Environmental Standards (n=1500), 1993-2010.
Conama is not on the list. The graph comes from a power point presentation by the Sub-Secretary for the Environment presented at a workshop held at the Catholic University (date unknown, 2010).



[12] Some reports put Santiago as the third worst quality air of world cities. http://urbanpeek.com/2013/04/13/top-10-cities-with-the-worlds-worst-air/
[13] These are decrees 12, 13, 45, 145, and 145.

The relative lack of standards is both a source and a reflection of distortions in Chile's environmental politics. Environmental standards are critical because the Chilean state can only do what it is expressly allowed to do, while business can do anything not expressly forbidden, according respondents. Standards are also critical because, as discussed in chapter 2, pollution was defined in relation to standards.[14] The lack of standards distorts environmental politics because their absence raises the importance of the EIA; few other standards exist to which to hold projects accountable to. But the EIA can not substitute for standards: bureaucrats can not hold companies to higher standards than those that are in the rule books. Standards and the EIA thus complement each other. Strong environmental regulation requires both.

The lack of standards reflects the distortion of politics produced by influential industry and political leaders committed to a small state. Industry blocks the approval of standards but attacks the EIA for being ad hoc. Standards would impose the same emission standards on all projects and companies, treating all these equally and predictably. In their absence, industry has to rely more on the EIA which is negotiated project by project. Industry thus falls into a contradictory position Chilean politicians - committed to a small state - have been slow to point out: industry attacks the EIA as 'arbitrary' but blocks standards that would apply to all projects equally.

Standard setting is slow because it is a participative process where participants are imagined to be equal and the state is a neutral broker. Standards go through a long process: scientific studies, a proposal, public commentary, review and commentary by the Advisory Council, more public comment, a cost-benefit analysis by academic scientists, and final approval by the Council of Ministers for Sustainability. Industry associations often hire scientific studies that they submit by email to Conama (now the Ministry), while NGOs and civil society participate somewhat less. Conama's Advisory Council, with two representatives each from different social estates (industry, labor, NGOs, academia, consultants), must approve proposed standards before they continue through the vetting process (cost-benefit analysis and approval by the Council of Ministers for Sustainability follow). Because the Advisory Council's decisions require a quorum, representatives will not show up as scheduled to delay decision-making. So the neutral state exercises its brokering power by re-scheduling the meeting for next month. Staff at the Environment Ministry explained that standards are a "social agreement" about the level of risk society is willing to accept. Their role was to broker this agreement through a fair, transparent process and avoid being co-opted by other interests. Their role was not to prevent poor environmental outcomes.

As in the Advisory Council and the standard-setting process, scientists participate in environmental politics as "one more input". Compared to President Aylwin's 1993 promises, the spaces for scientific participation have been fewer and less influential than expected. Required cost-benefit analysis for environmental standards have been as few and far between as standards, so few academic scientists have participated in these as several scientists complained. The Advisory Council is frequently seen to have

[14] An otherwise very technocratic agency director felt this was one of the major mistakes of the environmental framework law, but he had few ways to try to correct this wrong because his agency has such limited capacity to interpret rules or exercise discretion.

little influence and few scientists have been interested in participating in it. Ten scientific commissions were created to advise Conama in November 2000 on issues like climate change and endangered species, but these were never mentioned during interviews and do not appear very active.[15] An exception is the commission on endangered flora and fauna with participation from the Academy of Science, Association of Research Universities and a group of committed scientists who published red books frequently used in EIAs.[16] A policy studies unit for Conama was created as recently as March 2007.

Conama proved technically capable but not politically effective: it has not often successfully brokered social agreements about pollution and risk levels. Only the EIA, discussed in detail in the second half of this chapter, lived up to President Aylwin's 1993 promises. Nothing in the 1993-1994 legislative debates indicated that the EIA would rise to become so prominent in Chilean environmental politics. In hindsight, only environmental regulatory policy within Conama's control flourished. Standards and participatory bodies that relied on broad participation - including industry participation - floundered. Possibly this reflects the lack of political inclination of Conama's directors. Only President Ricardo Lagos tried to be more political and named Adriana Hoffman, a well known ecologist and activist, to direct Conama.[17] But Hoffman disappointed as an administrator and after a few scandals in the early 2000s, Lagos returned to a technocratic path by appointing Paulina Saball, who had a long career in state bureaucracy, to direct Conama (during the controversies of the Valdivia mill and Pascua Lama). President Michelle Bachelet appointed Ana Lya Uriarte, an environmental lawyer and militant of the Socialist party. In a move characteristic of Bachelet's style (P. Silva, 2009), Uriarte represented the best of both technocratic and political worlds. These technocratic directors, however, did not convince everyone. As two former Conama employees with good positions said, Conama had functioned "as an orchestra without a director".

Reform 2010: towards "more technical" politics

The rise of the EIA as Chile's number one policy tool led also to a rise of conflict around EIA projects. By 2009, the EIA faced a crisis of legitimacy a conflicts piled up around it. Every legislator could name several EIA conflicts in his or her district, ranging from small ones like the fate of an urban park in the little town of Buin to major conflicts like Pascua Lama (chapter 2). Furthermore, by 2009, Chile was preparing to enter the OECD which practically required an Environment Ministry to strengthen environmental

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[15] From Conama's website, accessed November 2010.

[16] These include well known figures like Fabian Jaksic, Mary Kalin Arroyo and Julio Gutierrez, among many others, who have worked to produce Chile's red books of endangered species.

[17] Hoffman had a more combative administrative style than usual, but she also made some very bad environmental decisions, like the approval of the highly toxic petroleum coke for power plants. Pet coke produces 30-80% more carbon dioxide than coal. According to a sympathetic collaborator, she could not keep up with the demands of the job and was inexperienced for this kind of job. On the other hand, her willingness to get involved at this level is rare. She did her best to respond to Hajek's 1984 call for scientists to be engaged and relevant (Hoffman was a speaker too at the CIPMA meetings, chapter 2).

standards. In response to these challenges, Chilean legislators demanded "more technical" solutions while the OECD demanded "more state". Despite the big carrot OECD membership represented, opposition to a ministry was nonetheless strong. In 2010 just like in 1993, the ideals of transversality and technical politics emerged as sources of legitimacy to calm pro-growth legislators' fears.

Better environmental management was a requirement the OECD imposed on Chile to join its club. In 2005 the OECD audited Chile's environmental institutions and infrastructure and found it lacking; the club strongly recommended a Ministry. Nonetheless, industry and many groups on the ideological right, like the think tank *Libertad y Desarrollo* that does policy research for UDI and RN party politicians, protested this expansion of the state. These arguments took up an amazing amount of time in Congress and the Senate, but the heart of the dispute was summarized thus:

> One thing is to compete on price, another to compete on obstacles. [OECD countries] are going to place a series of requirements on our products, and even if we gave these away, they won't let them in to their countries. That is how they will stop our exports, which are the motor of growth. So lets give the OECD the importance it deserves. I made some notes from its manual: comply with the law, effective implementation of security measures, protect wetlands, little ponds, birds - please note all the things the OECD thinks about in its seven or eight macro projects - set emissions standards, etc. With the resources assigned [to the Environment Ministry], will we be able to hire the assessments and studies to meet all these requirements? Of course not. International competitiveness affects the environment. We wont be able to join the OECD. (Legislative History 20.417: quote 200)

Legislators pushing for environmental regulation touted foreign models from Germany, the U.S., Scandinavia and New Zealand for Chile to follow, in opposition to groups linked to industry and the ideological right. Like in 1993, their opposition was so strong that it was ironed out in a closed-door, marathon negotiation in Congress, heavily criticized by environmentalists (Tecklin, Bauer, & Prieto, 2011). Again, there was a seeming contradiction; expanding free trade required a larger state.

To implement the OECD's requirement for a stronger state with more environmental authority, Chilean politics required retaining some notion of transversality. In 1993 transversality signaled values like consensus and negotiation, and projected an image of a coordinating agency that placed the environment across a broad range of different agendas. In 2009 Environment Minister Ana Lya Uriarte dismissed these ideals with a dosage of realism: transversality was difficult in a hierarchical political context. The constant search for consensus had hurt environmental performance. A consensus-based, transversal office of the past had to be replaced with a ministry with more power over its adversaries. Yet the shift towards a more powerful - and by implication more adversarial - ministry required assurances that power would not degenerate into conflict (the specter of the "Ministry of No") and that consensus would continue to guide policy.

Surprisingly, assurances came through appeals to transversal and technical politics, operationalized as an increase in the executive government's authority through the empowerment of ministries. Ministers are named directly by the President and form his or her closest cabinet of collaborators. Ministers in turn appoint agency directors (like the new EIA Agency director) and the top echelon of state employees. In Chile's hierarchical culture (Ross Schneider, 2009), the President wields enormous power over his or her ministers and democratic governments have been quite cohesive (P. Silva, 2009). The power of the executive is further strengthened because Chile is a unitary country with fifteen regions but no decentralization. Citizens vote only for municipal representatives, legislators, and the President. In addition to ministers, the President appoints Regional Governors who alone have policy initiative in their region.

Legislators proposed many ways to make politics more technical by regulating information, but these were rejected in favor of mechanisms that retained consensus by increasing executive authority through three distinct shifts: two new ministerial councils were created and the committee that approves EIA projects is now controlled by ministries. Proposals to make the EIA more technical that were presented between 2003 and 2010 were rejected: to force that the final decision on an EIA project be accompanied by a "technical report" (N° 619412, Nº 3.286-12), to require consensus among all "technical organizations" (N° 587512), to require the participation of environmental engineers to legitimate reports (N° 4394-12) and to criminalize the falsification of data (proposed by Senator Alejandro Navarro, no number listed).

These proposals share an assumption that technical reports are "right" and that no good reasons exist to not follow what the technical report says. More technocracy can be achieved by forcing agreement and criminalizing the misuse of knowledge (an example of ex-post accountability to redress damages). But beyond these assumptions, these proposals leave "technical" very ambiguous. In 2009 many civil society groups, including academics and NGOs, delivered statements to Congress that called nearly unanimously for a more technical EIA process and more scientific participation. But they had much more in mind than these vague proposals, and probably never imagined the reforms would increase executive authority as has happened, nor did they anticipate how hollow the legislature's notion of "the technical" is.

The first shift in favor of executive authority lies with the new Council of Ministers for Sustainability. As the new organization chart prepared by the Environment Ministry shows (figure 2), the Council keeps a vigilant eye on the Environment Ministry through more powerful ministries: Economics, Treasury, Mining and Public Works.[18] Its main task is to approve environmental standards, raising doubts as to whether this will speed up or slow down compared to the already sluggish pace standard setting has. The Council of Ministers for Sustainability was a victory for small-state, pro-development groups. As one representative said, "We will give the Environment Minister all the tools she needs, but I also emphasize that at the Council [of Ministers for Sustainability] she will always have monsters next to her."[19]

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[18] Also included were Agriculture, Health, Energy, Housing and Urban issues, Transport and Telecommunications, and Planning.

[19] Legislative History 20.417: quote 531

The second shift to executive power affects the appeal process for EIAs. Before the reform, appeals against EIA decisions were reviewed by the Advisory Council, composed of two representatives of different social estates as discussed earlier. Appeals are now reviewed by a new Council of Ministers composed of Environment, Health, Economy, Agriculture, Energy and Mining. So the appeal process for EIAs was taken out of social representatives and given to a new group of ministers, where industrial interests like Economy, Mining and Energy are heavily represented.

Figure 2. Organizational chart of new environmental authorities.
The lone rectangle to the left is the Council of Ministers for Sustainability. Their position here represents their ambiguous status informally over-looking the new ministry.

The third and most important shift towards executive authority lies in the reorganization of the final committee in charge of approving EIA projects. Before 2010 EIA projects were approved by *Coremas*, regional environmental committees, composed of the regional governor, four regional councilors, thirteen regional ministerial representatives, and the regional director of Conama. Since 2010 a new evaluating committee of ten regional ministerial representatives, the Environment Ministry's regional representative, and the regional governor approves projects. As a result of the reform, EIA projects are now approved by representatives of ministries in each region. There are no locally elected representatives on the committee that approves EIA projects.

Coremas were one of the most reviled bodies of the EIA and their reform towards a "more technical" and "less political" body was a motivating concern. It is difficult to exaggerate how important the reform of the Coremas was to environmentalists and communities. There was near unanimous agreement that these bodies needed to become "more technical" and "less political". This was achieved by eliminating regional councilors. Regional councilors are the only somewhat democratic figure that links the local and central levels in Chile's highly centralized government. They are elected by municipal representatives (who are elected by universal suffrage) and advise the Regional Governor (who is appointed by the President). Even so regional councilors were too political for Chile's technical politics and were removed from the Coremas. Worse, after a lot of debate, regional governors were reinstated to the Corema because many on the ideological right argued they are the most important local authority.

The direction of reforms towards executive authority begs the question why ministries, of all government offices, were seen as "technical" voices? Though regulated by laws of Congress, ministries and ministers respond directly to the President who appoints his closest allies as ministers. To Chilean legislators and others in government, ministries that represent "sectoral" interests, like agriculture or mining, are "technical" as opposed to "general" interest ministries like Interior. State employees are imagined to have autonomy from their Minister and discretion to apply the rules as they see fit. But this is not the case in practice, as the next chapters show. Instead, regional ministerial representatives are positions of political confidence. Most individuals appointed to those positions hope to climb the government ladder with a position in Santiago. They court their bosses in Santiago and often have only a passing interest in the region where they work. Tenured civil servants who review EIA projects are more likely to have deeper roots in the region where they work, but they work like bureaucrats who apply the rules and exercise little discretion.

In 2010 as local electoral politics lost power with the demise of the Corema while ministries gained power, direct public participation was also expanded. This pattern of a combined movement towards more technical and more participative democracy is characteristic of Bachelet's government, according to Patricio Silva (2009). Public participation in the EIA was expanded so now anyone can submit comments on EIA projects, not just members of the affected community. Smaller impact declarations may also trigger public participation if enough members of the community demand it. If a lot of new information is presented during the EIA process a new public participation process can be required. And public comments that are not adequately addressed can form the basis for appeal of an EIA decision.

Normative arguments for more participation notwithstanding, some worry that expanded direct democracy with disempowered bureaucracies and weak local politics will increase conflict and polarization. These concerns were expressed in interviews and at a workshop on the new EIA regulations that were being drafted in 2011. In this view, the new evaluating committee is like a trojan horse amongst a package of pro-environment reforms; as communities realize how far removed the new body is from their local interests, frustrations and demands for more direct democracy will only grow.

Legislators who supported the reforms, including Uriarte, did not seem to see the potential risks or contradictions.[20]

The risks were best expressed a few weeks later during the height of the crisis over HidroAysén. The Energy Minister summarized the heart of the dispute like this: "the people are empowered but they are not well informed because they are asking things of the government it can not deliver" (see chapter 6 for a longer discussion). So power is increasingly concentrated in the executive but not the discretion, expertise or authority required to re-shape policies. Interestingly, these shifts towards central control were largely not picked up by the media, opinion writers, or legislators, with a few exceptions. Further research should reflect on this shift in Chile's historical context where centralization was linked to the preservation of dominant socioeconomic structures (Levitsky & Murillo, 2012; Valenzuela, 1977).

II. Environmental Impact Assessments in Chile

Between 1993 and 2010 the Environmental Impact Assessment (EIA) grew to become Chile's number one environmental policy tool. Until 2010 the EIA was a process administered by Conama, from a subdivision called the EIA Service. Staff included an EIA director in Santiago with a team of reviewers who would be assigned to manage the entire processes for one project. This was replicated in each region - one EIA director with a team of 4 to 8 reviewers. According to respondents, most Conama staff worked on the EIA. Since 2010, the EIA is administered by an autonomous agency, the EIA Agency (figure 2, SEA).[21] The 2010 reforms sought to make the EIA more technical and democratic; as described above, this meant increasing the role of ministries and expanding direct participation. This section goes into detail about the EIA process and two fantasies that guide it: a technical and a democratic fantasy. While in the 1990s concerns about capacity guided Conama's priorities, in 2010 the driving concern was information.

Information is central. The EIA is a registry of objectivity in that it generates data, collects it, organizes it and disseminates it, transforming data into official public information for decision-making. Knowledge that goes through the EIA process becomes part of Chile's validated, official information about the environment. The EIA is not a database or data collection program, but a series of procedures and resulting reports that together register the country's objective knowledge about environmental impacts, harms, risks and obligations. But the promised technical rationality of the EIA is in crisis. Actors complain that the there is too little bibliography and that the EIA does not "speak truth to power" because politics gets in the way. In response legislators tried to regulate how information flows and is used, as detailed above. This section will detail

[20] At a workshop on consensus building I asked Ana Lya Uriarte during the Q&A if regional councilors were removed from the Corema to make it more technical, and if she felt this might have any negative consequences for representation. She answered yes to the first part and no the second part of my question.

[21] Some respondents went so far as to say the new EIA Agency is the old Conama, while the new Environment Ministry is mostly new because Conama did so little outside of administering the EIA. This is likely an exaggeration but has some truth to it.

the multiple sources of problems that erode the perceived objectivity of the EIA's information: the role of markets, privatization and rules.

This section describes how the EIA is supposed to work, in contrast to the next three chapters that look at three controversies that shook Chile's EIA politics. Using the lens of a registry of objectivity, the same analytical structure is used throughout: context, participants, legibility and standards of proof. Participants lays out who gets involved in the EIA process and under what conditions, paying attention particularly to experts from academia and consulting companies. Legibility focuses on how information is produced, vetted and validated, as the company submits its impact evaluation and government staff review it, under the coordinating gaze of the EIA Agency (previously Service). As the next chapters argue, the process often results in *illegibility*, contributing to the EIA's crisis of legitimacy. Standards of proof refers to how the process reaches closure. This is the most ambiguous phase of the process. Contrary to government staff's assurance that things are "pretty well regulated", closure is not reached when agreement is reached, but when time runs out.

Context: technocracy and democracy

EIAs are a technocratic and democratic policy tool. Technocracy lies in the emphasis on incremental improvements, suggested by specialized and expert actors, and selected through a rational process that considers the multiple risks, costs and benefits. Rather than suggest radical alterations to a project - like moving a paper and pulp mill to a different area, or substituting hydropower with solar panels - EIAs suggest incremental improvements like additional wastewater treatment or adding a bridge to compensate making a river unnavigable. Democracy lies in the origins of the EIA in Chile, adopted as part of the promises of the new democracy. The EIA is grounded in Chile's 1980 constitution and arbitrates between rights to a clean environment and to free enterprise (chapter 1). The twin goals of democracy and technocracy were in the 1993 Presidential memo that first introduced the EIA to Chile: "These instructions [for the EIA] represent a great achievement, as from now on we have technical guidelines based on a high degree of consensus and delivered personally by the President of the Republic."[22] This section discusses these twin goals in greater depth.

With the President's 1993 memo, the EIA became a voluntary procedure (it became obligatory in 1997). As represented in figure 3 the goal is to approve projects "if sufficient". The memo states explicitly that no project would be rejected due to environmental reasons. The Chilean EIA, likes those around the world, strives to change "business as usual" without blocking business (Glasson, Therivel, & Chadwick, 2005). The goal of improvement is embedded in assumptions about impacts. The EIA assumes that existing ecological conditions can be recorded (in a baseline) and the impacts of a proposed project predicted before it is built. This gap between existing and projected conditions creates the opportunity for incremental improvements, as reflected

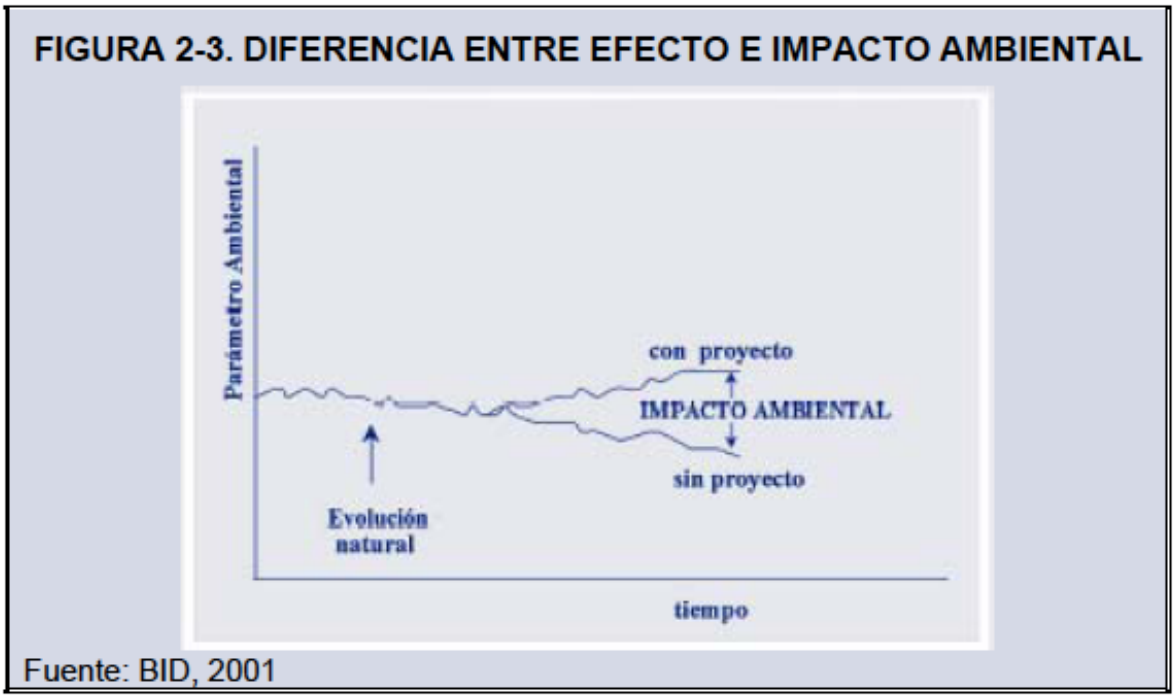
[22] "Instructivo Presidencial: Pauta para la Evaluación del Impacto Ambiental de Proyectos de Inversión" (September 1993). Signed by Rafael Asenjo, Secretario Ejecutivo, Conama. Obtained through a freedom of information request. Quote is on page 5.

in figure 4. Improvements in practice mean compensation and mitigation measures like replacing glaciers with a dam to regulate river flow, reforestation and pollution abatement technologies. In Chile and around the world, rarely does the EIA lead to changing the location of a project or blocking it altogether (Glasson et al., 2005; Owens, 2002; Pope, Bond, Morrison-Saunders, & Retief, 2010). The belief that incremental improvements, identified by experts, is sufficient to address communities' environmental concerns is central to the technocratic core of the EIA.

Figure 3. Improvement through EIA: diagram of mitigation and compensation
Source: Espinoza (2007) *Gestion y Fundamentos de Impacto Ambiental*

EIAs everywhere share these and other characteristics, but no two EIAs are exactly the same around the world. The Chilean EIA introduces some idiosyncratic sources of technocracy, particularly the focus on rules and regulations. Compared to a generic, 'best practice' type EIA, three inter-related characteristics of the Chilean EIA stand out (table 1). First, rules guide large parts of the EIA in Chile, including what projects are required to submit an EIA, what are the potential impacts projects may have, and the content of the impact assessment reports. In contrast, best practices recommend more flexible approaches led by government agencies. Second, the developer or company proposing a project plays a large role compared to the government. Like the UK, the Chilean EIA is 'developer led' or very privatized. The company drafts the terms of reference that define the scope and the studies, with help from consultants of their choice. In Chile in addition the company often owns the data it produces and there is little stock of available public data for others to access. Third, compared to a generic best practice approach, there is little room for discretion built into Chile's EIA. Prioritization of impacts, identification of risks and vulnerabilities, sensitivity

Figure 4. Environmental Impacts: "the difference between effects and impacts"
Source: Espinoza (2007) *Gestión y Fundamentos de Impacto Ambiental. Y-axis is "environmental element" and X-axis is "time". Top line is nature "with project" and bottom line "without project".*



analysis, multiple perspectives - all these forms of analysis that could add richness and depth are not practiced widely in Chile, as the next chapters will show.

These characteristics have consequences for equity, democracy and information flows. In terms of equity, the EIA in Chile has become so dominant many interviewees turned 'EIA' into a verb - *seización*[23] - to refer to environmental politics in general. The advantage is tailored evaluations for each project. The disadvantage is that even the smallest projects - a recycling truck - go through impact assessment though many activities could be more efficiently regulated through standards. The result is a huge EIA system that is expensive for small companies (figure 5). Most small companies have to submit Declarations (DIAs, bottom graph in figure 5), which are "light" EIAs without baseline or public participation; but declarations are still expensive for small companies and large companies have passed EIAs as declarations. Another disadvantage is that the environment is fragmented and cumulative, long-term and complex impacts are not well evaluated. All these reasons, including the challenges around publicly credible information, have led to the EIA's crisis of legitimacy among Chileans (for another discussion of this crisis see Tecklin, Bauer, & Prieto, 2011). The

[23] Adding the suffix –ción creates a verbal noun that denotes action or effect.

EIA literature has yet to address the causes and consequences of this level of bureaucratic conflict.

In terms of democracy, the EIA's structure in Chile falls short of demands for accountability. Accountability is supposed to be served through the EIA's organization as as an administrative "single window". The company proposing a project obtains through the EIA all the construction and operating permits it needs in one process. This is administratively efficient, as it coordinates state agencies and legal requirements so a project can not receive green light on environmental matters, but separately be denied another permit. However, the way this process has been institutionalized distorts how the EIA is supposed to exercise accountability: while in spirit EIAs are about preventing environmental harms, in practice the documentation and permits produced through the EIA are used to hold the company accountable if the project diverges from the promised conditions. For this reason the baseline that records existing conditions is critical. The ways this distortion happens are detailed in the next chapters. Accountability is more about redressing harms than preventing them.

Metaphorically the EIA is also a single window for the government and communities to influence a project and so is subject to a 'democratic fantasy': legally binding public participation. Outside the ballot box, no other mechanism or fora exist to shape policy. An EIA Agency employee said "the EIA works too well" to emphasize that the EIA is a one-stop-shop to exercise accountability. Communities focus their demands on it because they have no alternative channels. So environmentalists' (and communities affected by projects they do not want) often call for a legally binding public participation process.

Though easy to dismiss as a romantic appeal to a hyper-cohesive imagined community, this demand reflects dissatisfaction with existing forms of accountability and by extension of democracy. Accusations of a 'democratic deficit' are common throughout EIA politics; in chapter 5 activists criticize a "politics of completed actions", where decisions are not democratic because they are made preemptively and not through the process. Activists criticized the 2010 reforms because they were done behind closed doors in a marathon congressional session. As a result activists argue for an exaggerated democracy which is in fact un-democratic: legally binding public participation may seem like the zenith of democracy but actually subverts democratic notions of majority rule. Even a minority of one could have enormous power over the majority, leading to a democracy as undemocratic as the one activists criticize.[24]

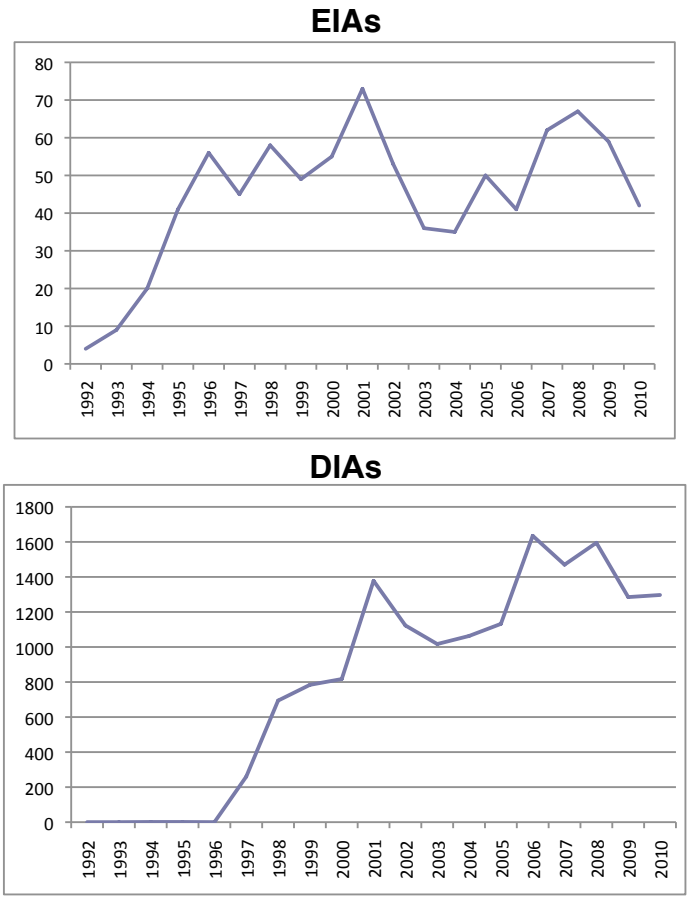
[24] http://www.latercera.com/noticia/opinion/ideas-y-debates/2010/09/895-293060-9-politizacion-e-institucionalidad-ambiental.shtml; and http://www.elmostrador.cl/opinion/2011/05/31/hidroAysén-la-responsabilidad-historica-de-bachelet-y-la-Concertación/. Chapter 6 has a longer discussion.

Table 1. EIA actions in Chile and globally Adapted from Lawrence (2004)		
EIA action	**Chile**	**Global "best practice"**
Screening: does the EIA apply or not?	Law lists projects that require an EIA.	Focus on large projects.
Scoping: what to study or focus on?	Law lists 6 impacts; developer drafts terms of reference.	Government authority control through terms of reference.
Proposal characteristics & content requirements.	Specified by law; developer and consultants carry it out.	Flexible process where authorities shape priorities.
Analysis of alternatives to the project?	Not required	Well defined, feasible alternatives are evaluated.
Baseline analysis: what are environmental conditions if no project is implemented?	Most important part. Only historical and current conditions documented, not future ones.	Required. Esp., sensitivity and significance of environmental components, functions & processes.
Impact analysis: what impacts, risks & uncertainties does the project pose?	Done by consultants. Limited use of likely scenarios or risks. Privileges certainty.	Predict likely future conditions, interactions, from multiple perspectives.
Synthesis and significance: to prioritize impacts	Some significance ranking done but very poor (see chapter 6).	Significance analysis with thresholds. Synergistic & Cumulative impacts.
Participation from third-parties.	Affected communities can participate in forum and on paper. Opened to everyone in 2010.	Emphasizes public understanding, negotiation, equity, power imbalances, build trust.
Management: mitigation and compensation enforcement?	Defined by EIA Agency. New enforcement agency (2010).	Integrate enforcement and monitoring in one strategy.

Finally, accountability suffers due to exaggerated or even fantastical notions of transparency pursued by the government. Every EIA study, call to meetings, legal document, letter or review from government agencies goes online and is accessible to anyone. Transparency standards grew through the 1990s to an exaggerated degree: every individual agency's review of the EIA is online, every demand for more information, information about meetings and who was there, every bureaucratic step is online for HidroAysén's EIA (chapter 6), while often just summaries and final reports are available for the Valdivia mill and Pascua Lama cases (chapter 4 and 5). Supporters of the government often applaud this and cite the high transparency standards as evidence of Chile's good government practices. It is not clear what all this transparency

serves, particularly when so much remains off-line: the original baseline studies, the terms of reference, the names of scientists and consulting companies responsible for collecting and analyzing data, and raw data series. The EIA process has become more transparent over time but not more accountable. Both increased transparency and expanded participation seem to be necessary but not sufficient conditions for a truly accountable and democratic government process.

Figure 5. Number of EIAs (n=855) and Declarations (n=15,552) by year, 1992 - 2010
Source: EIA database compiled by EIA Agency, accessed July 2011



Participants

In any process that aspires to be technocratic and democratic who participates is critical. Examining who participates in the EIA provides another view of Chile's hollowed out state: consultants, hired by the company or developer building the project, are the main participants, as noted in table 1. Companies select and hire specialized consulting firms to elaborate EIAs, and sometimes academic scientists of their choice. The EIA literature takes for granted the role of consultants though scholars often call for more participation from academic scientists and universities, without reflecting on why this is desirable or what obstacles exist (Ahmad & Wood, 2002; Doberstein, 2004; El-Fadl &

El-Fadel, 2004; Glasson & Neves Salvador, 2000). Furthermore, as noted in chapter 1, many countries try to regulate the production of knowledge, for example by certifying experts or drafting terms of reference. In Chile, in contrast, state regulation is focused on government reviewers. Only guidelines - not legally binding - try to regulate knowledge production.

One of the defining characteristics of Chile's EIA is that the developer hires the consultant, scientist or expert of its choice, creating a suspicion of conflicts of interest. Many in Chile and around the world believe consultants are beholden to their employers and will not produce studies, data or results that could hurt the hand that feeds them. In the case of the EIA, the objective is to approve the EIA documents and possible damages will only occur years later. Thus the accountability link between consultants and possible environmental damages is long and weak. On top of it, as discussed above and in table 1, potentially complementary measures - like the terms of reference - of public accountability are also weak in that the developer controls these. Though originally Conama was to draft or at least negotiate the terms of reference with the developer, this was dropped and never discussed again.[25] Furthermore, as discussed in the next few paragraphs, consultants have important political links.

Environmental consulting companies were founded recently but have grown quickly. Good consulting companies combine technical and political know-how. Many consulting companies were founded by individuals who were members of the original group of technocrats involved in environmental politics in the 1980s and who then worked on the proposed environment framework law (see also E. Silva, 1996). A politically influential person normally leads the consulting company, and many of them pinch staff from the EIA Agency. Multinational consulting firms are also important and often will buy a local company along with its political connections. The same company - Arcadis - did the EIAs of both the Valdivia paper and pulp mill and Pascua Lama. HidroAysén worked with an up-and-comer firm called Poch. It is a small, cohesive community that is embedded with the history of Conama and the EIA Agency.

Companies on average are reported to spend US$80,000 on an EIA. HidroAysén, the largest EIA ever in Chile, cost US$12 million according to the company, or 0.34% of the total reported investment. Interviewees estimated that a normal large EIA in Chile costs around US$1 million, putting the average cost of en EIA as percentage of total investment at less than 0.5%. Glasson and co-authors (2005) report estimates that range from less than 0.05 to up to 5%. Many feel this is very little given the supposed importance of the EIA. About ten big consulting firms exist and gross about US$7 million, according to a report in *El Mercurio* from 2003. Mining work dominates the sector; that is where the money and expertise lie.

Occasionally academic scientists and other specialists are hired to produce specific studies for the baseline. Baselines are the first part of the EIA; their objective is to characterize ecological conditions in an area before the project is built. The next three chapters focus on when and why academic scientists are hired, and who is considered

[25] Two documents available in the archives at the Environment Minister discuss this. (1) By Geotecnia Consultants, "Analisis de los procedimientos administrativos para le SEIA" (June 1995). (2) By Guillermo Espinoza (1997).

an expert by different groups. Actors have widely different views about who is an expert, and what academic science can contribute to public environmental policies. Compared to other Latin American countries, Chile is reported to have a lot of participation from consultants and little participation from scientists (Espinoza & Alzina, 2001). The over-reliance on consultants compared to academic scientists is in line with the historical role scientists have played in Chile and with pro-market policies adopted since the 1970s and 1980s, as discussed in chapter 2. Chile provides an opportunity to reflect on the pros and cons of science for sale at a time when many countries are moving in this direction.

Rather than regulate private experts (consultants), Conama and now the EIA Agency have tried to direct consultants through guidelines. Guidelines are a global best practice to set standards for how to construct baselines and predict impacts; they provide guides to data collection and analysis methodologies for specific topics, like stream flow in different condition. Conama issued many guidelines, but these were never mentioned in interviews nor where they relevant in the conflicts studied in this dissertation. Nonetheless, the director of the newly autonomous EIA Agency set out to make the EIA "more technical" by improving guidelines through the validation of the Academy of Science.

Alone among his peers, the EIA Agency's director defines technical with science. He hopes to draft dozens of new guidelines based on enormous decision trees drafted with the help of an inter-disciplinary team of researchers at the University of Chile. These trees will identify the need for a guideline. Then a public tender is put out to hire an academic group to draft the guidelines. The Academy of Science participates in vetting the terms of reference for the public tender and in the selection of the scientists who will prepare the guideline; in this way, the EIA Agency hopes to hire the best scientists for the job, not the cheapest as is normally required by Chile's system of public tenders. Hopefully, this will lead science to "permeate the country's public policy decisions". Successful uptake of the guidelines depends on how credible the Academy of Science is among different publics - including other scientists, companies and the public - and consultants' willingness and capacity to use the guidelines. This dissertation gives many reasons to think these are unreasonable assumptions. Unfortunately, the EIA Agency's director had few if any alternative sources of credibility to draw on.

The public and regulated part of the EIA process affects government reviewers. Though in 2010 the EIA moved from within Conama to an autonomous agency, the governments' participants have not changed too much: they are mostly civil servants and professionals, employed to review EIA projects led by EIA directors who are political appointees. The EIA Agency's director and each regional director change with each new government, but they manage reviewers that are more or less stable (reviewers who leave are generally employed by environmental consulting companies). The EIA Agency invites other government agencies to review a project based on the project's characteristics (e.g., the Geology Agency might not be asked to review a project about a salmon farm). Around 35 different agencies could potentially participate; only very large projects like HidroAysén generate invitations to all of these. Agencies differ in terms of

influence and capacity, and the most important are listed in table 2. Municipalities can review projects if they choose to.

When asked what to do in case of doubt, a regional director of the EIA Agency thought about it briefly and nodded approvingly: “Everything is well specified in the rules and regulations”. He went on to explain the only regulation he missed was one specifying the range of expertise his staff should have. Though at the time he had good staff (eight in total, most with more than five years of experience), he was missing some areas of expertise and this sometimes hurt their capacity to review some projects. But EIA staff only do part of the evaluations; most of the review is done by staff in agencies like those listed in table 3. These can often be under-staffed for the EIA. For example, Water Agency in Aysén has just two employees to evaluate EIAs and the Geology Agency has just one employee. Either for lack of staff or expertise, agencies may hire consultants or scientists to assist them in the review of parts of the EIA.

Table 2. State agencies that participate in EIA

English name	Ministry belongs to	Chilean name
Fisheries	Economics	Subpesca
Forestry	Agriculture	Conaf
Agriculture and Livestock	Agriculture	SAG
Water	Public Works	DGA
Geology	Mining	Sernageomin
Ports and infrastructure	Public Works	MoP

Those who review and those who approve projects are different people who work at different government offices. For example, from table 2, the Forestry Agency sits within the Ministry of Agriculture. When invited to review a large project like HidroAysen, the Forest Agency’s staff in Aysen will review the project; these are civil servants who live in the region for many years and have relevant training. The Aysen-staff may seek help, or direction from, their colleagues and bosses at the Forest Agency in Santiago. The reviewers’ evaluation travels first from Aysen to Santiago within the Forest Agency, and then from the Agency to the Ministry of Agriculture in Santiago, then back to Aysen through the Ministry’s regional office. This regional ministerial representative then votes on the project. His or her vote represents not just the Forest Agency, but also the Agricultural and Livestock Service that also sits within the Ministry of Agriculture.[26]

[26] Since 2010 the Environment Ministry also has a vote but government staff I spoke with did not know yet if the ministry will do its own EIA review.

This process is organized differently in each agency. One government employee quickly explained that "in this agency, we all work together from the beginning, so there is no changing the reports down the line in Santiago or anywhere". His comment was in response to accusations at the time that the Forest and Geology Agencies in Santiago had modified unilaterally (and illegally) the assessments made by agency staff in Aysen. Tensions are thus common and there is disagreement over what the relationship between regions and Santiago, agencies and ministries, and technical and political staff should be. Reviewers felt that ministerial representatives who vote on projects are not well informed of a project's EIA. Those who vote have little time to become familiar with the technical details, and for large projects these are overwhelming: EIA reports do a very poor job of prioritizing impacts and the EIA Agency does not summarize concerns in the new required "technical evaluation report" at the end of the process.

While reviewers generally agreed about their own role in the process, they disagreed about what should inform ministerial representatives' votes. Reviewers agreed their role was to be neutral arbiters. They used expressions like "be the net on the tennis court" or "draw the lines on the soccer pitch" or "just doing our job" to signal their adherence to the rules as specified in the numerous permits the issue through the EIA. Ministerial representatives, on the other hand, may vote based on what the director of their agency told them, that is, following the results of the technical review. Other reviewers believed representatives voted following broader political interests but informed by the review process. And other reviewers shrugged when asked about this and replied that representatives vote however they like. Agencies varied a lot in terms of the degree of communication between review staff, directors and ministerial representatives.

The public is concerned that reviewers and ministerial representatives do their job based on political not technical criteria. The government has tried to solve this with regard to reviewers by subjecting them increasingly to rules that guide their behavior at the cost of reducing their discretion, while treating ministerial representatives as technical by definition (see discussion on *Coremas* above). As will become clear in the next few chapters, however, there are broad disagreements about what political and technical mean.

Legibility

Concerns for the challenges reviewers and ministerial representatives face overwhelms concerns about the quality of information. Legibility is about the conditions that shape participation and the institutionalized channels that produce credible public information. There are good reasons to be concerned with the quality of EIAs. Only 22% considered EIAs "good" in Latin America and only 9% of 22,395 projects in the region were rejected (Espinoza & Alzina, 2001). Similarly, just one third of UK EIAs are considered good (Glasson et al., 2005). Global notions of good governance shifted from a concern for capacity, training and skills in the 1990s, to greater concern for institutional practices in the 2000s (Grindle, 1997). A similar shift is observed in Chile: whereas in the 1990s Conama was concerned with trainings, by 2010 concerns about

information dominated. Rather than address the market and conditions in which knowledge is produced, the government has tried to address concerns about information by regulating the content of EIAs more than empowering reviewers.

Questions about quality and information are questions about the distribution of power. Agencies are loosing discretion as they are increasingly bound to follow very well specified rules and executive authority. Squeezed by rules, reviewers have to focus their attention on what can not be completely specified by rules: that is the baselines that record ecological conditions of an area prior to the building of the proposed project. Baselines can not be perfectly specified in rules because the strength of the EIA lies in the fact that it reflects each project's specificities and interactions with its unique location. Furthermore, baselines are important because they are used to exercise accountability in case of harms down the line. So reviewers can only exercise discretion over the baselines - are these complete and unbiased? This leads reviewers down a rabbit hole as exhaustivity is their best or only option to hold projects to a high standard. Many complain, as a result, that EIAs are full of "irrelevant information" (Contreras, 2000; de la Maza, 2001).

As discussed earlier, rules increasingly govern EIA life in Chile. The best example of this is that environmental impacts are defined by law, before a single piece of data is collected or analyzed. Article 11 of the general framework law lists six environmental impacts that trigger the requirement of an EIA: (1) environmental health risks for the population; (2) significant negative effects on the quantity and quality of renewable natural resources (not minerals); (3) resettlement or otherwise interrupting the lifestyle of human groups; (4) proximity to populations or areas important for conservation; (5) large-scale and long-term impact on the tourism value of an area; (6) alteration of sites part of the national patrimony for archeological, historical or anthropological reasons.[27] Consultants can quickly deduce impacts based on a project's location. Proximity to indigenous communities or national parks will create "problems" but other potential impacts are "manageable", say consultants.

Rules govern nearly every other important aspect of the EIA. A three page list in the law specifies which projects must submit an EIA; this includes nearly everything except artisanal or subsistence activities. The contents, format and layout of the EIA are all specified by law: nine chapters that start with a general description of the project; a list of applicable environmental norms and how the company will meet them; a description of the impacts the project will generate in legal language; the area's existing conditions or baseline; the impacts and compensation or mitigation measures; monitoring; a summary of the above in tables; actions taken to ensure public participation; a summary of the whole report; and various annex with maps, further information, lab reports. Nearly every interview with EIA staff resulted in the rule-book being pulled out to provide verbatim responses to my questions.

In contrast, the 1993 Presidential memo lists "none" under legal precedents and gave Conama broad discretion and responsibilities: for drafting the terms of reference (negotiated with the developer) and a summary report, and to identify which projects

[27] These are further specified in Decree 95 that implements rules and regulations for the EIA.

needed to be submitted. Reviewers had discretion over a range of things related to the quality of information, like assessing if impacts had been adequately predicted, if the baseline established causality or if there was missing or biased information. These responsibilities became increasingly regulated or privatized over time, as listed in table 1. A 2007 memo is full of legal-linguistic turns to reduce discretion: it specifies the range of arguments state agencies are allowed to make (only based on technical and legal codes), and says Coremas can approve or reject projects disregarding the results of the review process as long as the decision is justified.[28] The Chilean EIA is visually represented as a highly simplistic and horizontal process that echoes these guiding values (figure 6). Representations of other EIA processes are usually more intricate and organized vertically.

The last frontier of reviewers' discretion lies in baselines, and this too is now under threat. For years different groups have appealed to a technocratic fantasy - a grand master baseline that encompasses everything in the whole country - to solve the EIA's credibility issues. The reformed environmental framework law gives the new Environment Ministry authority to do this: (article 70, numeral j) study biodiversity protection and conservation, administer and update a data base about biodiversity; and (article 70, numeral k) execute the needed studies and "compile all the available information to define one baseline for the country, national environmental accounts, including environmental assets and liabilities (*activos y pasivos*), and the carrying capacity of different environmental watersheds in the country." Furthermore, the law requires the EIA Agency to create a searchable database of EIAs in a kind of 'crowd sourced' master baseline. The new Ministry and EIA Agency were beginning this work in 2010 with inventories of wetlands, ecosystems and glaciers.[29]

This technocratic fantasy has broad support among many groups, including environmentalists who see it as a way to hold the government and the EIA process accountable. They imagine a grand baseline would act like a grand sheet on which every new stain becomes quickly and unambiguously visible. In environmentalists' mind, a grand baseline would move Chile closer to European-style land-use planning after the perceived failure of a U.S.-style model based on strong environmental emission and quality standards. Like the democratic fantasy of legally binding public participation, the technocratic fantasy represents an unrealistic attempt to produce more credibility and accountability in the EIA. Unfortunately, a master baseline seems likely to reduce agencies' and reviewers' discretion even further, producing a net loss in the EIA's quality (Levitsky & Murillo, 2012).

The idea of a master baseline or inventories has deep roots in Chile. In the early 1990s several inventories were published, including one by urban planners of 180 environmental problems chronicled from North to South; another by a consulting group called TESAM of pollution problems and available statistics river by river, from North to South (March 1995, for Conama); and scientists called for more inventories. In the late 1980s like now, scientists argued for the need to standardize data collection to create

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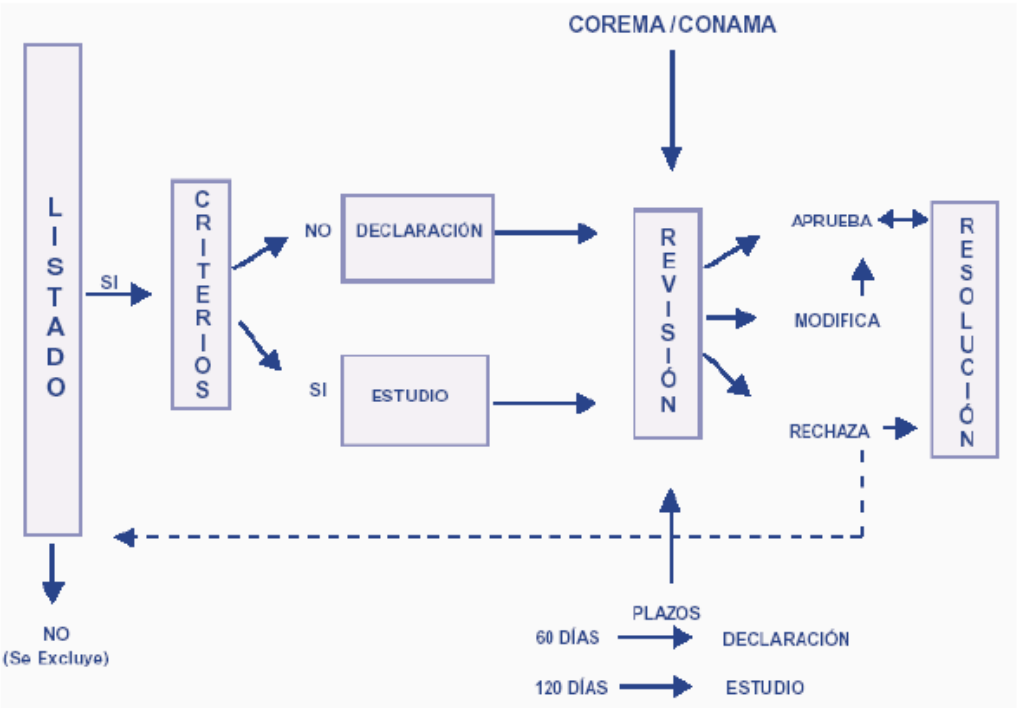
[28] Memo signed by Minister Ana Lya Uriarte, March 14, 2007.

[29] These efforts were just beginning during my fieldwork and inevitable disagreements over methodology and who was hired to conduct the studies existed.

accessible inventories of habitats and ecosystems on land and in the oceans.[30] Ernst Hajek in a study on capacity needs for Conama emphasized the need for bibliography. But the Senate in 1993 rejected calls to inventory the country, North to South, as scientifically and technically impossible.[31] Senators feared this was a tactic to delay environmental regulations, subjecting them to an impossible scientific standard.

Twenty years later efforts to inventory the country persist and have become a legal requirement for the revamped environmental institutions. This dissertation shows however that this kind of master baseline faces an uphill climb to establish its credibility. Disagreements over the credibility of different methods, the independence of scientists and consultants, and over what counts as sufficient scientific evidence or proof would undermine the baseline's value. Producing a further fall in reviewers' discretion, the master baseline would lock representations of local ecologies into a new scientific Ivory Tower, and disputes over credibility would obscure the really important disputes over development goals. As a technocratic solution, a master baseline would soon fail to ratify environmentalists' positions.

Figure 6. The Chilean EIA system. If a project is rejected, it can start again.
Source: Espinoza (2007) *Gestion y Fundamentos de Impacto Ambiental*



[30] Article published in *Ambiente y Desarrollo* (Vol. V, No. 2) August 1989.
[31] This was part of the discussion on the definition of natural patrimony, discussed in chapter 2.

Standards of proof

The process of making things legible needs to close when shared standards of proof are met. These can include many different things: calculus of risk, statistics, projections, opinion by experts or other groups, etc. Advocates of a master baseline might advocate that standards of proof are met when predictions can be compared against the master baseline. Alternatively, proofs might exist through a negotiation and consideration of political goals, like benefiting a certain community or voters. Different forms of proof exist, but they share a capacity to close debate and settle disputes. Chile's EIA reaches closure when time runs out. Beyond that, standards of proof are very unclear.

The EIA operates like a time-bomb. Once a project is submitted by the company for review, the EIA Agency has 120 days to review it. On the 120th day, the project must be voted on. The company can stop the clock at any time to do more studies to answer agencies' questions. State agencies review the EIA and go back-and-forth with the company, all in writing, rarely in face to face meetings, each side supported by an extensive if rather invisible network of consultants, scientists and evaluators who participate without necessarily adding their name to the process or documentation.

Before 2010 the EIA could go back and forth between the state and company many times until time ran out. Since the reforms EIAs no more than two rounds of back-and-forth between the government and the company are allowed. Ostensibly about reducing the EIA's time frame, this reform is really a measure to force companies to "put their best foot forward from the start". Companies have commonly withheld information from the original EIA to submit it later in response to reviewers' questions. While companies accuse reviewers of being exhaustive to the point of abusive in their demand for more and more information, reviewers quietly criticize companies of producing shoddy EIAs. Though business and right-wing sectors complain obsessively of the time to review, the fact is that on average EIAs are reviewed in just eight months. Since 1993 only 19 projects (of 855) were in review more than three years, and of these four were withdrawn, four were rejected and eleven were finally approved.

To obsesses about the time to review is to attack quality in the EIA. Regional offices of the EIA Agency are under strict time and budget constraints. In the case of HidroAysén's EIA, reviewers had 30 days to review the EIA which occupied "a cubic meter of information". Subsequent revisions were even quicker: 15 days, although HidroAysén added new data and maps. EIA review and evaluation is in fact a zero-sum game for state agencies: the EIA Agency has less time to do its work if it allows state agencies more time for review. Nonetheless, the government and the state aspire to make the process faster and more aligned with global good government practices. One regional EIA director explained:

> What we aspire to do as the EIA Agency is to make environmental evaluation more transparent…We think that with clear rules, concise and precise instruments, we can improve the evaluation of projects, so they

> can be evaluated to a higher standard and even faster, because many investors depend on this to be able to execute their project.

Although this director - recently recruited from the private sector - was shocked at how small his regional office's budget was and had nothing but praise for his team of reviewers, he insisted on the need to be faster, more transparent and more rule-bound.

When time runs out the EIA Agency schedules a meeting of the evaluating committee to take a vote. The evaluating committee (formerly the Corema) can approve, approve with conditions, or reject an EIA. The committee emits a resolution (*resolución de calificación ambiental*, RCA) which compiles information about the process and lays out the project's obligations. This is a contract for pollution between the state and the developer. Environmentalists often criticize that over 95% projects are approved. The approval rate is lower because an important number of projects are withdrawn, giving further credence to the idea that companies either withhold information or present bad EIAs that the government has to weed out. Only 5% have been rejected, which is lower than what Espinoza and Alzina found for Latin America as a whole (table 3).

Table 3. EIAs by result, 1993-2011

	N	(%)
Approved	594	68%
Rejected	47	5%
Withdrawn	133	15%
Not admitted	52	6%
In evaluation	54	6%
Total	880	100%

Source: elaborated from database of EIA projects obtained from SEA in July 2011. Only 712 EIAs of the total had both entry and exit dates. The EIA was voluntary until 1997.

III. Expanding the state: Enforcement and Environmental Tribunals

In 2010 Congress reformed the environmental framework law and ushered in a potentially new area with a significantly expanded state. In total four new institutions were created - the Environment Ministry and the EIA Agency - and a new Enforcement Agency (*Superintendencia*) and Environmental Tribunals. Significant as this is, the Superintendencia's budget in 2013 was just US$10 million, compared to US$74 and US

$44 for the Environment Ministry and Environmental Secretariat that depends on the President (table 4).

Table 4. Budget of new Environment Institutions 2013 in Chilean pesos and U.S. dollars

	Approximate Million US$	Chilean MM$
Ministry	74.2	35.6
EIA Agency	20.1	9.6
Superintendencia	10.0	4.8
Subsecretaría (funds regional ministerial offices)	44.1	21.2

Will the Superintendencia usher in a new era in Chilean environmental politics? As of writing (April 2013) cautious optimism is warranted. The mine at Pascua Lama made world headlines - including the Washington Post and the San Francisco Chronicle - after construction was paralyzed. In the last months, the EIA Agency fined Pascua Lama three times for violating the conditions of its environmental permit; local courts stopped the project due to accusations that the mine is polluting groundwater; and the Superintendencia is investigating. On April 23, 2013 HidroAysén was also referred to the Superintendencia for violating its relocation agreements. On the other hand, the Superintendencia's website reports that Barrick corporation, owners of the mine at Pascua Lama, turned themselves into the Superintendencia to get reduced fines allowed to those who confess their environmental wrongdoings. Furthermore, it has been indigenous communities in the area that raised the alarm, took the issue to court, and kept pressure on state institutions. What initiative if any the Superintendencia took is unclear.

Given the lack of standards, the Superintendencia's biggest task is to enforce the resolutions that result from EIAs: more than 11,000 of these exist. Also needing enforcement are about twenty remediation and prevention plans in areas that are "saturated" with pollution - that is, cities with high urban air pollution (e.g., Santiago, Temuco) and some highly industrial areas on the verge of environmental collapse, like Huasco (chapter 5), Ventanas in the region of Valparaíso, Tocopilla and Mejillones in the north, and Coronel in the south.[32] During fieldwork the Superintendencia had a very small staff and no director as it waited for the Tribunals to become operative. Staff were

[32] Since 2011 conflict is increasing in these areas, particularly Ventanas and Huasco. In Ventanas a school had to close because it was a toxic stew. In Huasco a massive pig factory has finally been forced to close after pigs started dying due to the poor hygiene in the plant. As the NGO Oceana argues, these are cases of environmental injustice: http://oceana.org/es/sa/nuestro-trabajo/energia-limpia/zonas-de-sacrificio/antecedentes

optimistic and hoped the new agency would transform environmental politics as usual. The Agency's founding documents do not transmit much of this vision, however. The emphasis is on "rationalizing" and "ordering" rather than "strengthening" Chile's environmental standards and requirements. On the positive side, fines have been increased and for the first time there is staff whose full time job is to enforce environmental rules.

Environmental Tribunals were regulated in mid 2012, and the first five ministers were sworn in late 2012. As of writing only the tribunal in Santiago is operative; two more will open in Antofagasta (north) and Valdivia (south). Of the first five ministers, two are familiar faces: Rafael Asenjo (lawyer) and Juan Escudero (engineer), both active in CIPMA (chapter two). While environmentalists pushed for the Superintendencia, pro-growth and business sectors pushed for Tribunals. Those less inclined to protect the environment argued it was not fair to have an enforcement agency without a process for appeal. The Chilean state has been organized in this way: for every agency that produces and implements policy - often in the direction of creating markets - there is a Superintendencia to oversee the "fairness" of the market and protect consumers. They exist for insurance and financial investments; for banks; for pensions; for health; for sewage treatment and public water; for casinos; for electricity and fuel sources, etc. Their actions can only be reviewed by the Justice department, not by the executive, though each belongs to a ministry. It remains to be seen what shape these organizations take.

Conclusion

Under the Bachelet government environmental politics simultaneously moved towards "more technical" and "more democratic" politics, as anticipated by Patricio Silva (2009). Both in its creation in 1993-1994 and its reform in 2009-2010 legislators appealed to technocracy or "technical politics" to bring the EIA legitimacy. The ultimate source of legitimacy in Chilean politics is consensus, and technocratic politics are a way to achieve consensus by arriving at the "right" policies and decisions. Throughout this twenty year period of democratic environmental politics, appeals to fairness, a clean environment, public health, the national patrimony or environmental rights were eschewed in favor of appeals to doing things correctly and following the rules. While technocracy maintained its appeal, its specific forms shifted somewhat. Whereas during the transition, technocracy was embedded in the idea of transversality - with an appeal to horizontal coordination - twenty years later technocracy lay in a stronger executive authority. Using boundary work rather than a typology of workers, over time Conama and government reviewers worked more like bureaucrats who apply tight, clear rules, than *técnicos* who exercise their expertise with discretion.

Taking chapters 2 and 3 together highlights a number of contributions the STS literature makes to the study of politics. First, to study the EIA as a case of technical politics-as-usual shows that everywhere technical politics exists in opposition to party politics. This is certainly the case in Chile (P. Silva, 2009), but Chile is not unique in this respect. Furthermore, technocracy is in demand by progressive, environmentalist and

activist groups and plays an important local political role. Scholars have tended to explain the adoption of the EIA as a top-down imposition from the World Bank, rather than looking at local political dynamics, and so have overlooked that communities actually demand more technical governance. While a rich literature shows awful results from misfired technocratic policies in authoritarian governments (Scott, 1998) and when imposed from above by unaccountable global organizations (Mitchell, 2002), Chile's experience is far more nuanced. The EIA represents a much more complex mix of democratic and technocratic demands, and of local and global influences, than has been recognized so far (e.g., Tecklin, Bauer, & Prieto, 2011).

Chapters 2 and 3 further show that the "technical" does not mean "scientific". In all the debates about how to make the EIA more technical, science was never a possible answer. The only explicitly scientific example came from the new EIA Agency's director who enrolled the Academy of Science to validate methodological guidelines. Other legislative proposals oriented at criminalizing the misuse of knowledge and requiring more "technical" agreement left "technical" undefined or vaguely associated with engineering. Related to this point, the third contribution an STS approach to Chile's environmental politics highlights is that there is broad disagreement within Chile about what "technical" is. Chapter 3 has shown that for those in the state "technical" means legal and rule-bound, while for those in government "technical" meant ministerial. Respondents often could not define "technical" when asked; just a few in government did not hesitate to say "legal". These disagreements will become overwhelming in the next few chapters.

The evolution of Conama to a Ministry shows that initial good government concerns, tied to capacity-building, were adequately resolved and yet Conama did not become as effective as many hoped. By 2010 Conama and the EIA it administered faced a crisis of legitimacy. The reform represents an enormous gain for Chile's environment, particularly with the creation of an Enforcement Agency and Environmental Tribunals, but there is good reason to be cautious. Environmentalists call for democratic and technocratic fantasies to make the state more accountable to their goals, while state agencies have not been empowered by the reforms. Not only are agencies beholden to more rules and increased executive authority, but the guiding ideal continues to be that of the neutral state that brokers agreements between imagined equal interests. Government and state staff unanimously described their role as "just coordinating", "moving the process along", "scheduling meetings", "being the net on the tennis court", and "drawing the lines on the soccer pitch". Critical observers who had worked at Conama said it administered the EIA like "an orchestra without a director".

Do the 2010 reforms represent gains in good government for Chile, as intended? Did Chile successfully resolve the contradictions between a small state and institutional capacity as needed to participate in global markets? Chile's current woes - energy shortages, paralyzed mining projects, and a new health and environmental crisis in salmon farms - warrant speculation that it has not resolved the contradiction well enough. Environmental problems are putting a check on exports. From the perspective of classic good government, Chile is doing well: it has implemented and follows feasible

rules, has clear procedures and pursues exhaustive transparency. But if good government requires accountability to local actors, then things are going less well. Regional councilors, indirectly elected by universal suffrage, were removed from the EIA to make it more technical while the new law centralizes power in ministries' through three new decision-making fora, a master baseline, and a more efficient evaluation process. State agents who review EIAs could represent local communities and ecologies by identifying what needs to be protected and how, and defending the local environment from national development interests. But this does not occur, and fantasies flourish.

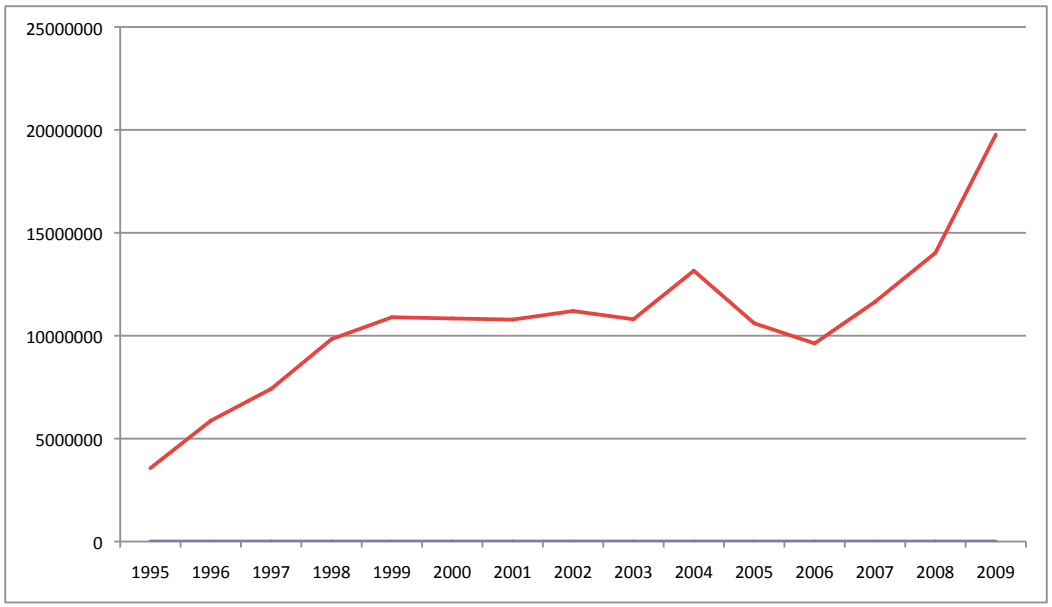
A new approach to government is needed, one that emphasizes discretion and is attuned to how credible public knowledge is produced and used. This is the subject of the next three chapters. Building on the finding that the EIA's legitimacy crisis did not lead legislators to revisit the market for environmental knowledge, which has done so much to undermine academic and environmental scientists as described in chapter 2, the next three chapters focus on this relationship between science, the state and the market. All three controversies began with an EIA but spilled over its rigid rules and regulations. The first case focuses on how the EIA failed to live up to expectations for accountability after an alleged accident occurred. The second case focuses on changing standards within the EIA that nonetheless fail to add up to an effective improvement on environmental standards. The third case focuses on how the EIA - even in the best circumstances with many experts and a reformed process - still failed to produce a convincing evaluation of impacts. The three cases look at different moments of environmental politics and of the EIAs lifetime, and show different attempts to reach closure: an adversarial process, a negotiation, and a rigid adherence to process.

Appendix. Budget data for Conama, Ministry and other Environment Institutions

Budget of Environment Ministry 2011-2013	
2011	62.0
2012	64.1
2013	74.2

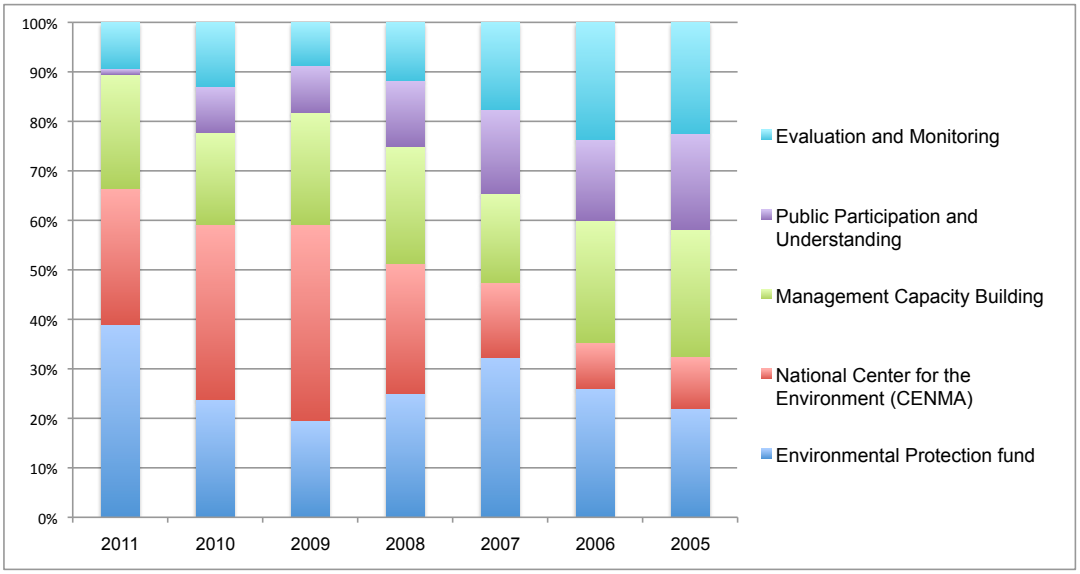
Partial Budget data for Conama (1995-2009)

Source: Ministry website supplemented by public information requests. Data in thousands of Chilean pesos. Data for 2010 excluded because of reforms made the budget data difficult to track.



Changing priorities at Conama, (2005-2011)

Source: Ministry website supplemented by public information requests. Data in thousands of Chilean pesos. These programs are funded from the same budget source so have been indexed to show changing priorities. Capacity building has been consistently important, often more so than other things like Monitoring, Research (CENMA) or Protection.



Chapter 4. The Valdivia Paper and Pulp Mill on the Cruces River

Panic and grief gripped the residents of Valdivia through the summer of 2004. The small city on the south-western banks of the Cruces river wetland was home to a large population of black-neck swans. That summer Valdivians fell under a cloud of putrid odors that caused nausea, skin and eye irritations and then watched in horror as swans started washing up dead and falling from the sky onto roads, bridges and backyards. When not dead, the swans were stupid and listless; they appeared on TV unable to hold their necks up, as if they had lost all strength and bone structure. With limp necks, they could not eat. Between September and December, thousands of swans had disappeared, fleeing the wetland. Those who fell out of the sky had postponed their departure too long and were too weak to escape. What caused this swan apocalypse? Six months earlier a paper and pulp mill had opened upstream; to many locals, its responsibility was a matter of "common sense" (graph 1). How to prove the Valdivia mill's responsibility or innocence has consumed scientists, the environmental authorities, local and national politicians, lawyers, judges, the staff at Celco Arauco that owns the paper and pulp mill, and a community of activists for the past seven years.[1]

The environmental disaster in the Cruces river was a watershed in Chilean environmentalism. The Environmental Coordinating Agency (Conama) and the EIA process it was responsible for administering were both young and their legitimacy was at stake. The democratic transition was safely behind Chileans, who had already voted in three elections, and the economy was growing. At Valdivia, environmental protection versus economic growth - the false choice that runs through all environmental debates in Chile - were forcefully pitted against each other. Demonstrations dominated by images of swans were met with demonstrations of lumber men in hardhats with chainsaws.[2]

This chapter tells the story of the scientists that got involved in the conflict. The Valdivia paper and pulp mill was among the first large projects to go through the EIA process in 1998, yet on opening the new plant was part of an environmental disaster without precedent in Chile's history. Faced with environmental disaster, Conama and Arauco - the company - turned to science for an explanation. Suspicions of conflicts of interest, inadequate funding, scarce background data and the legacies of creole science - struggling to reconcile the universal and local in scientific activity - helped undermine scientific authority. The conflict generated tense scientific confrontations in early 2005, which continued in court after the State's legal defense sued Arauco for environmental damages (State v Arauco).[3] The State hoped to use the fines Arauco would pay to

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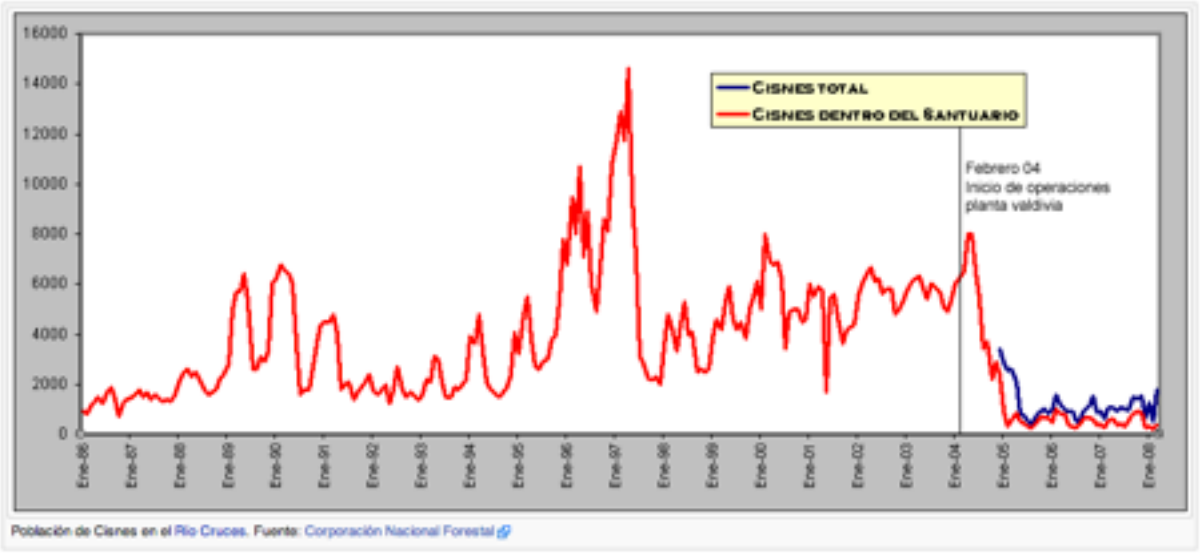
[1] The Judge stated she will issue a verdict May 17, 2013, the same day this dissertation is due to be filed.
[2] The documentary "City of Paper" (*Ciudad de Papel*), 2005, is an excellent reflection on these tensions.
[3] *Estado Fisco de Chile v. Celulosa Arauco y Constitucion*, Rol. 746-2005, First Civil Court of Valdivia under Judge Gloria Hidalgo. The parties are the *Consejo de Defensa del Estado* and Arauco. Prior to the crisis, Arauco was better known as Celco. This chapter uses the name in current use, Arauco, and calls the case State v Arauco.

remediate the wetland, protected by the Ramsar Convention on Wetlands of International Importance of 1971.

Dozens of scientists and consultants took the witness stand for both parties, and this material provides an excellent site to examine public demonstrations of scientific proof and credibility. More than with the EIA process, this chapter deals with events after the environmental disaster because those events put the EIA to the test: how useful was it for proving environmental harm and responsibilities for damages? Was it useful in efforts to hold companies responsible for their environmental impacts, at least to the standards demanded by Chileans? These events had far-reaching consequences: as a central participant and observer of environmental regulatory politics said, this case taught regulators, scientists and companies that the EIA is important because in case of an accident it is the only way to exercise accountability. In this way, the Valdivia Paper and Pulp Mill case reaffirmed belief in technocratic solutions to environmental conflicts. During the HidroAysén case discussed in chapter 6, this idea returns in the form of ecological baseline data.

Graph 1. "Common sense": swan population in the wetland over time. The vertical line marks the opening of the Valdivia Mill



Scientists did not emerge victorious from their experiences with the Valdivia paper and pulp mill case. The chapter begins with the stakes of the conflict and then introduces the participants, episodes of illegibility and finally so far failed attempts to reach closure. Throughout, the state and Arauco had very different ideas of what counts as relevant expertise, scientists constantly narrowed down their authority, and many expressed very critical opinions about scientists' public performance. All against a background of missing or erroneous data which leads to ambiguous notions of proof. Not only is the verdict still out on State v Arauco, but state initiatives to remediate the wetland or impose stricter standards have so far failed. The Valdivia controversy was

Map 1. Valdivia region, the wetland and the paper and pulp mill

played out in an adversarial manner where the courts gained some prominence as another site - complementary to the EIA - for adjudicating public credibility. In this case, however, credibility was not achieved and scientists, along with the companies and the state agencies they work for, lost public trust as a result of this conflict. Though “more science” was a lesson learned from the experience, this does not mean science practiced by scientists. Rather, it means science practiced by consultants working for companies.

I. Stakes: a battle for credibility

From the mill’s first environmental evaluation in 1998, where to dump the Valdivia mill’s wastewater was a problem. In the mid 1990s when Arauco was first planning the new mill the EIA was still voluntary, implemented by a 1993 Presidential memo. The EIA became obligatory and fully regulated only in 1997, so the Valdivia Paper and Pulp mill was one of the first big studies submitted for evaluation. Arauco explored two options: dump dirty water into the Pacific Ocean, at the Bay of Maiquillahue where the town of Mehuín lies, or dump treated dirty water into the Cruces river, about 30 kilometers upstream from the protected Carlos Andwandter Wetland Sanctuary, where black-neck swans and other bird species lived. Mehuín is a sleepy fishing village on a sandy bay, lined with camping sites and restaurants. Families there were not going to

risk polluting the ocean and distrusted the scientists, the authorities and the EIA process. For months they kept vigil on the beach to obstruct any attempt to collect samples from their bay. One local told me, "there was a price on the head of Jaramillo", a scientist that was collecting data for Arauco's EIA. Scientists got a Navy escort into the bay to collect samples, but after the Navy shot at local boats trying to intercept them this became known as the "Battle for Mehuín".[4] Defeated, Arauco decided to discharge the effluent into the Cruces river.

In 1998 Conama approved dumping the wastewater into the Cruces river conditional on adding expensive tertiary treatment, as well as a long list of elements to monitor. Conama mobilized its human resources to help in the evaluation, hired external consultants to assist on difficult questions like toxicity, and attempted to hold the project to high standards. Conama stayed within a technocratic approach, however, because it sought to make incremental improvements to the project - e.g., more wastewater treatment - rather than question the mill's location. As detailed in the section below on toxicity, the focus on wastewater treatment technologies reflected the recommendation of an external expert and the belief that any potential harm was manageable. Zero toxicity from a pulp mill was not just plausible but largely unquestioned. If the mill implemented Conama's long monitoring requirements and higher standards, the wetland's delicate ecosystem should withstand the presence of a paper and pulp mill a few kilometers upstream.

Despite Conama's early efforts, critics were skeptical because Arauco is a powerful company. A member of the Angelini group, one of Chile's largest family-owned business groups, Arauco owns almost one million hectares of tree plantations and five paper and pulp mills in Chile and has growing operations in Brazil and Argentina. Its actions shape the practices and economics of the sector in Latin America and increasingly the world.

Most simply, at Valdivia, the EIA failed to register prior conditions sufficiently well to unambiguously and quickly prove a "significant impact" had occurred. In this view, the EIA failed to adequately characterize ecological conditions prior to the building and operation of the mill, and without this prior knowledge it is difficult if not impossible to hold the company accountable for damage. This diagnosis of the EIA's failures informed the reforms adopted in 2010, discussed in chapter 3, that reinforced the importance of baseline conditions and increased the Ministry and EIA Agency's authority to maintain and disseminate baseline data. Though in spirit the EIA is about prevention, this case show that in Chilean practice it is about accountability when accidents happen.

[4] Until the 1990s, Austral University had a Maríne research station in Mehuín led by Eduardo Jaramillo. After he went to work on Arauco's EIA, locals withdrew their trust in him and the university. In their view, promises to monitor impacts sounded like an economic benefit going to the scientists at locals' expense.

Table 1. Timeline of events at the Validiva Paper and Pulp Mill		
1995 - 1998		EIA is approved with additional waste treatment. Effluent is dumped in the Cruces river rather than the ocean at Mehuín following violent protests.
2004	February	Operations begin. The mill is fined and briefly closed due to air pollution.
	July	Swans are declining, says International Union for the Conservation of Nature.
	August	Consultants MA&C report 19 violations of the mill's permits, including unauthorized excess production and waste disposal capacities.
	Novembr.	Swans drop from the sky and their population decline is evident. Protest is strong.
	Decembr.	Austral reports (scientific study) increased heavy metals. More fines are imposed.
2005	January	Conama temporarily closes the mill due to irregularities.
	February	Conama re-opens the mill arguing they have met new conditions. Austral reports (scientific study) decreased plant coverage in wetland relative to adjacent rivers. Zaror reports (scientific study) mill met its obligations.
	April	Austral reports (final scientific study) aluminum sulphate from mill's waste treatment is to blame. A week later, the Catholic University refutes Austral report. Ramsar reports (scientific study) many sources pollute the wetland. Arauco is sued by the state for environmental damages and by citizens for violating their constitutional right to live in an environment free from pollution.
	May	Conama modifies the environmental permit. Production limits fall and some emission standards rise.
	June	The Supreme Court finds Arauco not guilty in the constitutional rights case on a technicality and a misrepresented scientific study.
2006	August	Remediation plan for the wetland is published but never implemented.
	August	Conama authorizes the mill to increase production.
2009	July	Apellate Court of Santiago confirms the fines Arauco received in 2004-2005.
2010	February	EIA for waste pipeline from the mill to the ocean is approved. Protests continue.
2013	February	There is yet no verdict in State v Arauco. In 2012 six of the seven court-appointed experts found Arauco responsible. In 2013 press reports possible negotiations between Arauco and the State. New water quality and emission standards have not yet been issued and Mehuín continues to protest the projected waste water pipeline.

The Valdivia paper and pulp mill received environmental approval in 1998 but only started operations in early 2004. Operations were immediately followed by putrid odors that affected the surrounding towns, including the city of Valdivia, and then the swan apocalypse. The conflict that followed pitted government-paid and company-paid scientists against each other. Many described this conflict as a David and Goliath fight

where underfunded scientists confronted the powerful company or as classic corporate influence: the state acquiesced to the power and money of Arauco. But this reading of events does not fit with Chile's tradition for "strong institutions" (Stein et. al., 2005) and the efforts of Conama. The state employed a consultant during the EIA evaluation in 1997-98, another in August 2004, three more in early 2005 and several more in 2006 to help the state do the right thing. Twice it shut the mill and Arauco received historically steep fines. Arauco employed another legion of local and foreign consultants and the services of the Catholic University in Santiago. If it is corporate capture, how were these hundreds of professionals who evaluated, proposed and studied the events captured? Did prestigious scientists participate in Arauco's corporate web for personal monetary gain? Did this come at any cost to them?

Whatever capture may or may not have existed, it is nonetheless difficult to corrupt so many professionals, each with his or her own professional incentives.[5] In every interview, respondents spoke of trying hard "to do the right thing" because Chile "is a serious country". The next two controversies at Pascua Lama and HidroAysén raise the same question of capture; if these are cases of corruption, then it is broad and large-scale in Chile, contrary to most perceptions on this issue. Moreover, this chapter like the next two strive to show that to focus only a story of capture misses other important factors that have to do with knowledge production and state capacity.

This exemplified in on-going disputes about corporate sponsorship of science. In 2007 Arauco and other companies sponsored the annual meeting of Society of Ecologists from Chile and Argentina. The scientists and their corporate sponsors met great protest. Activists occupied the inaugural address, covered the walls with signs, and through a megaphone shouted:

> Are you not ashamed that your research is used and financed by companies like Barrick Gold, destroyer of glaciers… Or Arauco that has acidified more than one million hectares in southern Chile, dried out sources of water,…assassinated black-neck swans in Valdivia, the fish of the Mataquito river and the lives of thousands of peasants and fishermen who have had to migrate…[6]

If this is capture, it is capture on a large scale. This chapter proposes a different story that looks to expose the relatively stable institutional mechanisms that erode public trust, and with it accountability. Companies have captured knowledge production in the sense that, although there is no smoking gun, the suspicion of conflicts of interests is

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[5] I do not have data on how much each group of consultants or scientists was paid. Payments by Conama can be obtained through freedom of information requests; these sums are likely to be quiet modest. Payments by Arauco are private information and likely inaccessible. Beyond personal payments to scientists - which may or may have not existed - Arauco is a major sponsor of universities (both Catholic University and the University of Chile). One respondent described a meeting between Conama and Arauco with the presence of three authorities from the Catholic University (including the in 2004 to discuss how to respond to the environmental disaster.

[6] From a youtube video taken at the Annual Meeting of Ecologists from Chile and Argentina, 2007, available at: http://www.olca.cl/oca/chile/region03/pascualama279.html. See also chapter 3.

enough to erode public trust in science. In this context, the creole scientists working in neoliberal Chile faces a trade-off between relevance and integrity, where relevance is associated with anti-environment and ideologically conservative positions and integrity is associated with pro-environment and ideologically progressive positions. As discussed in chapter 3, creole scientists are not seen to be locally relevant. If they do not participate in matters of local importance, like the polluting effects of a pulp mill, they are regarded suspiciously because they remain stuck within their Ivory Tower. If they do get involved, they are regarded suspiciously about their ulterior motives: for profit or to promote corporate interests. Whatever their actual political opinions, creole scientists become players in political disputes between progressive and environmentalists forces and conservative, anti-environmentalists forces. In these conditions conflicts like that at Valdivia can flourish.

II. Participants

In 2005, after the mill opened and swans fell from the sky, the government and Arauco hired scientists to help them decide what caused the environmental disaster. Unlike the environmental conflicts that came later, during the Valdivia crisis every scientist that could have gotten involved was involved. According to a participant, everyone fell into a "scientific fantasy" that quickly turned acrimonious and spilled from academic channels to public spaces, including newspapers and television.[7] On closer examination the patrons of science - Arauco, the State - had different notions of what counts as relevant expertise. Faced with the question of whether "he who pays the piper picks the tune", the patrons used similar strategies to disqualify each other's scientific witnesses but scientists struggled to find a common voice. Outside of court the issue was skirted, with scientists attributing any silences to a cultural tendency to "keep quiet". Inside court different strategies were used to defend the piper's independence, but an unusual method stands out: reaching results contrary to the interests of your funders. While this may accrue trust within the close science-patron relationship, it is not effective in the public sphere.

Scientific fantasies

In contrast to other conflicts happening at the time, where expert communities were slow to get involved (chapter 5), when the ecological disaster at the Cruces river happened the authorities and the company fell into a "scientific fantasy" - everyone turned to scientists for answers.[8] Nearly every scientific group that could have gotten involved was involved, each reaching different conclusions and explanations. In 2005

[7] Letters to the editor at *El Mercurio* appeared daily in 2005, including a long debate on "the value of a swan". Scientific data or evidence is notably absent from all these letter that argue more about philosophy than concrete events. Several scientists participated in this exchange too and vented their organizational rivalries through the paper.

[8] "Scientific fantasies" is borrowed from an interviewee who worked with Arauco on communication issues. Interview July 2011.

the state hired three reports: from Claudio Zaror, a chemical engineer who is a university professor; from the Ramsar Secretariat for wetland protection; and from a group of local scientists at the Austral University. Arauco also hired academic scientists, from the Catholic University in Santiago, and many consultants. As the crisis progressed, in April 2005 the state sued Arauco for environmental damages and in 2008 both sides called their scientists to act as witnesses to the case. There are systematic differences between the state's and the company's definition of an expert, as evidenced by the profiles of those they called to the witness stand (table 2).

Table 2. Witnesses called to declare in State v Arauco by each party

	Total	From Valdivia?	From abroad?	Areas of Expertise	Organizations where they work
State	24	17	0	Vets & Zoologists; just 3 chemists	Austral, Govt. Agencies
Arauco	91	9	14	Engineers (31); chemists (8); others like economists & managers	Catholic U., Concepcion U., EULA, consulting co. & paper industry

The Austral scientists the state relied on were privileged observers of the events in Valdivia: they were inter-disciplinary, experienced and local. The team included geologists, ecologists, zoologists, biologists and others. They had research experience in the wetland and with Arauco. Several had worked on the mill's EIA both in the Cruces river and at Mehuín. Eduardo Jaramillo, the leader of the Austral team, had directed the University's Marine research station in Mehuín for years. His head was the one "with a price on it" in Mehuín when Arauco was trying to collect data for a wastewater pipeline to the ocean in the 1990s. Another team member, Ricardo Schlatter, had studied the swans for years and completed the Ramsar information sheets on the wetland through the 1990s. Their report became "the University's voice" and was initially well received by a community seeking accountability.

Just one week after its presentation the Austral report was refuted by a report from the the Ecology Institute at the Catholic University in Santiago, hired by Arauco for this task. Austral and Catholic University scientists were asymmetric colleagues. The confrontation was between traditional Chilean academia – modest in means and intentions – and the best of modern academia: strongly linked to industry and government, housed in modern, privately funded laboratories in Santiago, 500 miles north of Valdivia. Just as the Austral scientists are locals, those from the Catholic University are cosmopolitan; they wear suits and travel to the U.S. several times a year.

The Catholic University's report reads like a legal brief: its objective is to establish a reasonable doubt about Arauco's responsibility, and raises questions about Austral's analytical and data collection methods. Austral scientists felt betrayed and humiliated by their colleagues. For the broader scientific community of ecologists and biologists, the report broke scientific ethics because it criticized outside of peer-review mechanisms

and without adding new data or testing hypothesis. It was "not science" and, to boot, it was paid for by Arauco.

The scientific community tried to reconcile the parties at that year's annual meeting of the Ecology and Biology Associations, in a session about "The Role of Ecologists in Environmental Management in light of the Cruces river case." In scientists' recollections, the Catholic University was reprimanded for acting like a think tank and "science" was restored to its proper meaning - it requires new data. Speakers at the session argued that ecologists are important in environmental management but need to remain within their boundaries.[9] Fabián ß, leader of the Catholic University team, said ecologists "should not be judges" when participating in environmental impact assessments but leave the decision to the authorities. Raúl Arteaga, who was director of the EIA process at Conama during the Valdivia crisis in 2004 and 2005, worried that when ecologists "cross the line of what is natural to them" they try to impose their opinions as immutable truths, becoming judge and jury. The audience largely agreed that a more technical EIA was desirable, where more technical does not mean more scientific. The leader of the Austral team Eduardo Jaramillo declined the invitation because "there was no real willingness to dialogue" among Arauco and Arauco-paid scientists.

On the tricky question of whether "he who pays the piper picks the tune", participants were less forthcoming. Jaksic and Arauco agreed that this need not be so. For Jaksic, good contracts, disclosure and institutional structures can prevent this risk, and scientists must do their part and not practice "self-censorship". Andrés Camaño, Arauco's director of environmental affairs, said companies hire "studies, not results". The issue of good contracts was rarely mentioned by scientists during interviews, across all four cases, and only Jaksic is recorded to have brought this up. In contrast, Jaksic's second concern - that scientists practice self-censorship - was a common concern. Scientists often criticized their colleagues of "not speaking up" for fear of loosing future job opportunities and of "keeping quiet" to avoid conflicts. Some pointed to out-spoken others, like an Argentinean scientist on the Ramsar commission who gained the nickname "Maradona" because "with every comment he made a goal." For many scientists, Austral scientists were heroes for speaking up.

For those convinced that science is for sale in Chile (that is, "he who pays the piper most definitely picks the tune") signs of Arauco's influence were everywhere. Arauco's court evidence was sophisticated and expensive: satellite images, isotope tests, and sampling campaigns that government-paid scientists could never afford. One frustrated Austral scientist testified bluntly: with US$250,000 more they could have studied sediment records to challenge Arauco's claims. Arauco's influence was visible in politics too through small episodes that add up to capture, in the eyes of many. For example, then Senator Eduardo Frei, and former owner of the construction company that built the mill, invited a scientist opposed to Austral's hypothesis to present in the

[9] Society of Ecology and Society of Biology of Chile, November 16, 2005, "Informe sobre el Simposio: Rol de los Ecólogos en la Gestión Ambiental a Raíz del Caso del Río Cruces", 13-16 October 2005, Pucón, Chile. Available online at: http://www.bio.puc.cl/caseb/adjuntos/051022%20Inf%20Simp%20Rol%20Ecol%20Gest%20Amb%202005.pdf

Senate. Arauco kept looking to sign a cooperative agreement with Austral University, leading a scientist there to worry if this would erode the credibility of his data showing a slow recovery of the wetland.

Environmentalists trusted few sources of information. Environmental NGOs like the Chilean chapter of the Union for the Conservation of Nature had been the first to raise the alarm and pressure the Chilean government to request a Ramsar mission to study the environmental disaster in the wetland. But when the NGOs learned that the mission was not an "official" Ramsar mission they rejected the report. The Ramsar Secretariat suggested scientists to the Chilean government, who then chose and invited these scientists to come study the wetland. Faced with the need to evaluate the scientific information, environmentalists turned to family connections: the sister of one of the leaders of the movement to hold Arauco accountable was a scientist at Purdue University, Indiana in the U.S. She sent the Chilean activists a short memo about the Austral report. The activist-leader later used the information in the memo in court to deliver one of the clearest descriptions of toxicity and its effects on local flora and fauna. Arauco tried to dismiss this as "hearsay" - a tactic that underscores how contingent and informal practices for validating public knowledge are in Chile.[10]

The conflict between Austral and Catholic Universities was a conflict between integrity and relevance. As an Austral scientist said, they learned from this crisis that they faced a choice: either stay out of socially important issues, or accept industry funding to be "relevant". This lesson was reinforced by several outcomes. First, peace between the two universities came years later when Jaksic and Jaramillo agreed that the funding asymmetry had made their rival search an impossible contest. Poorly funded science, like that Austral had to do if it worked for the government, would never be good enough to answer the questions posed by a large-scale industrial plant like that Arauco owned. Second, the state proved to be a poor source of scientific funding. The Chilean national science foundation (Conicyt) rejected several research proposals in the wetland because the Austral scientists "lacked expertise in wetlands", the question was "too specific", or they "lacked historical data". Thus, integrity is short-changed by the lack of funding. The supposed protagonists of the "scientific fantasy" thus were regarded with more suspicion after the crisis.

Credibility in the courts

Scientists as witnesses provide a public show of proofs and credibility (Jasanoff, 1997). The first law suit against Arauco was a constitutional rights case, resolved between April and June 2005 on a technicality and a scientific mis-appropriation (table 1).[11] The second case is a civil damages - State v Arauco - that was filed in April 2005 and as of writing (May 2013) drags on. The State in this case is represented by the *Consejo de Defensa del Estado*, a public prosecutor that defends the interests of the state and citizens. The State's lawyers argued that based on the Austral and Zaror's

[10] Legal transcript, civil damages case: page 1763.

[11] Montenegro, Sergio, Valentina Duran y Jose I. Pinochet, 23 julio 2005, "Caso Celco: Comentarios al fallo de la Corte Suprema", in *El Mostrador* newspaper.

reports, there is a plausible likelihood that Arauco's Valdivia mill had polluted the wetland and negatively impacted local communities. The State demanded reparations to restore the wetland to its previous state. Arauco's lawyers successfully raised the bar of proof: to be found responsible, the Court needs incontrovertible evidence of the wetland's prior state and the cause-effect relationship between pollution, change and harm.

During 2008 the State and Arauco called their witnesses, many of them scientists, to testify on their behalf. Scientists had to undergo impeachment processes to determine the presence of conflicts of interest: was a scientist paid by Arauco independent, or was he negatively predisposed to the state? Was a state-paid scientist biased against Arauco? This section looks at the strategies scientists on the witness stand used to answer these questions (table 2).

Arauco's lawyers were adept users of science. In the first constitutional rights case Arauco submitted evidence from an "EULA study" that one day after the verdict was publicly renounced by EULA. EULA is Chile's only environmental science institute, at the University of Concepcion (discussed in chapter 2). The study was misrepresented with no consequences: the Senate gestured it would hold the judges, not EULA or the company, accountable. The scientific community did not cry foul or rally to defend its integrity or autonomy. In the civil damages case, while the state argued that Arauco-paid scientists were biased because "he who pays the piper picks the tune", Arauco lawyers used the impeachment process to define institutional autonomy; define science to make it equivalent to consulting practices; and embed conflicts of interest in state-paid science. The best way to prove scientific independence, say the scientists, is to reach results contrary to the client's interests.[12]

This passage by Arauco's lawyers is illustrative of these tactics:[13]

> "the degree of independence of the [Catholic U. and its Ecology Institute] are not under discussion…The researchers of the two most important universities of this country [Catholic U. and U. Chile] have given great demonstrations of their independence with respect to public and private entities that contract research." For example: Dictuc, a commercial arm of the university that certifies construction projects for the government; the Economics Department that issues recommendations contrary to the interests of its private funders; the university as a whole that receives government funding but has never been seen to emit reports favorable to the State; the University of Chile, where the best example is Marín, whose report was rejected by the Forest Authority but "paradoxically" validated through peer review. The Ecology Institute receives public funding and is guaranteed by publications in mainstream ISI journals…In contrast, the administration of the Austral University harassed professors that disagreed with the methodology and conclusions of their report…. "Independent

[12] Consultants in other industries made similar statements. See chapters 3, 4 and 5.
[13] Legal transcript, civil damages case: Arauco lawyers, 3789-3791. Parts are paraphrased for brevity.

> scientists nonetheless overcame the bias of the directors and the community of Valdivia, disseminated their results, and showed that there are honest researchers that overcome private interests even in very unfavorable conditions [a reference to Carlos Ramírez]".

Dictuc and the Economics Department blur academic and consulting science. Dictuc is a consulting company, and the Economics Department has long been an advisor to center-right political parties (Valdes, 1995). The examples of Marín and Ramírez are offered as proof that scientists who reach results contrary to their funders' interests are the best example of independence, something this scientist was explicit about:

> "In many cases our results have been opposed to or contrary to the opinions of those who hire us. For example, one of the funders of our institutional program "Water Quality Monitoring of the Bio Bio River"...is Endesa [an energy company]. I have conducted research published in international scientific journals like Biodiversity and Conservation where I have publicly shown the negative impacts that hydroelectric generation produces in the Laja Lake….To summarize, despite having received fees from [Arauco], this does not imply a dependence for the results of the study." (Legal transcript, civil damages case: Scientist, 1925)

Scientists used other strategies too to establish their independence. Peer review for published material was the number one strategy, as referenced in both quotes above. Organizational autonomy was another, sometimes by claiming to not know how money flows; the director of the Ecology Institute declared he "supposes that there is some funding [from Arauco] to the University but [he] does not know anything about it."[14] Finally, narrowing down the scope of expertise was common, and often used to marginalize scientific explanations in favor of consensus, negotiation and other political strategies, as explained in the last section of this chapter. For example, according to Fabián Jaksic: "we only commit to study the biological, ecological and biodiversity aspects for which we do not have to be informed about engineering issues like inputs or emissions that do not have to do with a biological evaluation of the state of the wetland and the changes that have occurred there."[15]

Arauco lawyers also tried to embed conflicts of interest in state-funded science. They argued Jaramillo, the lead Austral scientist, had a vested interest in proving Arauco's responsibility. Normal acts of science - like disseminating results in conferences - were "acts of repetition":

> [Jaramillo] is so invested in the 'cause against [Arauco]'…that a verdict that does not recognize the role of [Arauco]…would cause the witness serious academic harm, hurting his capacity to earn his own living. Such a

[14] Legal transcript, civil damages case: Scientist, 3971.
[15] Legal transcript, civil damages case: Scientist, 3728.

> verdict would hurt his professional pride, as illustrated…when the witness said he would conduct research to prove wrong the conclusions reached by the College of Science of the University of Chile.…This is itself a non-scientific attitude because the very essence of a scientific conclusion is to be merely provisional and probabilistic, so that scientists must maintain a prudential attitude and not commit spiritually or emotionally with hypothesis that must be open to discussion….These emotional factors have led him to commit to a crusade to transform his hypothesis into formal truth that by virtue of repetition he hopes to promote as true.[16]

These practices contrast to interrogations in Canadian, Swedish, Finish and U.S. courts. These became involved because some of Arauco's witnesses were scientists and consultants that live in these countries; rather than travel to Chile to testify, they testified in their home countries through the local legal system. The foreign courts recognized broad credentials of expertise and asked direct questions, and expert witnesses responded cogently. The Swedish magistrate asked a consultant if he thought the mill was responsible and he answered that he could not be sure but that Arauco should not be responsible given the original plan and information available when designing the mill. U.S. judges asked: "what do you have to do to keep current that professional engineer's license?" "Are there any other specialties or awards or publications you would like to describe?" "How does your expertise relate to the opinions that you were asked to provide in this case?"[17] Chilean expert witnesses were never asked these kinds of questions. On the contrary, Chilean experts spent much of their time answering "I am not a chemist", "I am not an agronomist", "I am not a forest engineer", "I am not a lawyer" and "I am not an enforcement agent."[18]

Is it the case that he who pays the piper picks the tune? Rarely is there a smoking gun to prove such a thing. The conflict around the Valdivia paper and pulp mill raised the issue but did not resolve it. On the contrary, a series of harmful lessons were learned from this experience, which continues to divide and fill with regret the scientific community. Reaching opinions contrary to those of your funders and peer reviewed publications were consolidated as proofs of independence. These forms of proof find support in Chilean institutions. Scientists not only receive bonuses for ISI indexed publications but respondents were quick to mention these as a marker of prestige. Further, the idea of reaching conclusions contrary to those of your funders was mentioned regularly by consultants and scientists when asked how they gained their employer's trust.

These are however problematic proofs of independence and raise questions about integrity and relevance. Peer reviewed publications are usually in foreign journals less interested in locally relevant questions. Foreign journals are at best accessible only to scientists at universities; government agencies do not have subscriptions to these

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[16] Legal transcript, civil damages case: Arauco lawyers, 688-89

[17] Legal transcript, civil damages case: magistrates and scientists abroad, 4812-14.

[18] Legal transcript, civil damages case. The first reference is from a forest engineer, page 1485. The rest were answers Jaksic gave to the first seven questions he received, pages 3707-10.

journals (and even universities have incomplete subscriptions). Many bureaucrats and scientists do not read English well enough to access these articles directly. So relevance is not well served by peer reviewed publications. Reaching conclusions contrary to your funders' interests is as relative as reaching the expected conclusions; whether you do or you do not, there is a suspicion of conflict of interests. Integrity is undermined in both scenarios. These forms of proof, furthermore, marginalize others like organizational autonomy, professional ethics, or contracts.

The suspicion of conflicts of interests is enough to erode public trust. In January 2011 forty-four Austral faculty protested a university-industry cooperative agreement with Arauco. Similar agreements exist all over the world, but Austral University was forced to rescind it because it violated the University's 2009 policy not to collaborate with any company with a public position contrary to that of the University. In a context full of distrust, a two-page agreement was not a sufficiently good contract to regulate the suspicion of conflicts of interest.

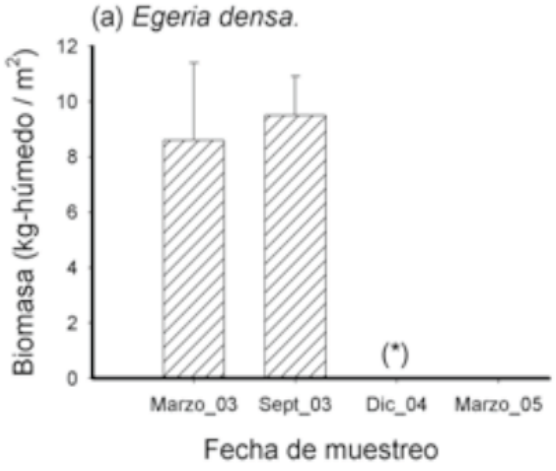
III. Illegibility

After an impact evaluation, scientific studies to assess pollution, and court cases - including a very comprehensive civil damages case - one might expect a degree of agreement on the important aspects of the case. This section follows some of the scientific discussions that took place within the impact evaluation (EIA) process and during the fallout of the crisis, both in the reports commissioned by the environmental authorities and Arauco and in the court case, to examine whether and how legibility was brought upon the controversy. What did the different actors involved learn about the wetland? What factors emerged as most important? Disagreements over credibility, data and methods, however, undermine efforts to produce stable claims about what happened. Public credibility was achieved through the impact evaluation process or court case that followed.

Even today, seven years after the Valdivia mill opened and the swans disappeared, the explanations, descriptions and beliefs about what happened seem boundless and few have changed their minds from their initial positions. After so many studies, court cases and public debate, some scientists believe Arauco was responsible and others that it was not, and all for different reasons. Some scientists said they did not believe Austral's report laying blame on Arauco, but still think the company was responsible for "other reasons". The names, numbers, methods and concepts used to represent the wetland, the disaster and Arauco's operations reflect these different opinions. But there are patterns to the differences. Scientists who believe in pollution-based explanations from Arauco's mill tend to emphasize the special status of the Sanctuary as a protected area, the uncertainties and risks, and take discrepancies in the numbers seriously. Scientists who privilege environment or nature-based explanations dismiss discrepancies in the monitoring data, continuously contribute new data and information to the debate, and try to erode the sanctity or social status of the wetland, the swans and their food: an aquatic plant called *luchecillo* (*egeria densa*).

A few things are not in dispute. Arauco began operations badly. It received fourteen citations from the authorities in 2004-2005. It was built to a larger capacity than authorized (850,000 tons vs. 550,000 tons per year), used more water and emitted more wastes than authorized, and failed to meet several monitoring obligations. Monitoring was sloppy, with broken equipment and episodes of mis-information.[19] For these violations Arauco was fined 200 Annual Tributary Units (US$144,000).[20] The state also made mistakes, including reducing Arauco's environmental monitoring obligations one year after issuing the EIA permit and issuing the permit without actually evaluating the environmental impacts of tertiary treatment. Conama closed and re-opened the mill twice and then disappointed the public by refusing to close it again (table 1). Arguably, the mill should never have been approved on a site known to have social and ecological significance and susceptibility to toxic effluent. Everyone agrees that the aquatic plant *luchecillo* disappeared and as a result the swans starved. The question remains: why did the *luchecillo* disappear and how can its disappearance best be described?

Graph 2. Disappearance of *luchecillo* in 2003-2004



No bridging objects

In the aftermath of the swan apocalypse, a proliferation of name and hypothesis were produced to try to explain events. The Carlos Andwandter Sanctuary includes several rivers that depend on rainfall and carve out a wetland, with large extensions of shallow waters, before flowing into the Pacific Ocean. Ocean tides interrupt and re-shape these river flows to create a salty, colder estuary. As in any classification scheme,

[19] Conama hired consultants MA&C to assess the mill's operations in fall 2004. This report and the illegalities it documented were never contested, nor were these consultants called to the witness stand. See: MA&C Consultores, October 2004, "Apoyo al Seguimiento Ambiental del Proyecto Celulosa Planta Valdivia Celulosa Arauco y Constitucion, S.A. Informe Final" Version 3, No. 2.
[20] Valencia, Antonio, 22 July 2009, "Celco Valdivia sufre serio revés judicial-ambiental" in La Nación.

each name – Sanctuary, wetland, river, estuary – is loaded with meaning. Whereas elsewhere episodes of environmental harm were managed with the help of scientific bridging objects that create a shared language and assumptions among scientists, the community and government (Wilkening, 2004), this case illustrates the absence of such bridging objects. Their absence contributes to conflict and distrust. Scientists paid by the government, or whose results pointed to pollution as the causal element, tended to call the area a "Sanctuary". Scientists paid by Arauco or whose results pointed to environmental or natural causes preferred nature-based names: "river" or "wetland". These patterns are observed in both the first reports prepared for Conama (table 3) and in academic publications (table 4). Knowledge of the area was so thin the importance of the estuary was only recognized later.

Table 3. Names describing the Carlos Andwandter Sanctuary in reports prepared for government use

Austral	Ramsar	Claudio Zaror	Catholic U.	CEA (1993)
Sanctuary (762)	Sanctuary (76)	River (64)	Wetland (54)	Sanctuary (51)
River (537)	River (65)	Sanctuary (23)	River (47)	River (15)
Estuary (109)	Wetland (13)	Wetland (2)	Sanctuary (39)	Wetland (2)
Wetland (63)	Estuary (6)		Estuary (6)	

Numbers in parantheses are word-counts and indicate relative magnitudes within each report. These numbers can not be compared across reports.

Alongside the proliferation of names there was a proliferation of hypothesis to raise doubts about Arauco's responsibility (table 4). During the trial witnesses unfolded hypothesis: "several [hypothesis] continue to appear", "hypothesis that now add up to seven", "that now are up to eight".[21] On the witness stand, Fabián Jaksic listed three chemical hypothesis; three physical hypothesis based on streamflow and UV radiation; two biological hypothesis based on ecological succession; and two "multi-variable" biological hypothesis. Testimonies jumped between ocean tides, rainfall, sediments, and dilution. Some argued that eutrophication in the river was very low and others that it was very advanced. Sometimes a powerful statistic appeared and was never mentioned again; one witness claimed that the Valdivia mill accounts for 92% of effluents flowing into the Cruces river. Scientists for environmental causes also questioned the value of different elements and hinted that their disappearance was a good thing:

> "*Luchecillo* is an invasive species that needs to be eliminated. The black-neck swan is an opportunistic species that eats whatever it can find."

[21] Legal transcript, civil damages case: Scientist testimony. Pages, in order: 1902, 1904, 1910.

> "*Luchecillo* is a submerged species, making it a highly aggressive weed that interrupts navigation. Its disappearance is equivalent to all the mice of a city disappearing."
>
> Victor Marín lists examples of environmental change to relativize events at the Cruces river: disappearing lakes, desertification, climate change, melting glaciers, and creation of the wetland. The *luchecillo* is an invasive species fought in other countries, like the San Joaquin Delta in California.[22]

Most of these hypothesis and representations did not pass peer review, despite scientists' insistence that peer review is the gold standard in academic credibility. Nearly all non-Austral scientists considered the UV radiation hypothesis academically legitimate, but it was never published in a peer reviewed journal and was based on just six-months of UV radiation data (table 4). Contrary to scientists' statements during interviews, the Austral group has six peer reviewed publications about the case, in contrast to just three by non-Austral scientists. Studies based on sampling and observation were more common and influential than controlled laboratory experiments. These patterns contradict scientists' perceptions about the case.

Even the number of swans that disappeared or died was disputed and mis-reported. The Forest Agency maintained a census of 34 bird species, of which swans and coots were the most abundant (table 5).[23] News reports at the time might even say that "just four individuals" were left.[24] On the witness stand, an environmental consultant hired by Arauco testified that swan population numbers were similar from 1997 to 2004. When pressed, she said the census numbers she had worked with were not the ones shown to her in trial though they shared the same source - the Forest Agency.[25] Forest Agency rangers testified for Arauco but dismissed points raised by other Arauco witnesses: they argued the *luchecillo* plant was not over-foraged or susceptible to frost, and sedimentation was slow. The rangers believed the wetland suffered a shock because the plant disappeared in just three months.

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[22] Legal transcript, civil damages cases: (1) Fabián Jaksic, 3425; (2) Carlos Ramirez, 2544; (3) Victor Marín, 3505.
[23] The Forest Agency (Conaf) manages protected and park lands. In Chile there is no equivalent of the National Park Service, Fish & Wildlife Service, U.S. Geological Society, Army Corps of Engineers or local water management agencies that collect regular, long-term monitoring data.
[24] World Wildlife Fund new release, "Sanctuary Devastation", 21 November 2005.
[25] Legal transcript, civil damages case: environmental consultant: 3932.

Table 4. Academic Publications about the Valdivia Paper and Pulp Mill, summary data

Article	University 1st author	ISI index journal	Reported funding sources	Causal element	Proof	Data sources	Described as…
Pinochet, D. et al., (2004)	Austral	No	No Info	Iron	Samples	Collected plants	Sanctuary
Ramirez, C. et al., (2006)	Austral	No	EULA	UV radiation	Additional case	Available data	*Bañados*
Mulsow, S. and M. Grandjean. (2006)	Austral	No	Conicyt	Sulfur & acid	Lab experiment	Produced in lab	Sanctuary
Artacho, P. et al., (2006)	Austral	Yes	Government	Iron	Samples	Swans	Sanctuary
Artacho, P., et al., (2007)	Austral	Yes	Government	Iron	Samples	Swans	Sanctuary
Jaramillo, E., et al., (2007)	Austral	Yes	Government	Aluminum sulphate	Samples & add. case	Available data	Sanctuary
Lovengreen, C. et al., (2008)	Austral	Yes	Austral	Reject UV radiation	Observation	New data	Sanctuary
Lagos, N., et al., (2008)	Austral	Yes	Government	Reject env. causes	Samples & Landsat images	New data	Wetland
Nespolo, R., et al., (2008)	Austral	Yes	Government	Pollution	Samples	Swans	None
Palma, A., et al., (2008)	Catholic	Yes	Arauco	Reject pollution	Lab experiment	New data	River
Norambuena, C. and F. Bozinovic (2009)	Catholic	Yes	Arauco & Conicyt	Environ-mental causes	Samples	Swans	River
Marín, V. et al., (2009)	Chile	Yes	Government	Sediments & freezes	Observation & Model	Available data	Wetland

Table 5. Population numbers of swans and coots in the Cruces river wetland

	Swans	Coots
Annual monthly average 1999-2004	5,286	10,821
Lowest monthly count 1999-2004	1,729	3,970
Population February 2005	289	640

Source: Austral Report, page 365. Based on Forest Agency census.

Graph 3. Swan deaths in 2004-2005 reported in Artacho et. al., 2007 (see table 4)

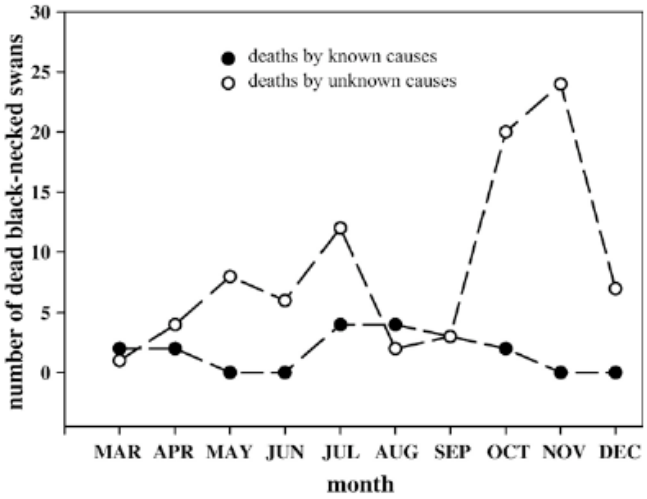

Fig. 2. Records of *C. melanocoryphus* found dead in the Carlos Anwandter Sanctuary during 2004.

The exact magnitude of the *luchecillo's* disappearance and causes are the core of the dispute. Are the swans migratory, opportunistic or a meta-population on a collision course by over-foraging the *luchecillo,* or none of the above? Did the *luchecillo* disappear suddenly, as in a shock, or gradually? Competing arguments like these were never made to stand up to each other. More than a dispute, the conflict occurred in a series of isolated statements to confuse the previous narrative that the swans, and their food the *luchecillo*, were emblematic species to be protected. Furthermore, this speaks to a failure of this EIA process: the original permit required monitoring indicator species, including *luchecillo,* but this was removed after Arauco protested. This, along with the generalized lack of knowledge about the area, made it impossible to determine exactly and with data how fast and when the *luchecillo* disappeared.

Many scientists doubt Austral's scientific evidence with one of several arguments. Some argue the causal mechanism of the aluminum sulphate was not convincing and looked to alternative hypothesis like UV radiation. Others say the *luchecillo* disappeared also from adjacent ecosystems not affected by the mill's pollution. Some years after the height of the crisis, others argued that because there was no measured shock felt by fish or other aquatic plants, the *luchecillo* could not have been killed by a shock. Or they point out that the 30 kilometers of river, before the wetland, that had pollution from the mill did not present signs of shock or toxicity. These skeptical scientists pointed to an informal consensus outside of Austral that evidence of Arauco's responsibility was inconclusive, and often felt Austral was also subject to a conflict of interest.

For the outside reader, these criticisms are hard to reconstruct. For example, there is no map of the area with estimated *luchecillo* coverage before and after the crisis. Alternative hypothesis are at least as shaky as Austral's (table 4). Over the years,

over thousands of pages of reports, and over hours of interviews, constantly new elements were introduced. The deeper question is: what is sufficient proof? In the Valdivia case, a very high bar was set: scientists demanded that the Austral hypothesis explain the entire ecological state of the river and the wetland beyond a shadow of a doubt. The gaps in background data, the weakness of emission and environmental rules and standards, and weather and water monitoring stations that are few, far apart, inaccurate and often private, all make data collection an art more than a science.

Toxicity in the environmental permit

If pollution killed the *luchecillo,* it was through some form of toxicity. Toxicity was regulated through the 1998 environmental permit issued by Conama after assessing the mill's EIA, described in this section. Toxicity from a paper and pulp mill is incredibly complex and may result from chlorine, organochlorides, wood resins, chlorophenols and, as Chile discovered, from waste treatment itself. During the 1990s, the toxicity of paper and pulp production was increasingly quantified and regulated in the United States, Canada and Scandinavia, where large conferences with academic, business and government actors were held (Halliburton & Maddison, 2004). Cleaner production methods like elemental chlorine-free (EFC) were an improvement but not a solution toxicity concerns. Yet Conama argued that "the effluent is not toxic", oceans also emit organochlorides, and an experience exists where fish lived in a river of 100% toxic effluent.[26] Conama's working assumption was that:

> Nevertheless, after more than 50 years of effluent discharge from almost 1,000 paper and pulp mills in the world, into the rivers of Canada, the U.S., and Scandinavia, important accumulations of organochlorides generated by the pulp industry have not been found in the ecosystem.[27]

The EIA's "no toxicity" claim reflected a confused discussion of AOX (halogenated organic compounds), the main indicator of toxicity and organochlorides required by the permit. AOX was adopted because some Canadian provinces and Scandinavia where moving towards a "zero AOX" policy. But it was also contested in the U.S. as inaccurate; zero AOX effluent could still be toxic (Halliburton & Maddison, 2004). Conama does not consider these admittedly difficult debates and adopts AOX as the indicator to regulate the Valdivia mill despite two major drawbacks: there were no rules in Chile to set an AOX standard and, worse, there were no laboratories in the country that could reliably measure AOX. Samples had to be sent to an undisclosed location abroad. In these conditions, fast detection seems impossible.[28] Conama implied

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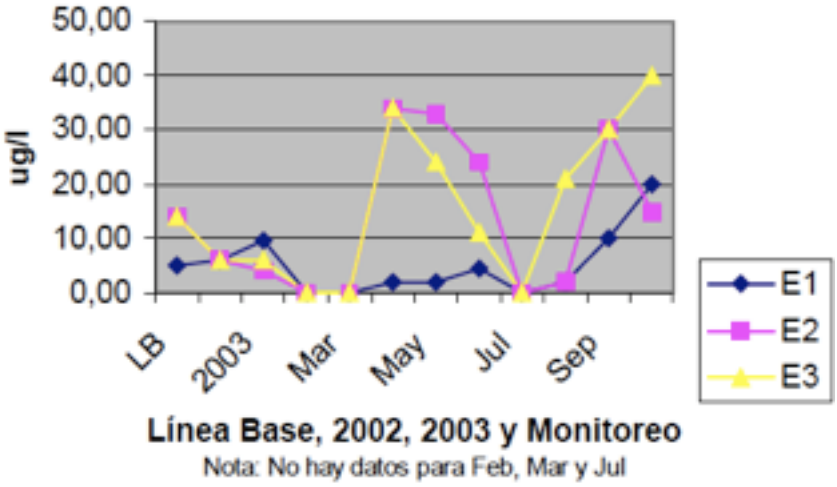
[26] Valdivia Mill Environmental Permit No. 279, October 1998: pages 13, 21, 24, and 47.
[27] Valdivia Mill Environmental Permit No. 279, October 1998: 18. Organochlorides exist in nature and are common, and they exist in industrial processes and are highly toxic. DDT, PCB and persistent organic pollutants are common industrial organochlorides.
[28] Valdivia Mill Environmental Permit No. 279, October 1998: pages 17, 28 and 71.

that AOX is minimized thanks to EFC and the use of tertiary treatment. In these ways, the Valdivia mill's permit denies toxicity rather than lay out a framework for managing it.

Where did Conama get its information from? It trusted reports by Jacobo Homsi, hired by the Agency, and consulting company GAC, hired by Arauco to prepare the EIA.[29] The data produced by both is private and only partially cited in the permit. Homsi's training and experience are not reported anywhere, and he is never called to testify in court or defend his recommendation; the only information provided is that he evaluated the environmental impacts of the mill's waste treatment and works at KRYSTAL, a local consulting shop. The permit suggests he recommended tertiary treatment, which removes nutrients like nitrogen and phosphorus through a chemical process that likely added aluminum sulphate to the waste stream.[30] Aluminum sulphate, the Austral University scientists hypothesized, caused the chain of events that killed the *luchecillo.* Despite Conama's faith in tertiary treatment, it was not commonly used in paper and pulp mills and, according to the Ramsar scientists, the Valdivia mill was using it only to remove color.[31]

Graph 4. AOX levels from the Valdivia Mill in April-October 2004.
No data is available for February, March and July. E1, E2 and E3 are the three water monitoring stations on the Cruces river. E1 is upstream and E2 and E3 are downstream from the mill. Graph from NGO *Acción por los Cisnes.*



Yet another problem with toxicity was the lack of bioassays with species from the Cruces river, a big concern among public observations to the EIA. Conama cautions that the toxicity potential of indicators like AOX are a "reference", not a local truth, until assays with local species are done, but these are not required in the permit. What

[29] Valdivia Mill Environmental Permit No. 279, October 1998: see for example pages 14, 20.
[30] Valdivia Mill Environmental Permit No. 279, October 1998: 12.
[31] World Wildlife Fund, "Informe the Observaciones y Recomendaciones", Valdivia, November 2005: 17; and Ramsar Commission Report, April 2005: 27.

species might be used is not specified; monitoring of benthic species is required, but not of fish, which are hardly mentioned. With the exception of bioassays with local species, all other aspects of pulp effluent and the Cruces river ecosystem are treated as if these were standard, universal units, rather than specialized and dynamic systems subject to a local calculus of risks or vulnerability to harms. Environmental risks are treated as discrete possibilities: "...in case situations that put the wetland at risk are detected, actions will follow in accordance with point 12 of this permit," where point 12 reads: "If unforeseen environmental impacts should arise, the company must inform the regional Conama..., and execute the necessary actions to mitigate, repair or compensate these, as corresponds. The authorities must be informed immediately following the detection of environmental impacts."[32]

Conama tried to impose strict standards on the mill but the permit suffered from obvious deficiencies - like being more than five years old when the mill came into operation - and from less obvious ones. These include privileging known concerns like nutrients and color to unknown ones like toxicity, coupled with a poor understanding of toxicity. Moreover, because impacts are defined by the law in article 11 (Law 19.300), the environmental permit does not engage these. Risks to the wetland were not subject to probabilities but to the law: they would be "unforeseen" and require legal redress. The environmental rules of the time also were a poor guide to action. When President Lagos asked Conama if he should shut the Valdivia mill, the EIA's director had six hours to review the scientific evidence which the lawyers would then use to determine if there was a legal imperative to suspend production. By then, Conama staff distrusted Austral's science - estimates seemed exaggerated and there was penchant to inculpate Arauco. The burden of proof again fell on Austral to prove beyond a shadow of a doubt Arauco's fault. This time, Austral's patrons at Conama were putting the pressure.

"Dancing with numbers"

This final section on illegibility shifts back to the aftermath of the crisis, in 2005, as scientists produced reports and actors in civil society struggled to make sense of these reports. International organizations like Ramsar and the World Wildlife Fund concluded that it is impossible to reconstruct what happened in the Cruces river, and that the proliferation of numbers, data, and analysis were inconclusive because every study is too small in scope. In addition, there was a "dance with numbers", to use a typical Spanish expression, which ranged from the illegal to the ambiguous or inaccurate.

Illegal fudging of numbers include discrepancies between laboratory reports and Arauco's monitoring reports submitted to Conama. Austral scientists documented these differences and used the laboratory reports, but Claudio Zaror noted the discrepancies and used the Arauco reports.[33] Zaror goes on to recognize a series of violations of the monitoring requirements in the environmental permit, but minimizes these. Equipment to

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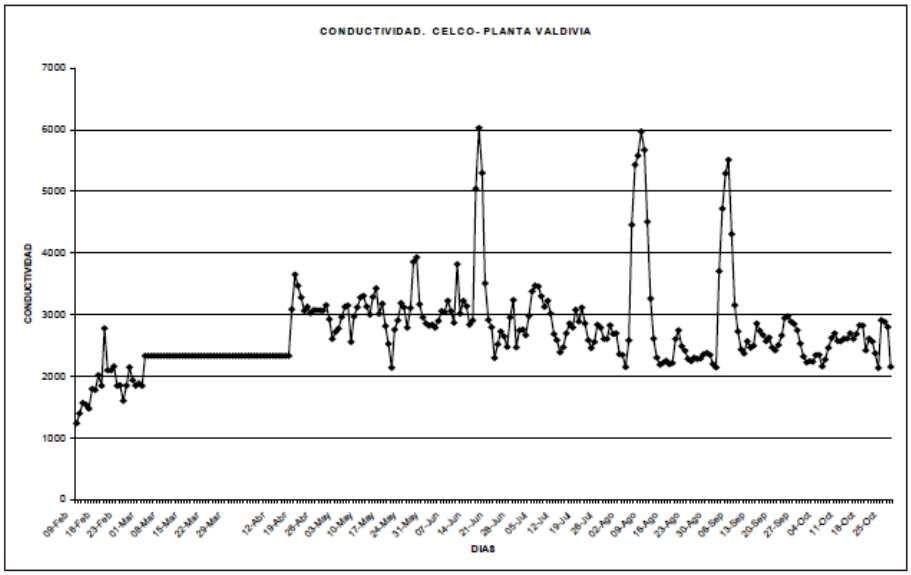
[32] Valdivia Mill Environmental Permit No. 279, October 1998: pages 28 and 71.

[33] Zaror, Claudo, 22 March 2005, "Apoyo al Analisis de Fuentes de Emicion de Gran Magnitud y su Influencia sobre los Ecosistemas de la Subcuenca del Rio Cruces": pages 23 and 27.

measure conductivity was broken for two months and the wrong methods were used to measure resins and acids, leading to an under-reporting of these and other elements, including chlorophenols. None of this bothered Zaror who argued that it was understandable that such a large operation should run into initial troubles.

Ambiguous and/or inaccurate data reporting included a seemingly endless

Graph 5. Conductivity from the Valdivia Mill, 2004, reported in Austral Report
The flat line indicates broken equipment



number of elements. Some alleged the mill was emitting unauthorized effluents and waters into the river of 350 liters per second; that it was emitting wastes in April even if it was not producing; and that it consumed 40 tons per day of aluminum sulphate. Others denied these claims or modified them: the mill only consumed 30 tones of aluminum sulphate. These discrepancies led Conama to distrust Austral's science. Another serious issue that receives near zero attention among the authorities is water flow in the Cruces river. Zaror reports that Arauco chose a questionable methodology to estimate river flow and asks the authorities to arbitrate how appropriate this is.[34] Less water means less capacity to dilute pollution in the river.

Finally, monitoring infrastructure was lacking. Only three water monitoring stations existed on the Cruces river, immediately before the mill, immediately after the mill and where the river enters the Sanctuary. Different reports emphasized problems with these. Zaror reported the last station produced inaccurate data because it is subject to ocean tides, and the Ramsar report says more stations are needed to estimate water depth at strategic points. No weather stations exist close to the river or the wetland. The nearest weather station was at the airport and recorded freezing

[34] Idem: 10

temperatures which Marín used to argue the *luchecillo* froze to death. Austral scientists protest saying that station is too far to be representative of conditions at the water level. These discrepancies are not unique to the Valdivia case. Similar complaints and episodes of illegibility occurred at Pascua Lama, around salmon farms, and in the evaluation of HidroAysén. Not only are water and weather stations few and far between, but often they are badly placed, inaccurate or privately owned.

Scientists will always argue for more data, so to reflect on the lack of it is a difficult task. A few respondents close to the Valdivia case, however, said they felt the thin historical record about the Cruces river increased distrust. One said, scientists' "epistemic condition" is to produce "incalculable" hypothesis and models, and the lack of data is a "conversation stopper". The proliferation of elements causing toxicity, shown in table 7, is perhaps a result of this tendency. All this reflects material limits on the authority of science in Chilean environmental politics. Such few and flawed data collection stations can not support a high bar of scientific proof.

Table 6. Causes of toxicity in the Valdivia mill's effluent identified by different actors

Actor	Causes of toxicity
Austral scientists	Aluminum sulphate
Ramsar scientists	Chlorine-based compounds
Claudio Zaror	Conductivity, sodium, sulphates, AOX, suspended solids, nitrogen, phosphorus, and resins.
ENGOs	Low water relative to effluent, chlorine, wood-based compounds

IV. Standards of proof

It is difficult to speak of proof in a case that remains unresolved after years of extensive studies and court testimony. Although several dozen scientists took the witness stand in 2008, the Judge appointed new experts to assess the evidence in 2009. Six of the seven found Arauco responsible in 2012, but over a year later the Judge has yet to issue a verdict. As of writing in May 2013, there were rumors that Arauco's lawyers were trying to reach a settlement with the State's defense team and that a verdict is due by the end of May.[35] This section tries to speculate on how much science will contribute to the verdict (if the parties do not settle first). Scientists spent more time on the witness stand defending science than contributing their expertise on the issue. Witnesses were cross-examined but these rarely if ever got to the content of science. The Valdivia case, unlike the cases examined in the next two chapters, brings

[35] http://www.biobiochile.cl/2013/01/29/nibaldo-mosciatti-consejo-de-defensa-del-estado-negocia-los-cisnes.shtml

in the courts as another site where the public validity of knowledge is established. Through this environmental damages case, the court was a site where the quality of the EIA was tested to see how well EIA science and evaluations could be used to exercise accountability.

Though science had a lackluster performance during the trial, nonetheless "more science" became part of the solution to the problems of public credibility and accountability. Arauco enrolled science to inspire confidence in the communities where it works more so than the state, whose efforts to remediate the wetland and impose new water quality standards have so far failed. These experiences speak to the troubled trade-off between integrity and relevance. Arauco provides the means for science to be relevant with seemingly sufficient appearance of integrity (assuming otherwise scientists would not participate), while the state provides neither opportunity to scientists.

Science in the courts

Scientists on the witness stand for the civil environmental damages case spent more time defending the authority of science than discussing the results of their work. Faced with questions from lawyers, scientists had to defend the authority of science while respecting the authority of the law. The Judge told scientific witnesses they could not speak to legal documents nor could they be too specific because they were not lawyers, and scientists drew strict lines between their authority and that of the law:

> [citing Stephen Jay Gould] I would like to clarify an acronym I will use NOMA (non overlapping magisterium) that indicates a clear division between the validity of science and of legal accusations. Basically, science and law use their own methodologies and can not be inter-changed.
>
> I never said the Valdivia mill had no impact on the Cruces river or the changes that occurred there, only that there is no scientific evidence…I am not aware of what it means to evaluate an input from an environmental perspective. As far as I understand, if the emission standard is met it is not necessary to do any environmental evaluation of any input because the regulator already decided under and above what thresholds we must worry about the environmental effects.[36]

The second quote was spoken by Fabián Jaksic, director the Catholic University's Ecology Institute and one of Chile's most important ecologists. He argues that the state, not science, has to determine environmental harms. Ecology, he suggests, has little to say about this. Economists from the Catholic University also testified to further undermine the role of ecology as a privileged discipline for understanding nature by affirming one universal science: "Naturally I am not an expert on ecosystems, but whatever the discipline where the scientific method is applied, this conceptual

[36] Legal transcript, civil damages case: Scientists, pages 2205 and 3713.

framework must be present."[37] Jaksic further argued that ecology privileges environmental or natural causes to human ones because it is "value neutral". He gives the example of climate change: only after 20 years natural explanations were discarded and scientists moved on to explore human causes to climate change.[38]

Moreover the spirit of this universal science is to continually disprove itself. Some scientists tried to refute Arauco's lawyers on this point but did not often succeed. Jaramillo finally recognized: "I have previously sustained that science has no monopoly on the truth and therefore there are no absolute explanations."[39] Another Austral scientist participated in a tedious quasi-philosophical debate when Arauco's lawyers asked him: "Do you share Edington's statement to the effect that scientific hypothesis should be signed with the phrase used by vendors, 'S.E.U.O', save for error or omission, because as is stated in Desiderio Papp's book, *Philosophy of Natural Science*, 'relativity' not only exists in physics but in all scientific conclusions?" They then discussed trends versus snapshots and the inherent uncertainty of knowledge illustrated by the revolutions caused by Albert Einstein and Stephen Hawking. The scientist replied that scientists must never remain with what they already know, otherwise "as doctor Maslow said, if you always use a hammer, all problems will begin to look like nails."[40]

On this point of accumulating knowledge Jaksic reaffirmed the value of money. He described their experiment to test the effluent's toxicity as "well funded" compared to the under-funded, and thus necessarily lower quality, work of Austral (see Palma et al., 2008, table 4). He also admits their study was not very representative because they used effluents from 2007, not 2004, because "[a test of 2004 effluents] has not been asked for."[41] According to Jaksic, science builds knowledge by increasingly comprehensive yet parsimonious hypotheses, beginning with natural causes. Another important environmental scientist that believes Arauco is not responsible argued that science grows through a probabilistic process that is "constantly revised, nothing is ever certain." In his opinion, the Valdivia case was unresolvable because initial conditions were poorly characterized.[42] The implications for Chilean science are clear: to be relevant to questions about pollution, science requires lots of funding and extensive background data, both of them obtainable only from private companies like Arauco.

The final misfired strategy used to affirm the explanatory power of science was to make science sound difficult. This strategy takes two forms, illustrated by the long quotes that follow. The first is the paraphrased testimony of a chemical engineer:[43]

> ...It is impossible to test the hypothesis that industrial waste caused the damage up to the standard of the U.S. Environmental Protection Agency's 1985 protocol for assessing water quality….It would take years and several

[37] Legal transcript, civil damages case: Economist, 995.
[38] Legal transcript, civil damages case: Jaksic, 3708.
[39] Legal transcript, civil damages case: 1393
[40] Legal transcript, civil damages case: 2419-2423.
[41] Legal transcript, civil damages case: pages 3706, 3719-20
[42] Legal transcript, civil damages case: 1915
[43] Legal transcript, civil damages case: 2589-2775. Parts are paraphrased for brevity.

> million dollars to gain [the necessary] knowledge, and: "I would say there is just one person in Chile with the necessary training to create such a mathematical model, because this requires advanced training in partial differential equations of a complex nature…and time series data of wetland conditions in the past, which don't exist." He mentions different possible explanations: the effects of El Niño and La Niña currents; the swans were a meta-population to go extinct from over-consuming *luchecillo*; or introduced carps ate the plant. He says these numbers come from Ramsar and the work of a previously unmentioned scholar called Hanki. The Cruces river is unique in Chile because of its high levels of chrome and nickel.
>
> He hypothesizes that waste treatment plants along the Cruces river emitted wastes which caused phosphorus to precipitate, which hampered the *luchecillo's* capacity to photosynthesize in the presence of iron. Asked if he has evidence for this he replies: "…I must have over 100 kilos of information referring to studies of the Sanctuary…consisting of books, PhD thesis from Europe and North America, about [*luchecillo*], for example, a great number of papers and books about environmental engineering and water treatment processes, accumulated over 40 years of professional experience that would be impossible to lay out in detail. In this moment, much of this literature is not available and is one of a kind in this country. To all this I would add a great many archives downloaded from data bases in 24 languages, which are the ones I can read.
>
> He finally reports that he has discussed these ideas with everyone except the Austral group. He was invited by President Frei to the Senate's Environment Committee to present these views. This was the only invitation for public speaking that he accepted. He submits the EPA's water quality protocol and an article from the journal *Nature* on UK phosphorus standards to accompany his declaration.

Though bolder than many of his colleagues, this scientist's testimony nonetheless relies on common discursive strategies. He raises the bar of scientific proof to unattainable goals: foreign methods used by the U.S. authorities, an explanation that accounts for incredibly complex phenomena like the El Niño and La Niña currents, and the need for inexistent data and incredibly scarce expertise. He bases his authority widely but unrealistically: 24 languages, 100 kilos of literature, and an invitation from the President. Finally, like everyone else, he introduces new elements not mentioned anywhere else: scholars who did not appear in any other report or testimony (Hanki), chrome and nickel, and hypothesis of different sorts (invasive carp, precipitating phosphorus).

A variant of this strategy was to get bogged down in unproductive conversations, like this one which ends with the scientist narrowing down his sphere of authority:[44]

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[44] Legal transcript, civil damages case: Scientist, 1409-11.

> Scientist: “The technical question is not formulated correctly because trace metals do not precipitate.”
> Lawyer: “Is the action of the aluminum sufficient to precipitate the heavy metals?”
> Scientist: “Heavy metals do not precipitate, only salts do.”
> Lawyer: “Is it necessary, for the aluminum to be sufficient to co-precipitate metals, for there to be a certain concentration of aluminum?”
> Scientist: “Technically, metals do not precipitate.”
> Lawyer: “Does the Austral’s hypothesis imply a process of co-precipitation?”
> Scientist: “If the question is about trace metals, these do not precipitate.”
> Lawyer: “The Austral report says: ‘an excess of aluminum sulfate can cause iron to precipitate’”, and asks the scientist to explain this.
> Scientist: “I am not totally sure, it must be due to the use of colloquial language so people can understand. This is chemistry, and I am a geologist.”

Scientists’ testimony focused on affirming the explanatory power of science in ways that ultimately undermined their claims to reliable, useful knowledge.

The state fails to produce “more science”

In 2005 after the environmental disaster in the wetland but before the civil damages case was clear to drag on as it has, the Chilean government announced a series of promises to ameliorate the crisis. A series of lessons learned from this crisis went on to inform the 2010 reform of the EIA, including better EIA baseline, monitoring infrastructure, and basic knowledge of the ecosystem. State agencies began work on a science-based wetland remediation effort, new water quality standards and new monitoring practices, none of which have prospered. Even the national science agency has abstained from funding research in the Cruces river. Sophisticated monitoring with indicator species and DNA analysis, recommended by Claudio Zaror and the Ramsar scientists, sound like science fiction in Chile where few industrial plants have even online emissions monitoring or receive surprise visits from the authorities.

One of the government’s responses to the crisis was a planned wetland remediation plan. In 2006 the Forest Agency, in charge of the remediation plan, got started by tendering new studies. But internal disagreements and public distrust broke the wetland remediation plan down. Boycotted by some environmental groups and stretched thin for resources as the civil damages case dragged on, the remediation plan’s death knell was a study by scientist Victor Marín (published as Marín et. al., 2009, table 4). Marín’s group used a “post-normal science” approach to connect science to decision-making, but got the opposite: a study no one agreed with or believed in, because it did not answer the question and had an unusual methodology. Suspicions still run so high that some scientists, not only from Austral, believe Marín received money under the table from Arauco. Post-normal science requires an “extended peer review” where members of different communities (civil society, experts, stakeholders,

etc.) validate the public credibility of the information to increase consensus and the stability of technical decisions (Funtowicz & Ravetz, 1990). In Chile, however, engaging stakeholders in a broad participatory effort finished discrediting the remediation plan and increased resentments among scientists and government staff.

Another government response to the crisis announced in 2005 was new water quality standards. Seven years after they were first promised, effluent and water quality standards for the Cruces river wetland are still in the making, ostensibly due to the "lack of prior understanding" about the area's ecology. Conama tendered several studies in 2006 - 2009 that have shed light on the importance of tides and complexity of the ecosystem. Conama continues to believe the fantasy of science – the scientists "just hand in the hard data" - and hired the same researchers at Austral for many of these studies. The fantasy survives in part because the scientists do not participate in standard setting; Conama leads a broad participatory effort, a cost-benefit analysis and several steps of political review that produce the standards (chapter 1). Meanwhile pollution continues to accumulate and no new monitoring stations have been installed.

The political authorities also put on a poor performance of trust. Since the crisis, a large brown stain appears on the Cruces river in summer. The stain is largely a mystery. Citizens are largely unswayed by the national sanitation agency's toxicity reports, so the regional governor bravely drank a glass of water from the stained river in 2006. The stunt backfired as angry parents asked what example the governor was setting to children, admonished never to drink water from the river because its waters are not potable.[45] The governor replied: "I never said the water is potable, it is only apt for water sports, and when you swim you can take a gulp without much risk", but Valdivians' concerns lay with the ecosystem and harms to them and other large mammals, like the swans, not with the occasional swimmer.[46] The local newspaper asked for "more clarity" from scientific sources, "more caution" from citizens' organizations, and "more leadership" from the authorities. The governor's complacency and the citizens' outrage were "two confusing positions…that recall our erratic reactions to events that affect our environment. Opinions are disoriented, misinformed and unbalanced."[47] The editorial could have reflected also on how the governor's office - newly crated after Valdivia became an administrative region in 2005 - had no discernible impact on the crisis. The performance failed to overcome public distrust and highlighted the gap between citizens' and politicians' concerns.

Arauco succeeds with "more science"[48]

After the crisis, since 2006, Arauco on the other hand has learned to take the environment and community relationships "seriously". That is, to act preemptively. Executives were fired, experienced community workers recruited and a new

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[45] Diario Austral de Valdivia, 5/02/06
[46] San Cristobal, Mauricio, March 2006, "De Intendente a Ciudadano: Entrevista con Jorge Vives" in *El Ciudadano*.
[47] Diario Austral de Valdivia A9, 5/02/06
[48] This section draws on interview material with three Arauco staff and two close collaborators.

environment division created under the direction of Andrés Camaño. Camaño changed Arauco's engineering culture away from cost-cutting towards investing in community relations and environmental management. He convinced the company that science can make your project "bullet proof" and Arauco now practices what they proudly call "research for corporate defense" through research consortia, like the one at Nueva Aldea, a pulp mill built after the Cruces river disaster.

Arauco staff see Nueva Aldea as the "anti-Mehuín" because they learned from their mistakes. At Nueva Aldea, Arauco pioneered the use of research consortia. These are a group of local universities, most trusted by communities, and foreign universities, most trusted by the company. The consortia is an all-around trust-building organization. It allays public fears of conflicts of interest because "it is unlikely that five or six universities would all be colluding with the company". Arauco executives can trust the consortia more than a university working alone, that might accept a contract even if it lacks the required capacity and saving every possible *peso*. Through the consortia Arauco interacts with the community, making a point for example of eating local fish and drinking local wine to prove to the community that the environment is safe. This works best in Chile: "like Saint Thomas, you need to see to believe". Like other companies in Chile, Arauco says they work with the "best of the best", employ the "best of the best" technologies, and produce valid scientific data and knowledge.

Furthermore, Arauco has integrated research consortia into new EIA processes the company participates in. When building a new mill or evaluating impacts to expansions or changes of existing mills, Arauco takes observations local communities make in the context of the EIA process and transforms these into long-term research plans that the research consortia takes on. The resulting science is "the only way" to explain accidents and determine the company's responsibility. They understand that "research allows you to explore things that monitoring does not". Arauco put this to good use when thousands of fish washed up dead in the Mataquito river, just downstream from another paper mill, in 2007. Arauco quickly determined its responsibility, paid the fines, and averted another social protest.

Mehuín, in contrast, continues its battle. Some locals are coming around to the pipeline after Arauco invested in education, emergency services, internet and "cultural programs" like games on the beach led by pretty women. Others continue to protest and claim Arauco used trickery to obtain data for its latest EIA, approved in 2011. Scientists allegedly entered the bay pretending to work to fix a deadly break, but in a drunken party the next day confessed to locals. Arauco's public relations campaign in Mehuín is similar to those by Barrick in towns near Pascua Lama (chapter 5) and by Endesa in Aysén (chapter 6). In these ways companies "buy people's consciences" so many accept the project rather than continue the fight. Others worry it is "bread today, hunger tomorrow".

V. Conclusions

The environmental disaster at the Cruces river was a watershed moment in environmental politics and continues to divide Chileans. For many, Arauco's corporate

influence preys on a weak state, where both the technocratic arm - represented by Conama and the EIA - and the political arm - represented by Valdivia's regional governor and the President's office - failed to act in ways that produced public trust and credibility. For others, environmentalist passions and over-zealous scientists staged an anti-development campaign based on weak scientific evidence. This is the overwhelming opinion of corporate and consulting staff, and also of scientists and engineers at several universities.

Political and environmental views among this group vary. What unites them is trust in political resolutions based on dialogue, integration and consensus, where science is one input among others. "I trust an agreement more than a [technological] silver bullet", said one interviewee. Others added: "Science is not enough", it must be "integrated" with social issues and "objectivity does not exist." Statements like these came from forest engineers, hydraulic engineers, biologists and water chemists working as academics at universities or in consulting companies. When asked about experts, interviewees would say things like "we became experts as we went along" or give ambiguous answers to the effect that everyone is an expert because it is not clear who the experts are. A sociologist insightfully said that the Valdivia case taught him that "the experts are not who we thought they were", meaning local and activists groups should have been incorporated into the company's disaster response from the beginning.

Scientists, in this group's view, break down the political dialogue. Scientists were disruptive because "scientists dressed as politicians" and "waved the flag of a certain position"; because "the academic ego led them all to want to be heroes"; because "there was a negative emotional charge against the company". In these ways, scientific and principled positions that appeal to evidence or to values grounded in justice and equity concerns are seen as stubborn and unproductive because they can not lead to the desired goal: a negotiated agreement. These criticisms of scientists point both to the little authority scientific evidence and opinion have in Chilean politics, and to the latent need for political leadership. Who "waves the flag of a certain position"? Who are the heroes? To the public, in the Valdivia case political leadership failed and Conama took two steps back for every step forward.[49]

Many in science, industry and even in government (including Conama) also believe that Austral failed to prove its independence from the state. Following the logic that scientific independence is evidenced by reaching results opposed to the patron's interests, Austral appeared to be biased because its report inculpated Arauco, which is presumably what Conama was after, following the logic of this large group of people. Marín's study, funded by the state but exculpating Arauco, was highest in this group's esteem, because his results proved his independence - they ran contrary to the state's interest. Scientists face a catch-22; whether results are aligned or opposed to the patron's interests, some groups will consider the science biased. Results, furthermore, are evaluated against interests more than evidence. This standard of independence is

[49] Events of public loss of trust continue to accumulate: in 2011 journalist Sergio Ñuño was fired because he accepted money from Arauco at the same time that he produced a television about the disaster exculpating Arauco, and in 2013 negotiations between Arauco and the State's legal defense to avert a verdict in State v Arauco produced strong media reactions.

both impractical and perverse. Any semblance of the truth is sidelined to speculations about interests.

Many scientists who implicitly or explicitly took Arauco's side already knew what Austral scientists only came to discover through their participation in the controversy - that to be relevant in Chilean society today requires working with industry, even at the risk of appearing to have a conflict of interest which will erode social trust in your work. But business relevance is not the same as social relevance, and the multiple gaps in background data, together with a weak institutional structure to manage conflicts of interest, practically guarantee that corporate cooperation will undermine scientific credibility in the public sphere.

The idea that scientists "wanted to be heroes" reflects a desire to be both locally legitimate and relevant. This is the promise of the successful creole scientist, but his opportunities today are limited. If cooperation with industry risks eroding credibility from the suspicion of conflicts of interest, cooperation with the state risks irrelevance or, at best, invisibility. Austral's experience in the Valdivia case, first with the 2005 report and then with the studies for the water quality standards, bears this out. Though the Valdivia mill violated multiple rules and conditions in its permits, Conama and scientific reports disagreed if water quality and emission standards had been violated.[50] The EIA failed as a register of objectivity in this case because it did not register sufficient information to exercise accountability when a disaster occurred. Conama tried to stick to the rules, but these were not a sufficient guide for action when making difficult decisions like whether to close the mill. Sticking to the rules does not make a strong institution.

Finally, the Valdivia case points to processes where the state of science - full of disagreements over how to know or what constitutes scientific proof - produces and reflects a state where professional identities are weak and unstable, marked by unshared representations and goals, and where trust is the most scarce of all resources. As opposed to co-production (Jasanoff, 2004), this is a process of co-destruction, as in the aborted wetland remediation plan or the long-awaited quality and emission standards.

[50] Zaror argued water quality DS/90 had not been violated and Austral that it had been violated.

Chapter 5. Moving Glaciers? The Conflict at Pascua Lama Gold Mine

The Atacama desert is the driest in the world, yet on its southern border lives a thriving agricultural community. The Huasco Valley farms fruit, *pisco* grapes and olives, for local and export markets. The range of Chile's divided social classes live in the Valley, from marginalized indigenous communities in the mountains, to landed farming classes in the valley, to the urban poor and middle class by the coast. Ecologically, the Valley is a border between the vast, dry desert to the north and Chile's mediterranean central valley to the south. For twenty years, Huasco has received more than its fair share of harmful industrial projects, leading to talk of a "sacrificial zone".[1] Cancer rates are three times higher than average. Small-scale fishing has closed. As the Huasco Valley dries out, the Atacama desert advances south. The desert has been advancing at the pace of mining; the border used to lie further north, at the Copiapó river, which dried out a few decades ago after large mining projects filled the region.[2]

Water and development are the stakes involved in the Pascua Lama gold mine. A binational mine to extract and export eleven million ounces of gold, some silver and copper, Pascua Lama was the first large mine proposed in the Huasco Valley.[3] Barrick Gold, the Canadian company that owns the mine, proposed to move three glaciers that would fall within the mine's excavation area to the side or to the waste pile. The environmental authorities (Conama) objected, first very timidly and then loudly, as public protest exploded. Thousands mobilized to protect the glaciers, in the Huasco Valley, Santiago, around the country and internationally. Glaciers transited from legal invisibility in 2000, to political centrality in 2005. Although many in government, business and science were critical of what they saw as a romantic view of glaciers as elements of pure nature, protestors mobilized to protect glaciers to protect agriculture. Glaciers symbolized sustainability in the sense of preserving long-term water supplies to maintain agricultural communities in which small, subsistence, indigenous and independent farmers have a future.

Pascua Lama had two EIA processes. The comparison highlights how Chilean policy-makers learned about nature through the EIA. How did the EIA process organize and produce information about glaciers, to pull them out of the state's blind spot? How did this information become credible in the public sphere? The EIA worked as expected:

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[1] http://ciperchile.cl/2012/06/11/el-valle-del-huasco-la-ultima-frontera/. In 2012 NGO Chile Sustentable launched a campaign with this argument, and a number of articles with this theme appeared. In addition to mining, Huasco has a power plant that uses pet-coke, an over-size pig plant that was at the center of major health violations, and another planed coal-fired power plant. See also: http://www.santiagotimes.cl/opinion/special-reports/25608-the-huasco-river-valley-a-look-into-chiles-sacrificial-zone; http://cryoftheandes.com/wordpress/

[2] I arrived at Copiapó town early one morning and went to the tourism office in search of a map. Over a *nescafé*, the tourism officer, in her 40s, reminisced about playing in the river as a child. Today its a dusty riverbed.

[3] A point of contention was a tax treaty between Chile and Argentina to share revenues. For a critical look see Luna, et. al., (2004) *El Exilio del Condor: Hegemonia Transnacional en la Frontera. El Tratado Minero entre Chile y Argentina.* OLCA: Santiago.

prestigious glaciologists got involved, representing different interests from business, civil society and government. Numerical and quantitative proofs were generated to respond to the uncertainties, like how important are the glaciers to downstream water flow?

Pascua Lama's EIA results were not as expected. Glaciologists were hired by each side to represent their interests through the EIA. As in the Valdivia paper and pulp mill controversy (chapter 4), scientists got involved to represent a position, not to act as mediators. Unlike the Valdivia case where expert participation became adversarial, in the Pascua Lama case expert participation was auxiliary to negotiations between political and business interests. Perhaps as a result, the final decision taken through the EIA process does not reflect glaciologists' collective assessment. None of the glaciologists involved argued for leaving the glaciers in their location, in part because the glaciers were already significantly negatively impacted. Conama, in the final EIA decision, argued for "protecting" the glaciers by leaving them in their location on "precautionary" grounds. But the reasoning and discursive practices employed were so contradictory that this decision failed to set a precautionary precedent. Conama's precautionary argument could be seen as an effort to exercise bureaucratic discretion; nothing in the rules obliged Conama to protect the glaciers. However, the quality of Conama's reasoning had the opposite effect: legislators used these experiences to argue for a more "technical" EIA during the 2010 reforms, where technical came to mean "clearer rules" and "more executive authority" as discussed in chapter 3.

The first part of the chapter introduces Pascua Lama's expected environmental impacts, common to many gold mines, and how glaciers came to be a focal point of protests. Glaciers were just one of many important environmental risks. The next three sections focus on glaciers in the EIA process: who got involved and why; what kind of data was generated and how it was used to make glaciers legible (and illegible); and the standards of proof applied to reach closure. Like the controversy at the Valdivia paper and pulp mill (chapter 4), "more science" in the form of monitoring and inventorying emerged as solutions to the political controversy. Credibility, in this case, is being cultivated by bringing the different parties to work together. The result, however, may be less than palatable to those who distrust experts and government.[4]

I. Stakes: "Cover ups, dishonesty and incompetence"?

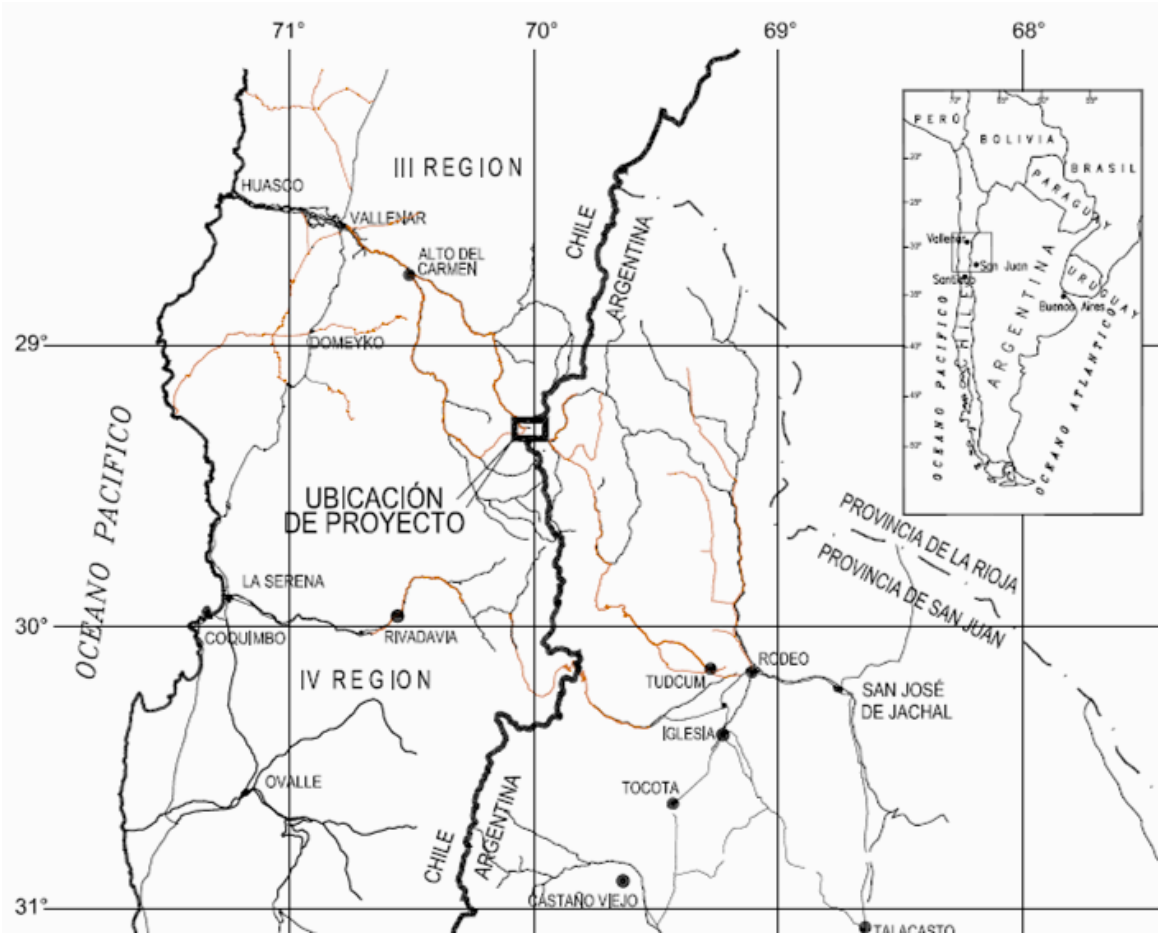
Gold mines like Pascua Lama can have many environmental impacts. First, rock wastes consist of millions of rock shards piled up in large flat hills called "cakes". This "sterile rock" contains minerals that acidify rain, snow and underground waters they come into contact with, through a process called acid-rock drainage. At Pascua Lama, each day 48,000 tons of rock will be extracted and deposited at two sites. One of these, Nevada Norte, lies adjacent to the Estrecho glacier and river. As 1,200 million tons of

[4] This chapter is based on interviews conducted between May and July 2011 with staff at Conama, the Water Agency, EcoNorte, Barrick, activists, and with all the glaciologists who participated except one. Two of these interviews were by email. The rest were in person. Some glaciologists spoke only briefly while others were available for a full interview. I would particularly like to thank Roxana Bórquez for sharing her degree dissertation with me.

rock accumulate there over 19 years, Barrick has to ensure the stability of this new hill, reduce contact waters and install catchment canals and pools to avoid acidic run-off into rivers (map 2). Second, industrial installations, the workers camp and the sprawling open pit - 1.3 miles wide and half a mile deep - are worked by humans, oil and chemicals that must be sent up the mountain and disposed of adequately.[5] At 5,300 meters, this is not easy to manage.

Third, mines use natural and infrastructure resources, like water and roads, that others also want to use. In the Huasco Valley all these resources are scarce; roads are in relatively poor condition and, as of 2010, no by-pass road had been built to spare the small town of Alto del Carmen the parade of trucks, many full of cyanide, rushing past the main square and school. Pascua Lama will use 370 liters of water per second (for

Map 1. Huasco Province, Chile. Pascua Lama is located within the small box. From Milana (2005): 5.



[5] The mine will use on average 57,061 gallons of oil per day. Pascua Lama Environmental permit #024 (February 2006): 104.

mineral processing and other uses).[6] Fourth, gold mining requires chemicals to precipitate gold, silver and copper from the rock. This large-scale use of chemicals has risks and produces wastes (known as "tailings") often kept in dams to evaporate liquids out. In Pascua Lama, these chemical wastes will accumulate in Argentina and were not evaluated by the Chilean EIA.[7]

Finally, mines destroy landscapes. At 5,300 meters above sea level, Pascua Lama's impacts are not easily seen but they were enormously protested. The mine threatened to excavate three glaciers and to indirectly impact two large glaciers nearby. Pascua Lama was exceptional at its time, but may be a harbinger of mining to come. Until recently, at this altitude and ore grade (ratio of metal to rock), mining was unprofitable. With temperatures permanently below zero, 200 kilometer winds, and low oxygen, workers can not work year-round. But as the price of minerals rises, more mines like Pascua Lama will operate.[8]

Pascua Lama underwent two EIA evaluations, in 2000-2001 and 2004-2006. While in 2001 Conama gave Barrick permission to move the glaciers, in 2006 Conama required Barrick to leave the glaciers in their current location. Because Conama changed its reasoning regarding glaciers, it is a good case to reflect on how well Pascua Lama's environmental impacts were evaluated through the EIA and how legitimate and credible the conclusions were. Pascua Lama's EIA was evaluated by Conama's regional office in the Atacama region. During the first EIA process, Conama focused on "traditional" mining issues: increased truck traffic, the transport of toxic substances on country roads, and water quality (e.g., acid-rock drainage). Barrick proposed to move three small glaciers - Toro 1, Toro 2 and Esperanza - and deposit them, if possible, to the side of the mine.[9] If this was not feasible, Barrick would place the glaciers in the waste rock pile, according to Barrick's original EIA report. The environmental permit Conama issued urged Barrick to minimize glacier loss and to relocate the three small glaciers onto the nearby Guanaco glacier. These incremental improvements aside, Barrick's glacier disposal plan raised few concerns within Conama. The glaciers represented a tiny percentage of the total glacier coverage in the area (4% according to Barrick) and downstream impacts would be negligible. The community questioned whether the mine would deteriorate water quality in the Valley, but as discussed in the next two sections their complaints were not taken very seriously during the first EIA process. As detailed in the participants section of this chapter, from 2001 members of the community began to mobilize against the mine.

Though in 2001 Conama approved Pascua Lama with permission to move the glaciers, at the end of the second approval process five years later Conama did an

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[6] Pascua Lama Environmental permit #024 (February 2006): 106.

[7] Argentina and Chile did separate evaluations. This chapter only looks at the Chilean side. It was surprising how little contact or collaboration there seemed to be across the border on several issues. Barrick Gold has been even more strongly opposed in Argentina than in Chile and accused of the worst forms of corruption. Renowned journalist Manuel Bonasso compiles these in the massive *The Evil: The K Regime and Barrick Gold* (2011). Buenos Aires: Distal.

[8] Gold is used in jewelry (59%) and investments (29%); only small quantities are used in medicine or technology. Since the early 2000s its price has risen by 400%. http://www.numbersleuth.org/worlds-gold/

[9] Pascua Lama EIA report (August 2000), Chapter 6: 38.

about-face to protect the glaciers: they could not be moved. Did the EIA fail to evaluate impacts, or did glaciers become more important between 2001 and 2006, or both? The participants section of this chapter narrates the events that led up to this second EIA evaluation process, when protest erupted to challenge both Pascua Lama and the EIA's legitimacy.

Under pressure from then President Ricardo Lagos and other political and business elites, Conama had to approve the new EIA but with better protections for the glaciers. To reject the project's EIA was not an option; Barrick already had an EIA that allowed it to build a smaller mine. From Conama's point of view, how to improve the project was the only question. This perspective was ratified by the agreement signed in June 2005 between Barrick and the largest business association in the Huasco Valley, the Irrigators Association. Between June 2005 and January 2006, glaciologists hired by the Irrigators Association negotiated through the EIA with glaciologists hired by government agencies to reduce and compensate Pascua Lama's environmental impacts. The second environmental permit was issued in January 2006. Though the project was a done deal well before this, it was still necessary to continue with the evaluation. The evaluation shaped the project through the conditions imposed on Barrick and produced a series of mixed precedents or "lessons learned" that informed the EIA reform in 2010.

One of the lessons learned had to do with glaciers; these moved from a legal blind spot to being regulated through a national glacier inventory maintained by a new glacier unit within the Water Agency. Pascua Lama was an environmentalist victory: Barrick was not allowed to move the glaciers as it had proposed, and new rules and organizations were created to ensure glaciers would be better protected in the future. Yet for reasons discussed below, few of the activists or communities involved felt this was a victory. On the contrary, most felt completely defeated by Chile's environmental regulatory politics.

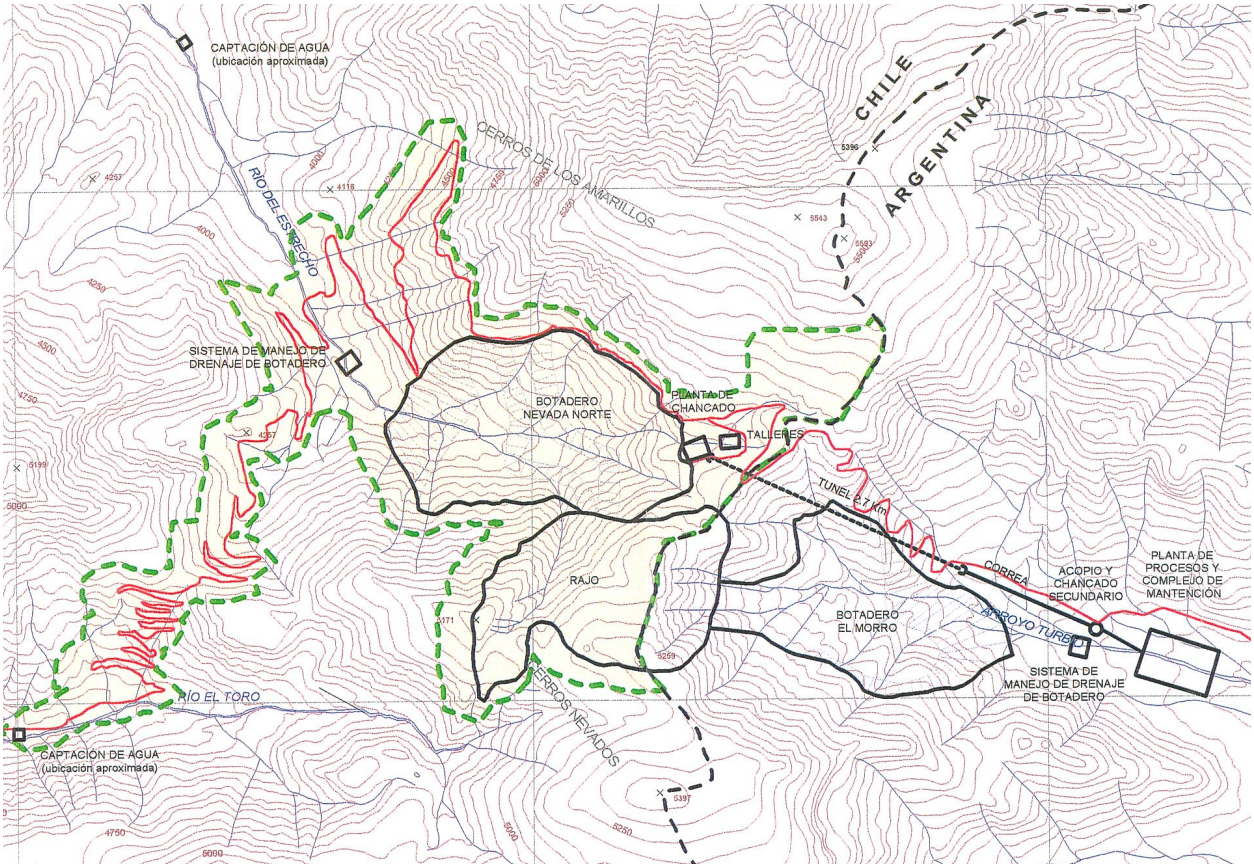
Glaciers versus development

When Pascua Lama's second EIA was submitted in 2004, Glaciers caught consultants, Barrick and the authorities by surprise. A Conama staff person said that in 2004 they asked about glaciers "with all innocence" and unsuspecting of the opposition the glaciers would incite. Another government employee said: "we really knew nothing about glaciers, it was a completely new topic for us."[10] An environmental consultant who worked on the project recalled how even her friends and family, who had never had much to say about her work, were alarmed and asked if this wasn't going too far. Peter Munk, who founded Barrick Gold in Toronto and made it a multinational, highly profitable mining company, had to face questions from his own concerned children.[11] By 2007 this

[10] Bórquez, Roxana. (2007) "Análisis del Escenario Actual de los Glaciares de Montaña en Chile desde la mirada de la Seguridad Ecológica". Memoria de Título. Escuela de Agronomía, Facultad de Ciencias Agronómicas, Universidad de Chile: 72.

[11] Peter Munk makes these declarations in the documentary *El Tesoro de América – El oro de Pascua Lama* (2010), directed by Carmen Castillo.

Map 2. Pascua Lama gold mine
EIA (August 2000) Chapter 5: 107.



Legend: *Botadero* refers to the sterile rock pile; *Rajo* is the pit. Mineral is transported by an underground tunnel for processing in Argentina. The Toro and Estrecho rivers are labeled.

surprise and “discovery” of glaciers had been replaced by a new glacier unit in the Water Agency to oversee that controversies like Pascua Lama’s would not be repeated.

Across the country, protestors claimed that moving the glaciers was “an insult to intelligence”. “A five year old can understand you can’t move glaciers”. The anger and frustration in these comments is a stark contrast to the naiveness of the authorities, the experts and Barrick. These groups took to putting words in activists’ mouths. Several scientists, government staff, consultants and business people were critical of what they saw as a romantic view of glaciers. One ridiculed activists’ concerns about “pristine, pure, untouched waters” which are really “a toxic stew of acidity and metals”. Peter Munk says he assumes people were upset because glaciers evoke the “pristine” and “pure”. Accordingly, Barrick thought that if people could see the glaciers they would realize these were of minor importance. “When people hear glacier they think of large majestic glaciers, like the Laguna San Rafael”, an ice mass of more than 6,700 square miles in southern Chile, according to a Barrick advisor. To correct this misperception,

Barrick invited anyone "willing to go" to the site. Like Arauco in Valdivia (chapter 2), Barrick believed that seeing is believing when it came to assessing glaciers' importance.

For activists, glaciers were a focal point for their needs for water, development and respect. Anti-Pascua Lama activists in Santiago saw strategic value in the glaciers. Understanding the glaciers required more data, bibliography, and analysis than the EIA contained, at the same time that "a few reports would not lead [Huasco residents] to abandon what they knew to be true from experience". The need for technical knowledge about the glaciers made them a weak link; for Barrick to answer glacier questions would be expensive but unpersuasive.

It is remarkable that the Chilean state, glaciologists, Barrick and many other observers failed to capture the social importance of glaciers for Huasco residents. Their threatened destruction was just "the straw that broke the camel's back", as expressed in this article, "*A Valley is Dying"*:

> People in the Valley feel that Conama staff that should be technical are political; and that in the area there are no experts in risk prevention or pollution with sufficient expertise for the Pascua Lama project. Indifference and hopelessness fill the Valley, which is loosing its youth. Many factors contribute to this hopelessness: a policy of "completed actions" practiced by Barrick; official submission to multinational companies; the suspicion that biased expert reports are well paid, and that political campaigns are financed by mining companies; the feeling that the environment is subordinated to the interest of capital to maximize its profits, without the state applying any effective regulation. The lack of regulation is evident in official actions, some in the Huasco Valley, like that by former President Eduardo Frei who said "national industry can not be stopped" to avoid air pollution from petroleum coke burning in Huasco. This is the same spirit behind unprincipled and dirty policies in other parts of the country, like at *Ralco* (a dam project approved despite strong opposition). All justified by one economic and ideological explanation, as repetitive as it is false, that "a country with US $5,000 annual per capita income can not afford to steward the environment, like Switzerland and countries with US$20,000 income.[12]

Because Huasco residents want development they oppose the destruction of the glaciers. From their perspective, destroying the glaciers and endangering long-term water supplies contradicted recent investments in an irrigation dam in the valley and the spirit of a recent regional development plan. In a context where the desert is encroaching, to recognize their water as a "toxic stew" would only deepen their sense of disempowerment, hopelessness and anger at the government.

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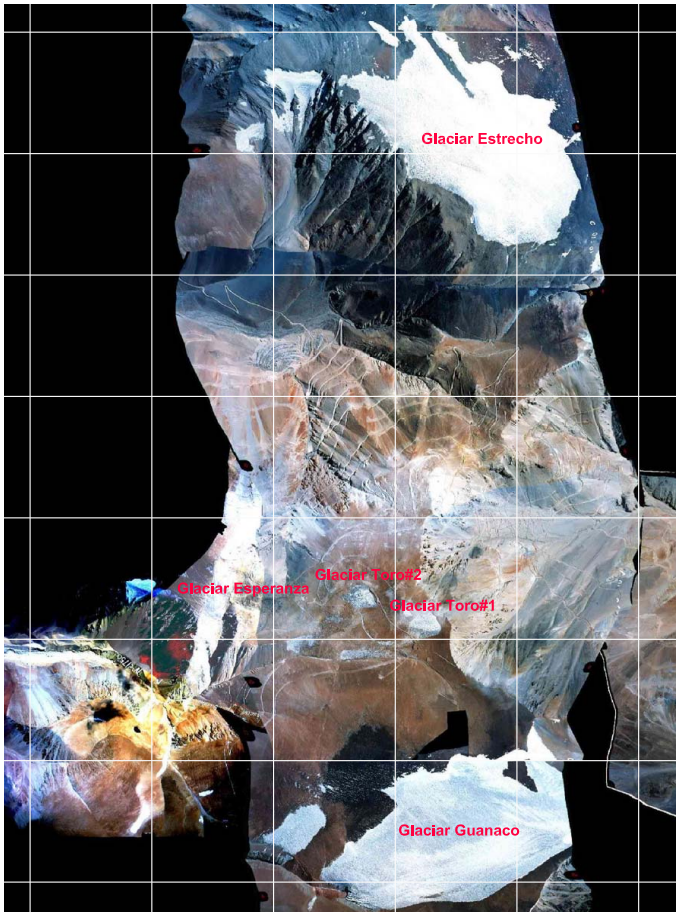
[12] Ossa, Manuel. "Un Valle se Muere". Pastoral Popular, nº 276, Sept./Oct. 2001

The opposition saw Conama as “elitist and exclusionary” because it failed to take their concerns seriously.[13] Among government staff, consultants and others close to the business, Conama failed because it did not know better. One pinned the government’s slow response to ignorance about glaciers. A glaciologist echoed this idea with “Chileans do not have a mountain culture” and another with “the state can not protect anything if they do not know what is there”. For others, it came down to carelessness: “Barrick kicked the ball, and if the state doesn’t catch it, its a goal.” For many, Pascua Lama was proof that the Chilean state had no interest in holding projects to high environmental standards.

Figure 1. Glaciers Estrecho, Esperanza, Toro 1, Toro 2 and Guanaco. EIA (May 2004) Annex 2-D: 6. Prepared by Golder Associates.



The first EIA only included computer-generated topographical maps with features. This is the first image of the glaciers to be reproduced in the EIA.

[13] Bórquez, R. (2007). For her degree thesis, Bórquez interviewed many of the actors in the Pascua Lama controversy during 2005. Her interviews reveal a deep schism between Conama employees and a frustrated public that feels spaces for participation are exclusionary and inequitable and that the authorities do not have the capacity or willingness to defend the public interest.

II. Participants

A small group of activists maneuvered from Huasco to Santiago to transform Pascua Lama into a national controversy. Like at Valdivia, this was a pluralist and democratic process, with voices from local and national civil society, different state actors and business interests (figure 2). Each "side" hired its own glaciologists. Unlike Valdivia where questions of environmental knowledge led to an adversarial, court-based process, at Pascua Lama the EIA was used to negotiate an agreement between one part of the opposition - the Irrigators Association - and Barrick.

As participants are introduced the events of the Pascua Lama controversy are narrated in this section. The section concludes with two reflections. First, actors hired glaciologists but for very different reasons that reflect disagreements over credibility. Second, in contrast to NGOs, government offices or business interests fairly fixed identities, glaciologists tend to have flexible and adaptable identities. Many of them move easily between different sectors, but this may create challenges when it comes to preserving their credibility with different groups.

Giving voice to community concerns: 2000 - 2001

A priest and two sisters of the order Missionary Sisters Servants of the Holy Spirit provided Church services to the Huasco Valley community, including the miners who worked at 2,800 meters above sea level for Barrick to prepare the future Pascua Lama mine. During the mid 1990s they offered mass once a month at the workers' camp. There they learnt about the project and saw satellite photos of the glaciers the Huasco community knew fed the rivers in the valley below. Many in the valley remembered how the rivers kept flowing through a seven-year drought in the 1960s, thanks to the "perpetual banks" up in the Andes. Sister Cristina, a natural of Indonesia sent to Chile by her order, drew on these experiences in 2000 when Pascua Lama's EIA was brought to her attention by Luis Faura, an elected municipal representative concerned about Pascua Lama's environmental effects.

Sister Cristina and representative Faura sat down to review the EIA's answers to the community's questions, raised months earlier during the public participation process organized by the regional Conama. The EIA reported several questions about impacts on the quantity and quality of water in the valley and about the fate of the glaciers. Conama concluded in the EIA: "In some cases it was possible to confirm that there are no objective reasons for the community's concerns...Other concerns were answered during the public session. And for the rest of their questions, Barrick has adopted specific measures that answer to the community's perspective and concerns."[14]

Unconvinced, Sister Cristina and representative Faura read through the EIA and marked good answers with green, representing hope; adequate answers with yellow; and unclear or inadequate answers with red, representing danger. After a day's work, red dominated their pages. Even before they sat down to make sense of the EIA, trust

[14] Pascua Lama EIA, 2000-2001, Chapter 9: 11.

in the authorities and Barrick was low after years of broken promises for road repairs, irrigation infrastructure and jobs. When Barrick promised to hire young men from the valley, the Church sent them to Santiago to train, but the jobs were not offered to them. Could they believe EIA documents that promised education, jobs, tourism and no impacts on agriculture in the valley? If EIA answers to their questions were so incomprehensible, could they trust the company and the authorities to prevent traffic accidents or prevent chemical spills? Almost half the EIA responses are offers for social aid to compensate - not reduce - environmental impacts.[15]

Sister Cristina and representative Faura persisted even after the approval of the project. At a retreat in Santiago, Sister Cristina met a religious colleague, Manuel Ossa, a soft-spoken gentleman part of the Ecumenical Center Diego de Medellin, a Catholic group with roots in liberation theory. Ossa introduced the emerging valley activists to Lucio Cuenca, of the Observatory for Environmental Conflicts (OLCA). The Church together with experienced grassroots activists went on to build Chile's first national opposition movement to a mine and one of the strongest environmental movements in Chile; OLCA still stages regular protests outside Barrick's offices in Santiago. Some months after Pascua Lama received its environmental approval in 2001 they began a two pronged protest focused on glaciers and development.

For the Church, glaciers were part of larger concerns about livelihoods and development. Ossa captured this in his article *A Valley is Dying,* that draws attention to the valley's predicament: the mine would only hasten the departure of the valley's youth by drying up and acidifying the rivers used for irrigation.[16] Moreover, the EIA process was untrustworthy and ineffective, Ossa cited witnesses who attest the glaciers had already been damaged by Barrick. Conama replied shortly after with an article called *A Valley with a Future.*[17] Daniel Alvarez, speaking for Conama, reported that a technical committee of "professionals from the different government agencies with competence on these issues" visited the mine site in August and October 2000 and could attest the glaciers had not been damaged. Investments in roads, energy, telephone lines and drinking water represented a hopeful future for the Huasco Valley.

Barrick's David Deisely replied citing the credentials companies often appeal to in these situations: their international reputation, that they complied with local regulations and they undertook voluntary measures like providing scholarships to local students. The rest was "false information", as Barrick had not moved any glaciers, and their environmental practices were high: the workers camp had a sewage treatment plant "unlike any other similar camp in Chile". Deisely concluded appealing to development:

> As a mining lawyer I know mining poses risks for the surrounding area and communities. But this is can be mitigated or at least compensated. What can not be mitigated without economic investments are the lack of education, of health services and employment opportunities that today hurt the valley's residents. We are convinced that with our project, and

[15] Pascua Lama EIA, 2000-2001, Chapter 9: 11-17.
[16] Ossa, Manuel. "Un Valle se Muere", Pastoral Popular, nº 276, Sept./Oct. 2001.
[17] Alvarez, Daniel. "Un Valle con Futuro", Pastoral Popular, November 19, 2001

> with the necessary safeguards, the valley "will not die" as you write, but will "resuscitate".[18]

Ossa visited the mine, invited Barrick, along with two young glaciologists. Through the *Pastoral Popular* journal, Ossa, Faura and others continued to protest Pascua Lama. Though Ossa published an article rectifying some of his previous claims, the deeper issues of pollution, drying up of opportunities and poverty persisted. The two young glaciologists also published in the *Pastoral Popular* saying that the EIA had overlooked the presence of rock glaciers and that moving the glaciers would assure their destruction. As a result, it would be more honest to compensate the loss of the glaciers than propose absurd conservation measures, like moving them.

Figure 2. Civil and Institutional Actors in the Region of Atacama, Province of Huasco and municipalities of Vallenar and Alto del Carmen. National authorities are in Copiapó.
From Bórquez (2007): 104.

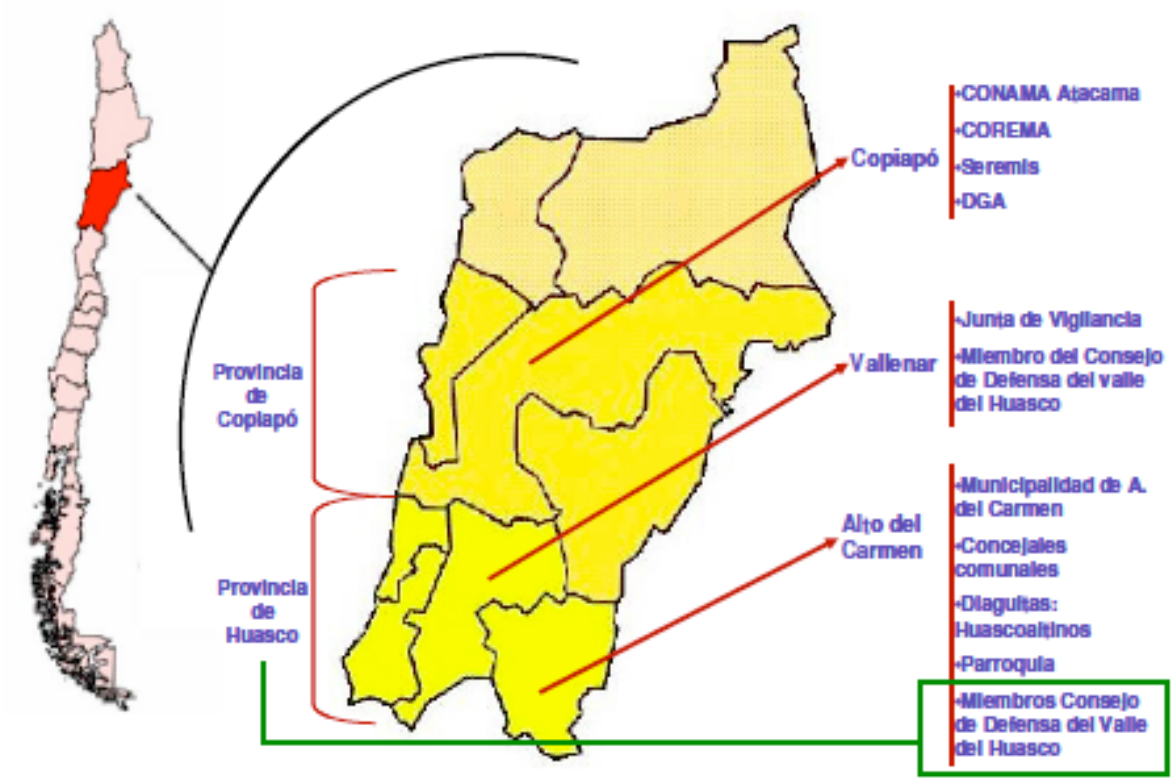


Figura 28: Mapa espacial de los actores involucrados en el conflicto

[18] Deisely, David, Letter to Pastoral Popular, November 19, 2001

The making of a national concern: 2004 - 2006

It was a strange thing that Pascua Lama had a second EIA process. Officially, a new process was required because Barrick wanted to build a larger mine. This may be so, but Barrick could also have submitted an amendment, a procedure widely abused in cases like this to avoid the costs and risks of a second EIA. Others say the mine was postponed after the price of gold fell before rising again in 2004. Another possible reason may be that Conama had rejected Barrick's "Glacier Management Plan", required under the first EIA process.[19] A new EIA that more adequately addressed the issue of the glaciers may have been tacitly recommended to the company. Whatever the reasons, Barrick's experiences during that second process guarantee that no company will make such a mistake again.

By 2004 things had changed inside and outside the valley. Outside the Valley, the efforts of the first group of activists were paying off. They attended meetings of social groups, including a Chilean "Social Forum" where students from the University of Chile joined their cause, and young valley residents became mobilized. Inside the valley, farmers were discussing what to do with an expensive new actor: the Santa Juana irrigation dam. The first large, state-sponsored irrigation project in decades, under Chilean law irrigators have to re-pay the state for the dam (about US$40 million). In every valley in Chile, water users are members of the Irrigators Association that enforces water rights and use. The associations are a capitalist democracy where everyone is a member but votes are proportional to how much water you own.[20]

In Chile's dry north, "you are no one outside the Irrigators Association." The Huasco Valley's association includes industrial multinational farmers, traditional large land-holding families (akin to a local "aristocracy"), small farmers who produce for local markets, and subsistence farmers.[21] Barrick was "just another partner" in the association. Francisco Bou Jr., the son of the Association's then director and an anti-Pascua Lama activist, worked with others to convince the association to question Barrick and oppose the project. The language of death permeates recollections of these events: "they will kill our valley", the "valley is dying", "assassins of glaciers" and "what will you do to save us?" The Association, an elite, capitalist and powerful organization, had never questioned the value of development projects like Pascua Lama. Their affinities lay with progress, meaning investment. But maybe their sons knew better? Maybe they could not trust Barrick? The Association had just reached an agreement on how to finance the new irrigation dam, and they wondered, if it was true the valley's waters would acidify, was the Santa Juana dam a financial death sentence? So this became "a fight between Goliaths."[22]

The Association took measured steps. They gathered new information, heard different opinions and funded posters and flyers. Above all, they hired consultants to

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[19] I was not able to find a copy of this rejected plan, nor is it clear if Conama or the Water Agency objected.
[20] Irrigators Associations were created by the famously neoliberal 1982 Water Code (Bauer 1998).
[21] In Spanish, the *Junta de Vigilancia de Regantes de la Cuenca del Río Huasco*.
[22] In Spanish, "*una pelea entre grandes*", according to a participant in these events.

produce an “independent, scientific-technical position” in response to the new EIA Barrick had submitted. What was their public right under the EIA’s public participation process was also “a declaration of war”. Here as in the case of HidroAysen (chapter 6), to make observations or raise questions through the EIA’s procedures is seen an activism against the company. EcoNorte, the Association’s experts, presented an assessment of the second EIA in February 2005 to a packed crowd in the main square at Alto del Carmen. This was, the association thinks, “the first official document of opposition”. To call this an act of “war” and “opposition” highlights to what extent criticism is not tolerated in the Chilean EIA. If successful regulatory science requires critical communities to challenge and improve standards (Jasanoff, 1990; VanDeveer & Dabelko, 2001), these practices have not been accepted by most Chileans who see criticism as “an act of war”.

Convinced that Pascua Lama needed environmental improvements, the Irrigators Association set out to negotiate a deal with Barrick. They were under pressure from experience - “no one will walk away from 11 million ounces of gold” - and from members of the government who told them “to get the best agreement they could get” because the project would ultimately be approved. The Irrigators Association agreed to stop opposing Pascua Lama in exchange for assurances that the Valley’s waters would not by acidified. The EIA would have to reflect these assurances, and so the agreement handed control of the EIA process to the Association: Barrick agreed to let the Association fire their consultants and hire new ones of the Association’s own choice. The Association’s experts replaced Barrick’s experts half way through the second EIA. In this way, the Association’s experts at EcoNorte transformed their environmental demands and concerns into law. The community was devastated by the agreement, while business sectors saw it as a success, “the most millionaire and complete environmental agreement in Chile’s history”.

Glaciologists get involved: 2000 - 2006

Whereas in 2000 there were “no glacier experts in the country”, by 2004 there were many. Each had an employer in an example of pluralist and interest-based participation by scientists in the policy process. While everyone agreed glaciologists were experts, they disagreed what made them credible (in contrast with chapter 2).

The first non-Barrick glaciologists to visit Pascua Lama were Gonzalo Barcaza and Pablo Wainstein, invited by Manuel Ossa in March 2002. Barrick invited Ossa to the site after their unfriendly exchange on the pages of the *Pastoral Popular* journal. Ossa had spent months searching for credible glaciologists to advise them. His contacts in consulting companies and universities told him that Chilean glaciologists regularly work for mining companies, so they were not trustworthy for Ossa and the activists. He turned to the NGO Mining Watch Canada, but had no funding to bring a Canadian glaciologists. Ossa chanced on Barcaza and Wainstein, after one of them rescued a neighbor’s stray ball and was introduced by the neighbor to Ossa. Barcaza and Wainstein were just finishing their university studies in glaciology and were too young to

have worked for anyone else. Their observations were published in the *Pastoral Popular* and provided Ossa and OLCA welcomed scientific validation of their criticisms.[23]

The second group of glaciologists worked for Barrick and the Association. These include specialists at Golder Associates, Barrick's original consulting company, and Juan Pablo Milana, Michel Vallon and Christian Vincent selected by EcoNorte as part of the agreement between the Association and Barrick. EcoNorte is a small environmental consulting group based in a town just south of the Huasco Valley. It works mostly with irrigators associations in the dry north and is not part of the select, Santiago-based consultants. The Association hired EcoNorte because they knew them; the owner of EcoNorte is the ex-wife of a former advisor to the Association. To add a little prestige, the Association asked EcoNorte to hire someone from the Northern Catholic University, located north of the Huasco Valley. To "speak as peers to Barrick's consultants", they hired Milana who was familiar with the Argentinean-side of Pascua Lama, and Vallon, a world-expert on Andean glaciers with experience from the 1970s.

Glaciologists who worked for the government have a different story. Within Conama, the staff person responsible for coordinating Pascua Lama's evaluation in 2004 felt it was important "not to go down in history as the only agency to approve a project about glaciers without the opinion of even one glaciologist". This second time around Conama was suspicious that the mine had grown but the environmental impacts had not grown proportionally. This tipped them off to ask about the glaciers, "with all innocence" and unsuspecting of the opposition the glaciers would incite. The central government agreed to fund two studies: on the impacts of dust on the glaciers and a baseline report. Conama then proceeded to look for "any glaciologist"; as far as they knew, there were no glacier experts in Chile. They chanced upon Cedomir Marangunic and his consulting firm, GeoEstudios. Only later they realized he was "perfect" because he had standing among industry, because of his long experience working with mining companies, and the government, because of his academic publications. Marangunic was a retired Professor from the University of Chile who had left the university decades earlier because he did "too much practical work".

The Water Agency also sent a team to the site, led by Fernando Escobar, who has decades of field experience in Chile. By luck, he had returned to glacier work just prior to Pascua Lama's re-emergence following a hiatus he took to protest how unimportant glaciers were to the Chilean state. The best evidence of the state's disregard of glaciers is that, though Escobar was working at the Water Agency during Pascua Lama's first EIA, he had never even heard of the project. Now that things had changed inside and outside the valley, his team went to Pascua Lama and returned with a short but damning report they hoped everyone would read: the three small glaciers were small because they had already been significantly damaged, and accumulating dust from mining operations would only accelerate the damage. The report resonated widely and even appeared on Chile's best political commentary show, *Tolerancia Cero.*

[23] Barcaza and Wainstein left Chile soon after to complete their PhDs. I was unable to interview either, but they provided some statements for this project.

Yet another glaciologist got involved: Andrés Rivera, of the Center for Scientific Research (CECS), hired by the regional government of Atacama province, to which Huasco belongs. CECS is a private, non-profit institute specialized in a few areas, including theoretical physics, biotechnology and glaciology. Guided by an influential and visionary director, Claudio Bunster, CECS hoped to transform scientific organization and funding to make it more cutting-edge and useful, on the model of U.S. research institutes.[24] CECS is not managed by any university - which Bunster once called "mini Soviet Unions" - and relies on scientific funding from the government, foreign organizations and increasingly the military. CECS has a strong public vision, relative to other Chilean scientific institutions. For example, the military participates in Antarctic expeditions to strengthen democracy through science. CECS and Andrés Rivera have scientific prestige that made Rivera an obvious choice for the regional government.[25]

Reflections on glaciologists' participation in the Pascua Lama controversy

When it came to selecting glaciologists to work with, each interest group had very different notions of who they trusted and why. Activists looked for glaciologists untainted by industry experience. EcoNorte, an upstart consulting group needing to win over Barrick, looked for international prestige. Conama, despite not having much idea where to look, what to look for or what to expect, was happy with a combination of political and business credibility. The regional government did not rely on Conama and had their own, independent assessment. Rivera was recommended to them.[26] In Chile's pluralist, science-based democracy, only business seems to have privileged academic credentials over other sources of credibility and, as seems typical in Chile, preferred international credentials over local ones.

It is interesting to reflect on what interest groups did not consider when choosing their glaciologists. As a science, glaciology sits between disciplines and is taught at schools of geography, geology and engineering. Glaciologists receive different amounts of training in chemistry, biology and ecology. Chilean glaciologists are increasingly technically specialized. One glaciologist complained that a young man he had recently worked with introduced himself as a "radar glaciologist", meaning he really knows how to use ground penetrating radar well. Chilean glaciology began in the 1950s when French and Japanese glaciologists arrived to study two fairly unique types of glaciers common in Chile: low altitude glaciers, like those in Patagonia, and arid glaciers, like

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[24] The controversy over universities can be read about here: http://jaquevedo.blogspot.com/2008/07/la-fuerte-critica-de-claudio-bunster.html On CECS' vision for science see their website's press file, particularly articles "Inaugurated in Valdivia the country's largest autonomous science institute" (01/14/2007), and Bunster's wikipedia page: http://en.wikipedia.org/wiki/Claudio_Teitelboim. For a center with a public vision it is remarkably inaccessible to inquiring social scientists.

[25] It is rare for the regional government to hire its own "scientific voice". I was unable to interview the participants of these events to confirm what led them to make this decision. Further, I did not find documents of the meeting but a respondent showed me notes from the meeting with a list of attendants' names.

[26] I was unable to interview people from the regional government. I can only assume they selected Rivera because he was recommended and a local expert.

those in Huasco. Relative to other sciences, glaciology maintained itself through the 1970s and 1980s because the military had an interest in Antarctica, where Chile has land claims. Nonetheless, like other scientific communities, glaciology remains small. Furthermore, glaciology is more of a team-science, as it is inter-disciplinary and with long and expensive fieldwork periods, and teams have been difficult to support in Chile.

Glaciology is a field science that is dangerous and difficult. Its a field that attracts many mountaineers. Experience on the mountain, taking measurements in extreme conditions, and knowing the terrain are what matters. Nearly everyone agreed there are no more than two or three experts, among them Gino Cassassa, also at CECS, who did not participate in Pascua Lama. When choosing glaciologists, interest groups never asked about field experience nor seemed concerned about the practice of glaciology. They did not ask about credentials either, like what background in hydrology, chemistry, ecology glaciologists had? Were they specialized in arid or wet glaciers or have experience with both? No one in the different interest groups knew about these things, with the exception of EcoNorte (staffed by scientists, they gained a working knowledge of glaciology through the project).

Conama staff did not ask about these things either and were openly ignorant of their importance. For example, the Water Agency's only ice expert, Escobar, has decades of field experience but no professional degree. His expertise was often dismissed for this reason, as this quote spoken by a Conama employee shows:

> The government agencies had no knowledge of what glaciers meant. The Water Agency in Santiago had one person who knew something, but he is not a glaciologist...[the second time] Conama was allowed to hire consultants so a glaciologist came three times to review all the documents, he was really top notch. This allowed us to have someone at the table on the level of the companies, because they had a group of about 30 consultants or specialists. While from the agencies, we were the same old group of no more than four or five. It was incredible, you really felt like 'we are really at a disadvantage here'. Because among the capacities these companies have, like these that really have a lot of resources, is to bring glaciologists from France and Argentina. They could pay for it, but what about us?[27]

This quote highlights Conama's lack of staff and expertise relative to companies like Barrick. But it also highlights the prejudices that exist in favor of foreign credentials. In this case it is almost comical, because the Argentinean glaciologist in fact lives closer to Huasco than Huasco is to Santiago. Yet being a foreign somehow made him prestigious and inaccessible.

Further, though the speaker above correctly emphasizes Conama's lack of capacity and expertise, this does not fully explain Conama's erratic behavior. Although Conama knew in 2000 that there were glaciers in the area that would fall into the mine's

[27] Bórquez 2007: 72.

pit as construction advanced, the office did not consult with any glaciologists about this. In 2000 Conama could have consulted with Escobar at the Water Agency or with any of the academic and consultant glaciologists that became involved during the second review. Lack of capacity is one explanation for Conama's failure to call on experts in 2000, where Conama staff did not have time to seek experts or know when to ask for outside advice. But other explanations are also possible. Conama's failure to call on experts could also reflect a strategy to narrow down its responsibilities. Because the state is only empowered to do what is explicitly allowed by the rules, and there were no rules explicitly requiring Conama to regulate these, it had no authority to make greater demands on Barrick. In this case, Conama's move in 2004 to improve the quality of evaluation regarding glaciers represents an effort to exercise discretion. Conama's failure to call on experts in 2000 could also reflect the story told by those responsible for Pascua Lama's EIA process in Conama: they did not call experts because they did not think it necessary. There is some ambiguity in problems with institutional capacity.

Each group that hired glaciologists did not change their opinions or assessments much. The priorities and vision of NGOs, Conama, EcoNorte or Barrick remained more or less the same. Only the Irrigators Association was seen to "change sides", in a move that gained it hostility from those in its community that opposed the project. As new data and information emerged during 2005, the terms of the debate barely shifted, as the next section will highlight.

Glaciologists, on other hand, had more flexible identities. With relative ease they moved in and out of the public and private, academic and consulting sectors. For example, the data produced in Pascua Lama's monitoring plan travels first to Wainstein who reviews it from his office at BGC consultants, in Canada; then to the Water Agency, where Barcaza now heads the Water Agency's Glaciology Unit, and to the EIA Agency, who gives the data to Marangunic to audit. Recently Rivera was hired by Barrick to advice on the monitoring plan. In this way, glaciologists do not appear overly concerned about working with industry, and the pool of glaciologists NGOs or civil society find trustworthy is constantly reduced.

A final point is that public exposure was difficult for the scientists. Glaciologists work had limited reach, but were exposed to enormous criticism, including from each other. It was surprising in interviews that each interest group relied narrowly on their experts. Even at Conama, they had little awareness of Milana's work or of Vincent and Vallon. No one knew of Barcaza and Wainstein's early involvement. EcoNorte did not know much about Marangunic's work. But criticisms flowed easily, and most often were targeted at academic glaciologists. Milana was criticized for changing his opinion too much; Vincent and Vallon for being "arrogant" and "inexpressive"; and Rivera for pulling out because the controversy "was too political" or "to avoid problems".[28] These may or may not be fair statements; the point is that they were common criticisms others had about these glaciologists. They help to highlight the costs of participating in a public controversy. At this time, scientists involved in the Valdivia paper and pulp mill

[28] I have not found evidence that CECS "pulled out" of any commitment. They declined to participate in the monitoring plan initially. Only Barrick's glaciologists was more maligned: he was "an expert on ski slopes" and "knew nothing about statistics".

controversy (chapter 2) were cast as heroes or goblins depending on where you stood on pollution. In Pascua Lama criticisms were tamer but no less common.

III. Illegibility

Pushed by activists opposed to Pascua Lama and their concerns with glaciers, Conama and Barrick had no choice but to take glaciers more seriously. Through two EIA evaluations, glaciers transited from a legal blind spot to being central to the process. Though EIA science made the glaciers legible, it did not fill all the data gaps nor did it settle how much water the glaciers contribute to the Toro river downstream. The process, furthermore, alienated many who continue to wonder about the relative importance of threats glaciers face from climate change and mines.

Pascua Lama's EIA process is also interesting because EcoNorte, upstart consultants not embedded in Santiago's social hierarchies, disrupted EIA-as-usual conditions. They changed the balance towards more scientific references and exposed the gaps and inaccuracies in data. The contrast between the EIA before and after EcoNorte's involvement highlights how much is normally left unpublished in EIAs. Compared to other consultants, EcoNorte was more frank about the limits of data.

A technical coup shifts Pascua Lama's EIA

This second addenda breaks with some traditions of the EIA process: in a series of presentations, EcoNorte gives the names, places of work, training and experience of the new authors. Traditional EIAs occur only in writing, and do not make the authors of a report clear; there are no presentations at which to ask clarifying questions or debate alternatives. For example, in Pascua Lama's first (traditional) EIA scientists are listed in an appendix, and with luck their degrees may be listed. The logo of the main consulting group involved, Arcadis, does not appear anywhere. It is impossible to know which documents were prepared by Golder Associates nor to attribute authorship.

In contrast, the Irrigators Association introduced their team to emphasize the gain in credibility:

> This diagnosis of water quality in the Huasco river's watershed has been done through the Irrigators Association by institutions and *técnicos* of demonstrated independence and objectivity, so their results may be accepted by all agricultural, industrial and mining companies committed to environmental stewardship and especially, Irrigators associations.[29]

Whatever the law says, there is a problem with credibility caused by the suspicion that science is bought and sold. Elite business groups like the Association are suspicious too, not just radical activists. The Association also prefers the word "*técnicos"* to "scientists" or "experts" or even "specialists". It is interesting that the term "experts" is so

[29] Introduction to presentation of EcoNorte's results obtained from a power point presentation.

rarely used and, although here the Association reached out to scientists, this echoes Conama's earlier limited self-awareness of the limits of its own knowledge. Likewise, it points to an ambiguity in expertise or science as a concept or profession in Chile.[30]

Compared to traditional EIAs, EcoNorte's addenda is well written, concise, and informative, and seeks to add clarity to Barrick's prior "confusing" and "imprecise" materials. The word "new" is used more than 200 times: there are "new studies" to propose a "new plan". The document dramatically expands the amount of data and models on questions about mass balance, winds, water quality, pollutants, and others. Table 1 lists different reports that formed part of the second addenda with information about each report's bibliography. A lot of this material was original or from the scientific literature, including a baseline study of glaciers, estimates of mass balance, wind dispersion and fine dust. Consultants' work is self-referential. Judging by the bibliographies, consultants only use scientific literature when they have not tackled the issue before, as in the studies on wind and fine dust. Table 1 also shows that official data is rather thin: only one government report is used, about the Echaurren glacier near Santiago.[31] Whatever the shortcomings of the literature cited in the second addenda, it is dramatically more comprehensive than that cited for the first EIA. In that report, just 44 bibliographic references were used in total and almost half were about flora and fauna.

The second addenda shows a rise in academic credentials - eg., Milana, Vincent and Vallon -, although Barrick's original consultants at Golder Associates continued to be very important, producing studies on wind, dust accumulation and other elements. Consultants introduce themselves by appealing to their international reputations - "offices in..." - or not at all; e.g., who is Michael Jones? The table shows that who produces a study has implications for what data they use - e.g., scientists use scientific literature and consultants use their own work - and how they present themselves.

[30] This is reminiscent of Hayden's finding in Mexico, where science had no sharp edges nor was a clearly defined, shared concept. Hayden (2003), see introduction.

[31] This contrasts with the importance of state-sponsored studies in Aysén (chapter 4), and reflects each region's different relationship to the central government and development policies. Aysén is desolate and remote and required colonization, while Huasco was well occupied by a landed upper class that required less state intervention.

Table 1. Reports prepared for Pascua Lama's second addenda						
Title	**Client**	**Author**	**Author's credentials**	**Report's bibliography**		
				# Ref.	**Avg. year publica-tion**	**Types of references most cited in bibliography**
Baseline: Glaciers and Permafrost (Oct. 2005)	Irrigators Assoc.	Milana	Independent consultant and Research fellow, Hydrology and Models group, CEAZA	52	1989	Scientific articles
Mass balance for Esperanza, Toro 1 and Toro 2 glaciers, winter 2005 (September-Oct. 2005)	Irrigators Assoc.	Vallon and Vincent	State Professors, Joseph Fourier University; Observatory of sciences of the universe at Grenoble; Glaciology and geophysics of the environment laboratory of the CNRS	0		Data collected by the authors. Maps by Barrick. In responses to Conama, cite five scientific articles.
Baseline: Geomorphology (Nov. 2005)	Barrick (CMN)	Golder Associates	Offices in North America, South America, Europe, Asia and Australia	9	2003	Work by Golder
Wind dispersion model (Nov. 2005) [by Golder]	Barrick (CMN)	Golder Associates	idem	17	1988	Scientific articles
Geotechnical revision of the Toro 1 ice deposit (Nov. 2005)	Barrick (CMN)	Golder Associates	idem	1	2004	Work by Golder
Studies of Ice Fields and Glaciers for Pascua Lama project (Nov. 2005)	Barrick (CMN)	Golder Associates	idem	34	Post 2000	Monitoring by Golder + reports from Echaurren glacier
Model of fine dust deposition due to mining activities (Nov. 2005)	Barrick (CMN)	Golder Associates	idem	0		Disclaimer
Water balance of the glaciers at the mouth of the Toro river, and potential changes in downstream water flow. (Nov. 2005)	Pascua Lama project	Michael Jones	7609 Pickard NE Albuquerque, NM 87110 (505) 280-4985 maj666@comcast.net	6	Post 2000	Consultants

EcoNorte reshaped Pascua Lama through this second addenda, becoming the "little guys" who came to solve Barrick's problems. Barrick tried to undermine them, for example, writing speeches for the head of EcoNorte to deliver to Conama. They would taunt them: "why do you need all the data, if you wont have time to look at it", and try to deny them access to data. But EcoNorte held its ground; they had absolute trust from the Association, because they were part of the same community with shared personal ties, a rural lifestyle, and close to the local university, and gained trust from Barrick by hiring international glaciologists. They also had a cohesive team and direct access to Barrick's director for Chile, Ron Kettles. But even he would pester, asking: "why don't you take out some of those 30 monitoring stations, you don't know what to do with them". EcoNorte's director would reply they could not touch what had been negotiated. This was an effective separation of the technical and the political.

Missing data

Missing data is central to understanding Pascua Lama's EIA. The most glaring gap, of course, pertains to the glaciers themselves. Both EIAs, from 2000 and 2004, began with the same data on glaciers, described as "compact ice" that is "impossible to distinguish from snow". Photographs from different years (1997, 2000, 1981), scales (1:8000, 1:10000, 1:30000 from a plane) and in color and black and white were used to estimate the size of the glaciers within the mine's area of influence; no other data is provided. Rock glaciers are similarly ambiguous: "probably just a few meters thick, where the nucleus with ice most likely is less than 10 to 15 meters thick, given their position on the top part of the river's watershed."[32] No data, tables, photos or graphs are provided in support of this statement. Neither EIA cited even one bibliographic reference about glaciers.

As the second EIA process progressed information expanded, both through new studies and references (e.g., table 1) and through the release of data. Conama asked Barrick to release their meteorological data used to calculate snow accumulation and melt, critical to estimating the impact on downstream water flow. Barrick replied they would release the numbers only to the Water Agency, "prior agreement" on its usage and maintenance. After EcoNorte took over the EIA these efforts to keep data private were shattered. EcoNorte made a point of releasing all the data so anyone could replicate analysis.

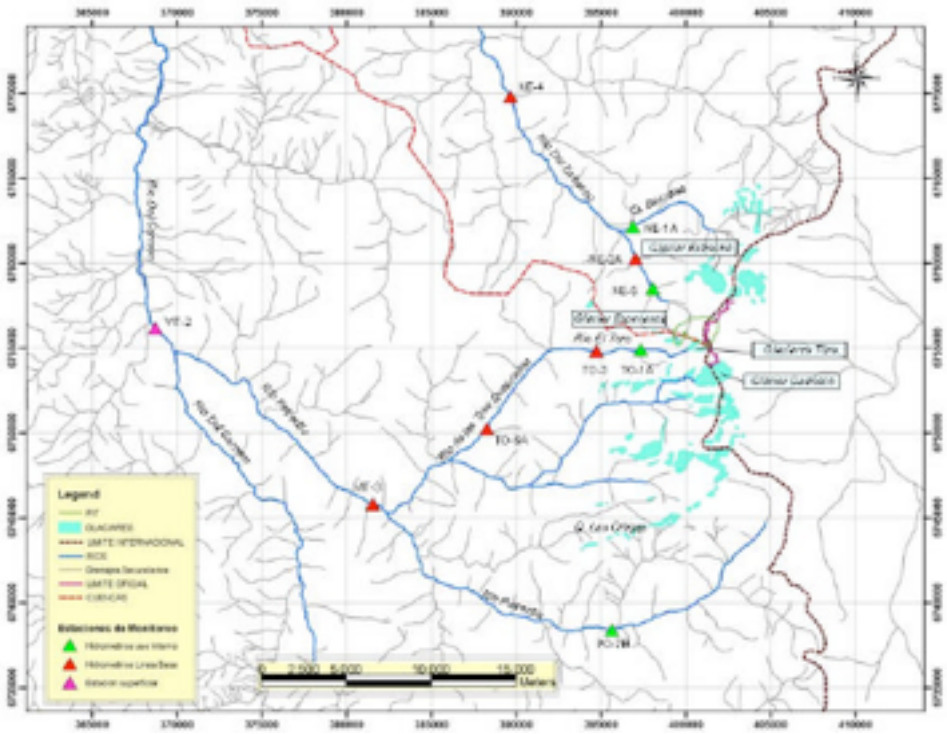
EcoNorte also highlighted the gaps in data: with no meteorological stations near the mine site, all the previous analysis were based on (flawed) estimates. Data series measuring snowfall or wind do not exist. Water flow from the glaciers was estimated from data obtained at station To-1a, located on the Toro river at 4,300 meters above sea level; this is almost 1000 meters lower than where the glaciers are. Consultants estimated snowfall, temperature, and others from conditions at lower altitudes, adding a correction factor for a certain constant gain in elevation. As predictions climb up to over

[32] EIA (May 2004), Chapter 5: 25.

5,000 meters the cumulative error grows. According to EcoNorte, it was so large that consultants had under-estimated the size catchment pools for acid water should have.

Consultant Michael Jones preferred to use snowfall data from *El Indio*, a station at a similar altitude, 40 miles south, owned by Barrick. This data, however, is owned by Barrick and inaccessible to most. Consultants often prefer to use privately-owned stations because these are strategically located and usually in better condition. The Water Agency, for example, struggles to maintain To-1a because of the cost of access from their city offices. As a result, To-1a is known to measure water flow incorrectly because of minerals silting up in it (the water stations are visible in map 3).[33]

Map 3. Rivers and monitoring stations in the Pascua Lama area
From Jones, M. (Nov. 2005): no page number.



The triangles represent water monitoring stations. The resolution is too low to read the legend in the original also. Illegibility like this is not uncommon in Chilean EIA documents.

Jones validates his model, based on the *El Indio* data, with a formula taken from the U.S. Army Corps of Engineers and with estimates from the Echaurren glacier. He concludes the glaciers are shrinking following a similar pattern. In the case of Toro 1, Toro 2 and Esperanza, he estimates a loss of 9 liters per second and no changes to non-glacial sources of water. He does caution, however, that during droughts the Toro

[33] Jones, Michael (Nov. 2005) "Water balance of the glaciers at the mouth of the Toro river, and potential changes in downstream water flow.", Annex II-F of Pascua Lama EIA, Second Addenda.

watershed provides 10% of the water that reaches farmers so during drought the glaciers are important. Exceptionally, Jones' report provides nearly as many charts and graphs as text.

Pascua Lama is exceptional because it raised questions about the quality of data directly; most often the EIA's rigid back and forth between Conama and the company side-steps these questions. Conama has few resources to raise them, and the company - despite the mantra that everything is public - has the upper hand because it owns strategically placed and better maintained meteorological stations.[34] On one occasion the question of data quality, and how it intersects with ownership, was raised as a disclaimer:

> The current report about Dust Deposition was prepared exclusively for Barrick Gold. The report was prepared based on information and data provided by the personnel at Barrick Gold. In the project evaluation, Golder trusted in the good faith of the information provided by others and the regulatory authorities. Golder does not accept responsibility for deficiencies, misinterpretations, or imprecisions contained in this report as a result of omissions, misinterpretations or fraudulent acts by any of the persons involved.
> During the course of preparing this report, Golder used the best, commercially-reasonable efforts consistent with the level and capacity normally shown by professionals in current practice working in similar conditions.[35]

Beginning to see glaciers

After hundreds of pages of studies, the EIA did not produce conclusive data about the glaciers. The glaciers became "official" in April 2005, when Conama raised a number of alarming questions and demanded new information from Barrick. Until then, Barrick had dragged its feet. The second EIA proposal replicated the outcome of the first: Barrick submitted a three page "relocation plan" to move the "chunks of ice" by truck to areas that are not too steep and within the watershed.[36] Barrick's science and ideas changed only after it was forced to negotiate with the Irrigators Association and replace its consultants with new glaciologists and consultants.

Conama's reservations were based on three sources: the Water Agency, Marangunic and Rivera.[37] The Water Agency submitted a short report concluding that

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[34] Pascua Lama was so rare in the amount of data released to the public that staff at EcoNorte use this data to teach classes at the local university; they consider it the "most complete data series in the country".
[35] Golder Associates (Nov. 2005) "Model of fine dust deposition due to mining activities: Pascua Lama Project, Final Version": 72.
[36] First EIA, second addenda: 3.
[37] Publicly available memos exist by the Water Agency and Rivera, but I was not able to find one by Marangunic. In contrast to today's practices, then Conama did not publish their own observations. The first addenda is one large document prepared by Arcadis, Barrick's local consultants.

"...we can discard the Company's theory that the reduction in the glaciers' size is due to climate change" and that the nearby glaciers were likely to suffer the same fate. Rivera, in a public memo published in the newspaper, questioned the accuracy and quality of the data used to predict impacts. He called for many new studies and asserted that Barrick's proposal would destroy the glaciers.

Barrick's response was guarded. They argued for the privacy of their data, appealed to their "international experience", and gave three "positive" examples of moving glaciers: two from Canada and one from a gold mine in Kumtor, Kyrgyzstan, owned by another Toronto-based mining company. An intern at OLCA spent the summer exposing these experiences. One involved a glacier conditioned into a ski slope. The other involved a proposal to move a glacier that was quickly abandoned as impractical. And Kumtor was an environmental disaster to Chilean eyes; even those who snickered at activists' "sudden love" for glaciers did not like Kumtor's experiences. Activists felt both relieved and sad to see that "things could be much worse".[38]

A second addenda followed prepared by EcoNorte. EcoNorte modified Barrick's original plan: rather than move the three glaciers and put them on the Guanaco glacier, they proposed to keep them within their natural watershed by placing all the glaciers on Toro 1. With the photos in Figure 3, the addenda strongly suggested climate change was the primary cause of the glaciers' demise. This way the water stays in the Toro river, and the more important Guanaco glacier is not impacted. They also re-cast Pascua Lama as both unique and universal, and Toro 1, Toro 2 and Esperanza as "ice patches" in contrast to "traditional" or "typical" glaciers:

> The new Glacier Relocation Plan will not affect typical or traditional glaciers because the ice patches at issue are "reserve glaciers". They do not have any lateral movement except a likely in-detectable reptation....
>
> Many international experiences moving glaciers exist, but few if any involve ice patches with a similar metabolism, at similar altitude or conditions as these, as no places comparable to the dry Andes exist. The Relocation Plan faces no technical difficulties, except the possibility that the ice will be lost. Most likely, this ice will melt from natural causes following observed trends....
>
> In sum, no project like Pascua Lama exists. In all likelihood some have existed but never before was a detailed plan like this drawn up. Rather the ice was simply treated as waste rock. The lack of comparable experiences does not mean that useful lessons about glacier management can not be extracted from other projects, because glacier management is a universal practice.[39]

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[38] On Kumtor see: http://bankwatch.org/our-work/projects/kumtor-gold-mine-kyrgyzstan. It is an interesting parallel and counter-point to Pascua Lama, which is mentioned as good example because of the activism to protect the glaciers. At Kumtor the glaciers went to the sterile rock waste.
[39] Pascua Lama Second Addenda (Nov. 2005), Chapter 3: 66-67.

The political negotiation between Barrick and the Irrigators Association required an intellectual negotiation, achieved by reviving the concept of "reserve glaciers", in which the top and bottom sections of the glacier are unconnected, producing homogenous ice rather than differentiated zones of accumulation and loss. "Reserve glaciers" was a concept developed by Louis Lliboutry, a French glaciologist who pioneered the science in Chile with his treatise (and PhD dissertation) *Snow and Glaciers in Chile* (1956). Another word used to describe the three glaciers was "*glaciaretes"*, understood as a diminutive by the public.[40] In contrast, the nearby Estrecho and Guanaco glaciers were "traditional" or "evacuator" glaciers. Glaciers without movement like these are more susceptible to global warming than those with movement.[41] In this way, the new team tried to make the loss of the *glaciaretes* tolerable, and they published photos to show the loss to climate change.

The re-conceptualization of glaciers opened yet another rift with the community, who saw it as a "downgrading" of the glaciers. Nearly every activist considered this a linguistic turn to save Barrick's project, while nearly everyone else referred to Toro 1, Toro 2 and Esperanza as "*glaciaretes*", "glorified ice patches" or "relict ice". Many believe the three glaciers were once one large glacier, but no research has been done to determine this. Were the *glaciaretes* once glaciers? It seems it is too much work to find out, but the different causes of glacier destruction - global warming versus mining - and society's reaction to glacier protection and management, hang in the balance.[42]

The biggest question, of course, is how much water these glaciers, or *glacieretes*, contribute to the Toro river and others that sustain the fields downstream? Milana estimated that in a worst case scenario 20 liters per second would be lost during the driest month (summer, January). This holds if five hectares of ice are removed, where each hectare yields between 0.68 and 0.98 liters per second, about half the original estimate Barrick submitted. Jones estimated a loss of 9 liters per second in summer, and 10% of the watershed during droughts. These analysis came to summarize, in a way, the confusion that existed previously. However, as the authors recognize (because they are EcoNorte, not an EIA-as-usual scenario), there are uncertainties in these numbers because there is no snowfall data over 4,900 meters. Should they assume snowfall keeps increasing as it does at lower altitudes? And what might the water-content of this snow be? These were unanswerable questions.[43]

Another difficult to answer question had to do with the depth of these glaciers, which matters for estimating how much water is in a given hectare of ice. Barrick's team proposed measurements based on Ground Penetrating Radar, that uses waves to produce underground images. Conama rejected this method, asking for samples, ice cores, and numbers. Academic credibility was mobilized to legitimate the radar - it was

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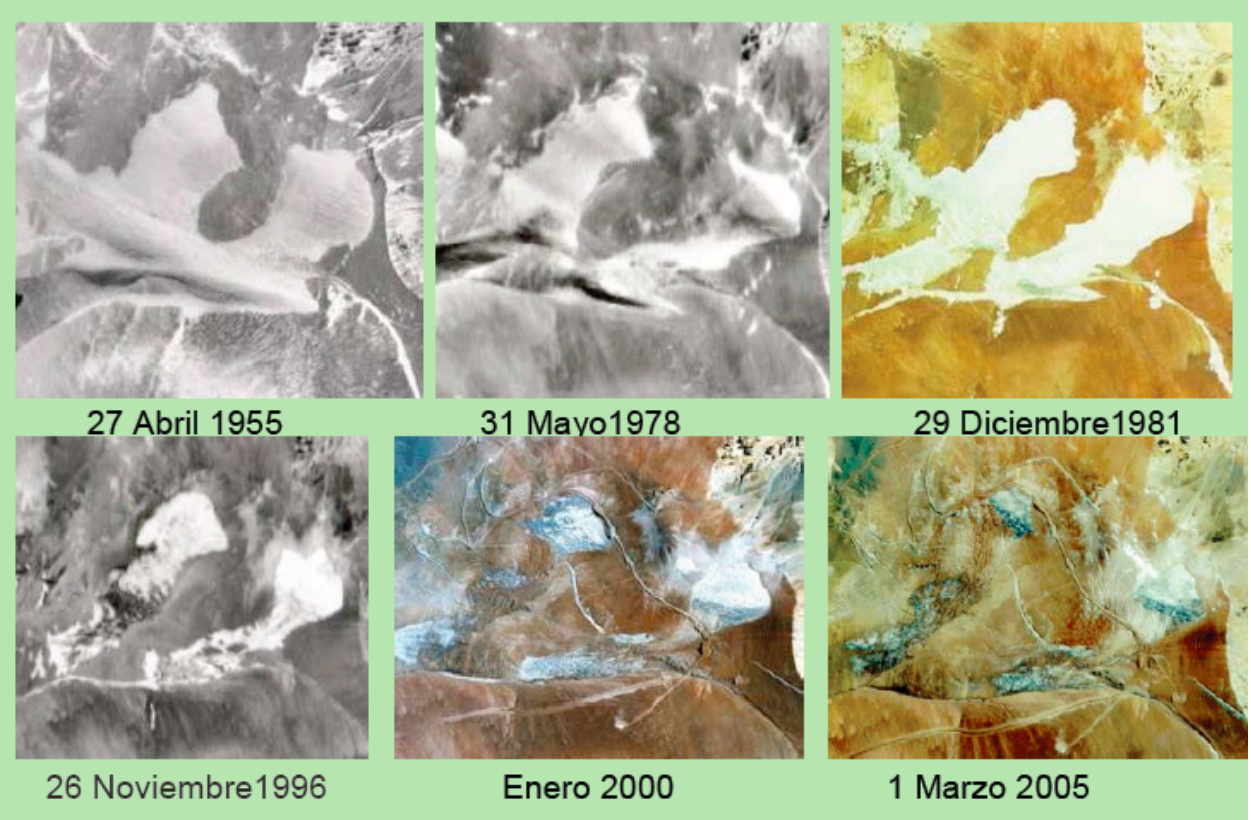
[40] Chilean glaciologists call these in English niche, wall-sided, cliff glaciers or ice aprons.
[41] Pascua Lama Second Addenda (Nov. 2005), Chapter 3: 3-7.
[42] It is important to note that photographs of glaciers can be misleading because glaciers may be over-sized if it was a year of heavy snow fall, or under-sized during years of drought. Many data points are needed to correct for seasonal variations like this. Likewise, it should be noted that explorations began in the Pascua Lama area in the early 1990s or 1980s.
[43] Pascua Lama Second Addenda (Nov. 2005), Chapter 3: 65.

validated by Andrés Rivera, Milana and Vallon and Vincent.[44] But Conama was unconvinced and used this argue the baseline was "incomplete".

In this EIA, as in others, blind spots persist after evaluation. Rock glaciers and permafrost, the "really important thing" according to many, look very similar to rock or dirt; they are in fact ice layered into the ground or the rock. "They aren't pretty" or have the aesthetic allure of large, white, gleaming glaciers, though they contain a lot of water and keep the ground stable (figure 4).[45] The EIA accepted that they lay outside the mine's area of influence, something nearly everyone questions, including consultants close to the process. Their omission is surprising because Milana is described - or dismissed - as an expert on rock glaciers and permafrost. Given how the EIA presents information, in a rigid question and answer format, it is impossible to reconstruct beyond this why rock glaciers were excluded. Barrick claimed they lay outside the area, and Conama agreed.

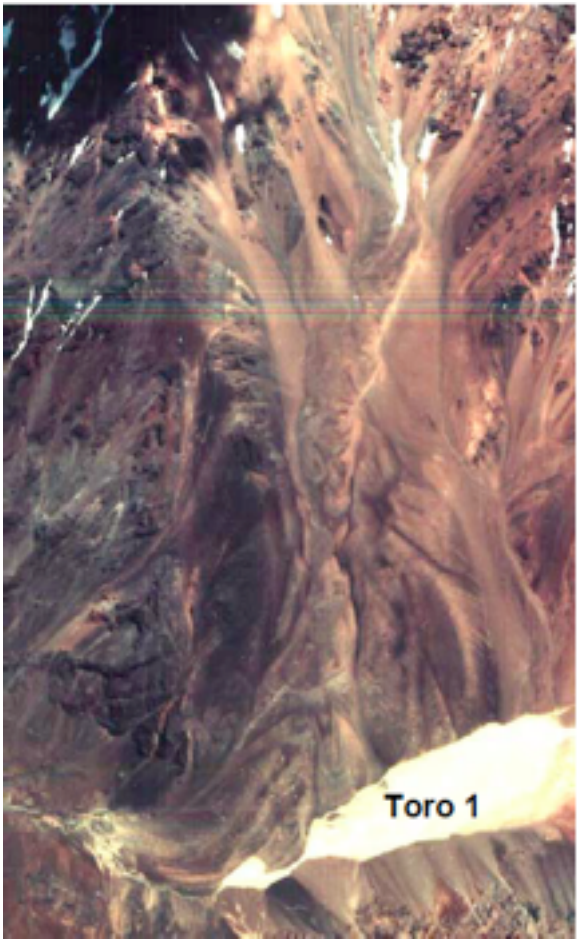
Figure 3. Toro 1 and Toro 2 over time.
From Milana (Oct. 2005) "Ice and Glacier Baseline studies for Pascua Lama": cover page



[44] Pascua Lama Third Addenda (Jan. 2006), Section 2: 1-2.
[45] A rock glacier may be destabilizing the sterile rock waste pile, which could cause major impacts.

Figure 4. Rock glacier in Toro river watershed

From Milana (Oct. 2005) "Ice and Glacier Baseline studies for Pascua Lama": 75



IV. Standards of proof

As Pascua Lama's assessment came to a close, more science was needed. Monitoring and inventorying glaciers emerged as the best long-term solutions to the challenge of managing Chile's glaciers, and understanding their role in the country's water supply. The question always remains, however, how this data will become credible in different spheres, including the public one.

Though Conama decided to take a precautionary approach and protect the glaciers at the end of the EIA evaluation, the reasoning that led to this decision is sufficiently contradictory that few find it credible or convincing. Standards of proof are, as in the Valdivia and HidroAysén cases, ambiguous. Pascua Lama's environmental permit reflects that science - in this case glaciology - is largely marginal in public decision-making, compared to ambiguous definitions of the "technical" and "political".

Conama tried to protect the credibility of the EIA process by labeling it “technical” but in this case events made the distinction untenable.

What were the alternatives?

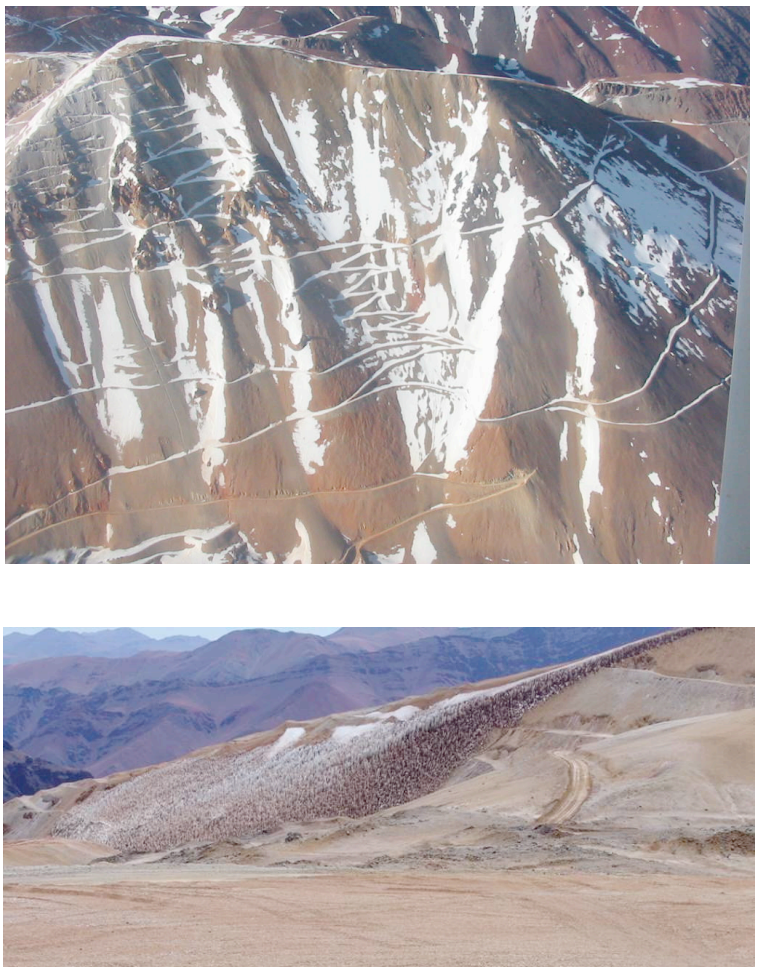
If the purpose of the EIA is to improve projects, in the case of Pascua Lama’s glaciers it fell rather short of that goal. Despite all the scientists who got involved and all the pages of studies, the discussion never moved beyond two options: relocate the glaciers or not. Only two other proposals were made, both ostensibly by EcoNorte’s glaciologists, and neither was approved. The first involved compensating the loss of the glaciers with a dam of five million cubic meters and a maximum cost of US$5 million. The EIA report states this dam would “comfortably compensate” any water losses but does not justify the statement with data. That is because the dam had been proposed by lawyers and farmers, not glaciologists or hydrologists, during the negotiation between Barrick and the Irrigators Association. The other proposal was to protect the nearby Ortigas glacier, also owned by Barrick. None of the state agencies or scientists proposed any alternatives, in an example of how rigid the EIA is and how closely state agencies stick to known actions.

Furthermore, the EIA process did not ultimately succeed in reaching agreement over one critical piece of information: how much water would be lost if the glaciers were lost? Glaciologists proposed several different numbers based on different methods that combined analysis based on field measurements and on models. The final environmental permit reports these different results without trying to synthesize, arbitrate or choose one analysis over another.

The glaciologists, no matter who they worked for, agreed that relocating the glaciers would not preserve them, leading to a loss of water downstream. They did not agree, however, on why or whether they should be preserved, in part because the glaciologists agreed the glaciers were small - simple *glaciaretes*. Small glaciers meant a small loss of water. Why were they small? Only the Water Agency pointed the finger at Barrick and the decades of mining explorations and operations to prepare for the mine. Their memo argues this clearly, loudly and uniquely. Andrés Rivera’s memo to the government talks about roads on the Esperanza glacier. Officially, only the Water Agency accused Barrick openly. The rest touched on the issue lightly or not at all.

Conama also avoided asking Barrick directly about existing damage. Whether the release of dust, construction of roads, and explosions had already damaged glaciers was marginalized to focus on future damage. Conama preferred a scientific approach and asked Barrick to provide data comparing three scenarios: removed glaciers, dust-covered glaciers, and unaffected glaciers. Barrick side-stepped the issue with a slightly different classification. The reports produced in the second addenda on dust dispersion and wind (table 1) go largely unquestioned. Measures to reduce dust 10-15% are adopted by taking some operations underground, relocating some industrial processes, and reducing roads. Again, more monitoring is required.

Figure 5. Photographs of roads and dust on glaciers near Pascua Lama. Source: Bórquez 2007: 88, 90.



Yet many had experiences that speak to damages to Pascua Lama's glaciers (figure 5). On a visit to Pascua Lama's base camp, a respondent saw an enormous photograph hanging in the cafeteria of one of the glaciers with a huge machine on top of it. Another drew criss-crossing lines with his fingers to signal the roads over the glaciers. In Congress, another respondent was asked whether Barrick had already damaged the glaciers. He assented but the recorder asked "you mean, there was not very much scientific rigor in [the consultant's] studies?". Roxana Bórquez, a student at the University of Chile who wrote her undergraduate thesis on Pascua Lama's glaciers and helped with materials for a draft glacier law, and Alexander Brenning - a Canadian glaciologist - have both published accusations of existing damage to the glaciers.[46] Like

[46] Bórquez reports on an account given by a former employee to the Environmental Authority (Conama) and a report submitted by Barrick to the authorities in 2005 recognizing causing damages to the glaciers (Bórquez 2007: 95). I was unable to find this report. See Brenning, A. (2008) "The Impact of Mining on Rock Glaciers" in *Darkening Peaks: Glacier Retreat, Science and Society.*

in Aysén, here too I was told "only foreign scientists denounce these things". OLCA filed a suit against Barrick after they found "a few paragraphs buried deep in some report admitting to the damage", but the case was dismissed in court.

Conama took a precautionary approach. The final permit argues that information was insufficient to evaluate the impacts of relocating the glaciers, so they could not be moved.[47] Glaciers dominated the final permit; they are mentioned 168 times compared to just 43 times for acid rock drainage. Likewise, in contrast to the EIA of HidroAysén, where the authorities largely dismiss questions about the social and political value of nature (chapter 6), Pascua Lama's permit declares that glaciers are part of the community's "natural patrimony" and are "water reserves"; they deserve protection.

But the permit's reasoning is full of contradictions. Uncertainty in water flow data led to a precautionary approach, but uncertainty over dust impacts led to a few compensation measures. Neither of the two issues was that uncertain. These excerpts from Pascua Lama's environmental permit illustrate these contradictions:

> In a worst case scenario, assuming the total loss of glacial ice in the area of the mine's open pit, and without implementing any of the proposed compensation measures, the impact on water flow is estimated at 2.5 liters per second on average each year, or 9 liters per second in the driest month of February. This measure has been validated by the Water Agency, given that this agency calculated an even lower potential impact of 2.5 liters per second in February.[48]

Although concrete estimates of water losses were available, and these were validated by the Water Agency, Conama treated this information as "uncertain".

In contrast, Conama does not require estimates or data to settle the issue about dust. For example, Conama asks for new studies that can remain vague: "...analysis of mass balance will yield data on albedo and other factors that describe the physical processes shaping water resources, but it is not critical to quantify exactly the potential impact....". And it introduces an arbitrary distinction between industrial and natural dust: "...the glaciers in the area of Pascua Lama currently have large quantities of dust naturally deposited on them." The permit is labyrinthine as evidenced by references like this: "see information in Addenda 2, Annex III-A Section 4.11, page 102 and Annex III, pages 11 and 26 of this second document". The permit is badly written, for example:

> This is particularly visible in the area of Toro and Esperanza, where the geology is such that erosion is high and dust travels far, both because of wind and melt, frequently covering ice at lower surfaces (sic).
> With respect to impacts from particulate matter, the Water Agency's regional office says the real effects of industrial dust on the Estrecho and Guanaco glaciers, the presence of ice in permafrost (and its importance

[47] Pascua Lama Environmental permit #024 (February 2006): 129.
[48] Pascua Lama Environmental Permit #024 (February 2006): 130. See also page 129 for a full picture of Conama's contradictory analysis.

> as a water resource), and the management of snow moved from the industrial installations accumulated in the area (sic). In all these cases, the company says it will do studies and will answer Conama's questions, once the study is approved.[49]

These passages from the environmental permit illustrate the contradictions in rationale and what many in the public see as the EIA's failings. Conama on the one hand declares one of the most studied issues "uncertain" but left others for which no studies were available to be determined only after the project's approval. The EIA's standards of proof have nothing to do with conventional forms of proof; rather, EIA-time has run out and the project must be approved.

Does the EIA matter? Blending the political and the technical

A senior Conama staff involved in Pascua Lama's evaluation explained this precautionary decision in terms that blend technical and political criteria. There was a technical, scientific, political and social consensus to protect the glaciers. Conama had to approve the project – "no one [in state agencies] would go against what the President of the Republic says" – but "luckily this time technical and political criteria coincided", because the President would not take on the political costs and legal risks of destroying the glaciers. As the EIA process was wrapping up, more information was not useful because they already had "the technical conviction to protect the glaciers". This kind of blending of technical and political criteria, where the glaciers were spared because the executive government wished it so, is strongly opposed by Chilean environmentalists.

Conama's "technical conviction" likely resulted from a "very productive meeting" held sometime in the fall of 2005, between the regional governor Yazna Provoste, Atacama Senator Ricardo Nuñez, Conama and the Water Agency, each accompanied by their glaciologists. Provoste and Nuñez represent politics, because they are directly or indirectly-elected representatives that belong to the government. Conama and the Water Agency, in this context, are implied to represent the technocratic, bureaucratic state. Blending the political and the technical, as Conama saw it, also required keeping them strictly separate. Staff at Conama said they were "thankfully" spared this process and effectively "armored" from politics; in fact, they could not recall much about the agreement, the Association's participation or the change of consultants (e.g., the incorporation of EcoNorte and Milana).

This description illustrates the ambiguity of "technical". At one point the speaker implies that "technical" lies in the EIA's scientific reports and quantitative estimates; that is the "technical conviction". At another point, "technical" lies in Conama as a whole - that was Conama's role at the meeting with the clearly political Senator and Governor. But the meeting shows that technical and scientific are distinct categories. The political government and the technical state attended the meeting with their own scientific advisors. The flexibility of the boundary allows this Conama employee to try to defend

[49] Pascua Lama Environmental Permit #024 (February 2006): 131.

the credibility of the process despite the political imperative to approve the project: he could plead ignorance of anything that happened outside the EIA's pages despite being present at the very productive meeting.

Soon after the productive meeting, Barrick and the Irrigators Association announced their agreement. Barrick agreed to pay US$60 million to the Association over ten years for "irrigation infrastructure", in addition to environmental measures like the installation of 30 online monitoring stations, additional measures to avoid acid rock drainage, new studies and the dam to compensate the loss of the glaciers. Activists were devastated. It was "an agreement between private parties" to which the state had been complacent, unconcerned to bring a "technical" opinion to bear on a political agreement (Bórquez 2007: 71). Manuel Ossa had years earlier called this a "policy of completed actions": the state, both local and national, had already decided to approve the project rather than take their concerns seriously. Public participation was done under false pretenses.

Two things emerge from activists' reactions to the agreement. First, activists share concern with the technical/political boundary with individuals in government and industry, but are also concerned by a public/private boundary. That is why, from their point of view, Pascua Lama is evidence of a co-opted EIA process. Although the final EIA did not reflect the content of the agreement between Barrick and the Association, to activists what mattered is that the government had sheltered an agreement between private parties. Nearly all the specificities of the case - like debates over water loss, dust deposition or long-term water quality in light of climate change - mattered less than the suspicion of corruption.

Second, activists do not distinguish between the technical and the scientific, like government actors do. For activists, the scientific is not a salient concept - it was hardly mentioned, even in this case where glaciologists played such a prominent role. What matters to activists is how the political imposes itself on the technical, as in how the Lagos government wanted to approve the project despite what activists considered should be the technical position (because, in fact, glaciologists never defended the glaciers although Conama did, so in a sense activists technical position was imagined). Activists instead complained the political was "not democratic" because a democratic process has to be open-ended, fair and transparent. This means the EIA should promote accountability ex-ante by preventing bad projects. In contrast, for the government and the state, the EIA should promote accountability ex-post by producing the legal documents needed to hold the company accountable if it violates its environmental permit or damages occur.

Monitoring at Pascua Lama

As every party to the controversy hired glaciologist-advisors, so monitoring - more science - became a solution onto itself. Pascua Lama's glaciers went from the waste pile to being among the best studied in Chile. A seven-person team works full time to monitor these, plus others that work part-time on Pascua Lama. Every month they fly up by helicopter, a 45 minute ride, to take measurements on Toro 1, Toro 2,

Esperanza, Guanaco and Estrecho glaciers. The equipment is among the best available; often times they are “measuring phenomena we do not understand well”, because it is on the cutting-edge of glaciology research. The reports are “ping-ponged back and forth between Conama (now the EIA Agency) and Barrick”, via the scientists. This is supposed to last for 20 years, as long as the mine operates. Monitoring Pascua Lama’s glaciers is a large-scale, expensive, sophisticated science effort that represents a massive epistemic shift in the Chilean state with regards to glaciers and now involves nearly all the country’s glaciologists.

But is the monitoring plan and data credible? Ron Kettles, Barrick’s Canadian director in Chile during the controversy, felt strongly that monitoring had to be done by a public institution to be credible. Kettles also preferred a local actor. There were few choices. CECS is legally private. The University of Chile has a number of glaciologists, busy with research in Antarctica and Patagonia, and they are located in Santiago. The Catholic University of the North did not have much glacial capacity. Only the Center for Environmental Studies of Arid Zones (CEAZA), located in the city of La Serena, close but autonomous from the local University of La Serena, just south of Huasco, met both criteria. Created in 2003, CEAZA was part of a generation of institutes meant to build “regional scientific excellence” and links to industry with government funding.

Being new and facing ever-present funding challenges given the government’s irregular commitment to fund science, CEAZA has to establish its credibility. Though the contract with Barrick is important, CEAZA has many sources of income as its annual reports show. Nonetheless, many say, if they lost Barrick’s contract the glaciology unit would be closed. Charges of opportunism like this, taken to try to undermine CEAZA’s credibility, are accompanied by charges of scarcity: “I know full well that CEAZA has not had access to all the resources it needs to do the job well”, implying that Barrick and the government have sometimes been less than cooperative. Like its cousin institution in Aysén, the Center for the Study of Patagonian Ecosystems (CIEP), CEAZA also has to carefully navigate Chile’s credibility politics, marked by an insincere discussion about the role of funding in scientific independence.

CEAZA’s glaciology team is young, international and academic, and are less concerned with Chile’s complicated credibility politics. PhD scientists from France, Netherlands or New Zealand have settled in La Serena to take advantage of the opportunities to study climate change through glaciers in arid areas. To combine “excellent science” and monitoring, however, maybe undermining both. Climate change research will result only after many years of data are built up, and the work in the meantime is not very fulfilling. They worry it is not useful for regulatory purposes either, because monitoring yields probabilistic scenarios rather than cut-off points. By the time an impact is detected, it will already be an impact; it will be too late to implement corrective measures. In the best case scenario, the monitoring data will help inform better glacier protection practices for other mining projects.

Monitoring is not very efficient either, and as more voices are added to the process the criticisms multiply. Current Barrick staff disagreed with Kettles’ vision and preferred to work with consultants. So consultants BGC and GeoEstudios, and scientists at CECS, were hired by the EIA Agency and the Water Agency to audit and

propose improvements to the plan. The plan is heavily criticized; it is too ambitious, too unwieldy, too large, not practical and not useful for making decisions. There was, however, at the time of research no consensus how to correct these failings: "there is widespread agreement that the plan needs to be changed, but no one takes the initiative to change it", said one participant.

A microcosm of the larger plan is the 30 water monitoring stations Barrick was forced to introduce by the Irrigators Association. Proposed by a lawyer during the pressure to negotiate, because he knew similar projects in Chile at most had just one, the consultants then had to be somewhat creative about where to place so many stations. Likewise, the monitoring plan was described as "the most ambitious of its type in Chile ever" that goes "well beyond the UNESCO's requirements". Rather than do the sufficient, the plan sought to be "the best possible". This communicates credibility more than hiring CEAZA. In Chile the language of the "best" is used to argue for credibility, for no reason other than size.

Shortcomings aside, monitoring is helping to build state capacity. After the Pascua Lama controversy, a glaciology unit was created within the Water Agency, led by Gonzalo Barcaza, who visited Pascua Lama with Manuel Ossa in 2002. The Unit is well funded by the state and by the Inter-American Development Bank. They employ six professionals, plus three administrative staff, and was looking to hire two more PhD scientists. PhD scientists are rare in Chilean government. There are just one or two in the Environment Ministry, and none I could identify in the EIA Agency. They also have a little house at Pascua Lama and can - and have done - surprise visits. The capacity to do surprise visits is also rare in Chile.

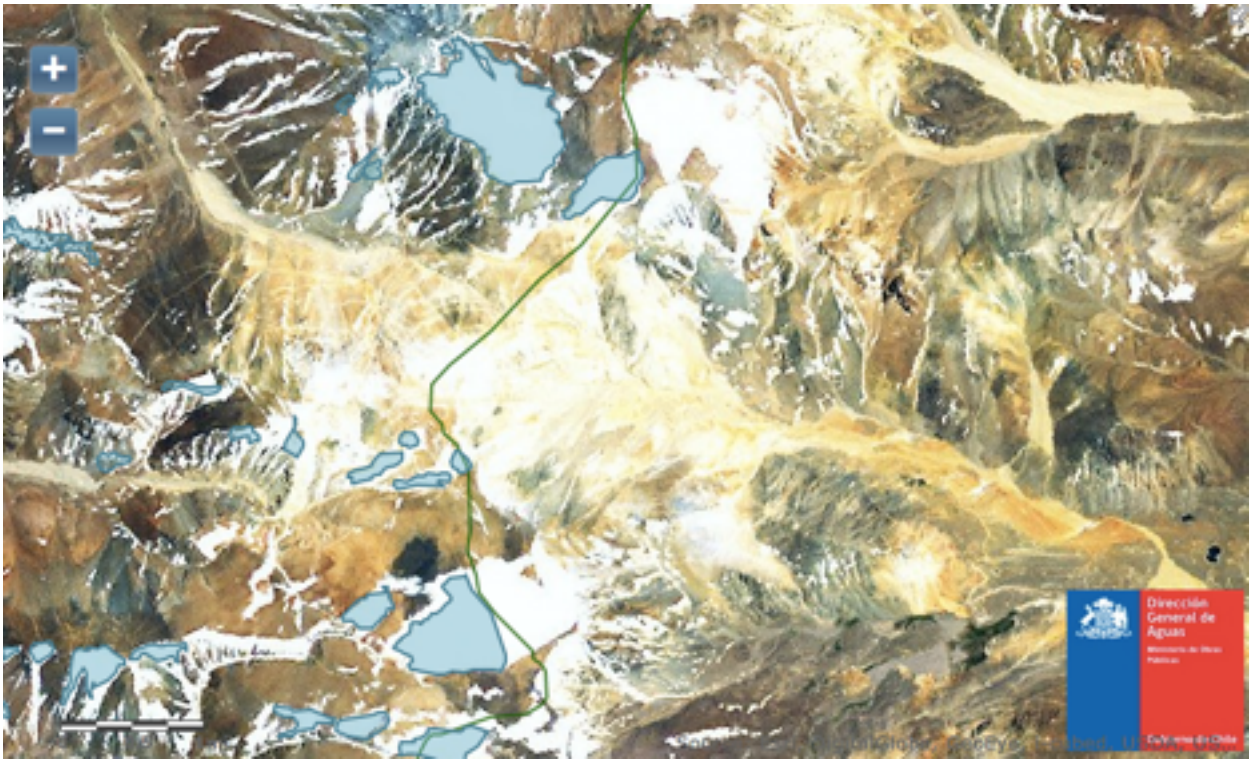
Inventorying glaciers inside and outside Pascua Lama

Barrick was also required to do a full inventory of glaciers in the Huasco region, which mirrors a national effort to inventory glaciers. For the first time, after 2006 the state began mapping glaciers and putting this information online (figure 6).[50] Community members and Senator Antonio Horvath, a representative of Aysén and arguably one of Chile's most consistently pro-environment representatives, proposed a national law to protect glaciers following Pascua Lama. A law like this would provide legal grounds to sue companies that damaged glaciers. Though President Michelle Bachelet committed to this during her campaign, the executive later lost interest and glaciers instead became part of the EIA, managed by a new glaciology unit in the Water Agency. Critically, the Water Agency is a "sectoral" not a "general" interest. Whereas the EIA Agency or Environment ministries are general, Water, Forests or Geology are "sectoral" - that is, they belong to ministries that use natural resources for production: these are the Ministries of Public Works, Agriculture and Mining, respectively. If glaciers were an ecosystem to be protected they would have been assigned to the Forest Agency or the new Environment Ministry, that was being planned at the time. As water resources to be

[50] http://www.dga.cl/productosyservicios/mapas/Paginas/default.aspx. Now, anyone with some spare time can go and count how many glaciers fall into mining pits. In less than 10 minutes I found two.

used, they were assigned to the Water Agency. In this way, they fall into Chile's property rights regime for water that many credit for deteriorating Chile's environment (Bauer 1998).

Figure 6. Pascua Lama and its glaciers in the national glacier inventory maintained by the Water Agency.
Source: http://www.dga.cl/productosyservicios/mapas/Paginas/default.aspx



The large glacier at the top is Estrecho and the large one at the bottom is Guanaco. In between there are two long but small glaciers in two parts - these are Toro 1 and 2 - and to the left is Esperanza. Pascua Lama's growing operations are visible in the lighter colored, golden area. Roads are visible. The inventory does not report what year these images are from or if they are updated in real time.

The glacier inventory, legally, is created by individuals who propose glaciers to add to the list. In practice, the Water Agency is leading the effort with help from external studies. Funding from the Inter-American Development Bank and the Chilean government make this possible. Another set of studies they hired set out to standardize Chilean glaciology, including a manual for evaluating impacts on glaciers by GeoEstudios and a "national strategy" by CECS. The national strategy is a foundational document; it defines and centralizes all Chilean knowledge about glaciers. The majority of the 454 bibliographic references it lists are about Chile, but just two are about human impacts on glaciers.

How credible is this information? The national strategy and the manual for evaluating impacts on glaciers lie in drawers. Until the evaluation manual is validated, it only represents "Marangunic's opinion". It will not be validated anytime soon. The Water Agency is also criticized as timid. Again the question of funding is divisive. For some, the Agency needs to move slowly and carefully, and for others it needs to be bolder and accept industry funding. It is interesting that even after Pascua Lama, many close to government do not see that industry funding would erase any credibility the Water Agency may have now or in the future among Chileans broadly.

Pascua Lama expanded and entrenched the EIA, not just by adding a new resource, but by changing standards of transparency. The experience of Pascua Lama led many to support reforms adopted in 2010: private negotiations are no longer allowed; public participation was strengthened; and projects can not have more than two rounds of questions and answers (chapter 3). The hope is that "companies will now put their best project forward" rather than reserve information to release during the evaluation process. Business is concerned that an EIA without negotiation will be "less flexible".

V. Conclusion

After all was said and done in Pascua Lama's six year environmental evaluation, the battle was won but not the war. Glaciologists agreed that moving the glaciers as Barrick had proposed would destroy them. But they did not agree on why or whether to protect them. Focused on the narrow question the EIA asked, glaciologists concluded the three glaciers were too small to warrant special treatment and - with the exception of the Water Agency - let slip the opportunity to argue that glaciers need protection from mining activities. In contrast to scientists' participation in the Valdivia mill controversy, nearly contemporaneous with Pascua Lama's controversy, glaciologists took the path of relevance and participated in this question of public interest. They did so without narrowing the scope or authority of their trade, as the ecologists did on the witness stand over the Valdivia controversy (chapter 4).

Pascua Lama is a fascinating case because in many ways it was an environmental victory. Public protest led Conama to change its reasoning and require the company to preserve the glaciers where they are, which means a smaller mine for Barrick. Barrick also had to accept significant improvements, at a cost, to prevent other environmental harms like acid rock drainage as well as an expensive monitoring plan. And the controversy moved national policy and awareness: glaciers became official, with a new unit to look after them, new EIA requirements and new training and research programs (e.g. like CEAZA). And yet nearly everyone involved with the case feels defeated: the community is "broken", glaciologists are critical of nearly everything that happened, and the credibility and relevance of the monitoring information are in question. As of writing in May 2013, Pascua Lama is paralyzed after Barrick admitted to failing to meet several of its environmental requirements. Defeat dominates, however, because of Conama's lackluster performance, the Irrigators Association about-face, and Barrick's policy to lead with money - so the Irrigators Association and many families in

the Huasco Valley were “bought”. From the perspective of capture, it is less the state that is captured in a conventional sense than different civil society actors.

From a few scattered photos to an online inventory, glaciers became visible to the public and the state following Pascua Lama. The Water Agency played “a very decent role”, according to one activist. State agencies are under-staffed, under-resourced, under-empowered by the law and their attitudes. Government technocrats are the first to argue they can only do what the law explicitly authorizes them to do, while companies can do anything not expressly forbidden. In this case, because there was no law protecting glaciers, Conama was assumed to have no authority to act in their protection. But, as in this case, public protest can spur agencies to reaction. The contrast with the after-math of the Valdivia paper and pulp mill controversy is interesting; compared to the failures of Conama and the Forest Agency to produce “more science” to remediate and protect the wetland there, the Water Agency has been fairly effective at producing “more science” to assist in glacier management. How? With international aid and by enrolling every glaciology group in the country in the effort. Glaciology is a small and tight-knit community, despite their epistemic differences. The Water Agency is also more influential than Conama or the Forest Agency.

Did glaciologists face a challenge of integrity, like the ecologists, zoologists and veterinarians at Valdivia faced? Though glaciologists were certainly criticized, they were never accused of “wanting to be heroes” as in Valdivia. At Pascua Lama, the glaciologists were not the “environmentalists” - communities of Huasco, activists and NGOs took that role, and suffered from it in the sense that their main message was willingly misinterpreted. By dismissing the opposition as nature-lovers enthralled by glaciers, the fundamental connection between glaciers, water, agriculture and livelihoods was summarily brushed aside. Environmentalism was kept under control by stripping the movement of its economic and equity motives. This way, glaciologists and Conama could focus on the narrow questions required by the EIA rather than the larger questions posed by mining practices in Chile. The EIA process, with its adherence to rules and procedures, privileges this kind of relevant science to an integral science. Scientists also prefer it to shield themselves from public criticisms, like those suffered by the “environmentalist” scientists at the Austral University in the Valdivia controversy.

This partnership between science and rules may not work for long. The Huasco Valley residents who did so much to protect the glaciers, never recognized this as a victory. “Ours is a broken community”, destroyed by Barrick’s social aid given to divide and conquer, the betrayal of the Irrigators Association, Conama’s incompetence, and a complicit executive government. Since 2006, the Irrigators Association has been subverted by Barrick who now holds the majority of votes and spends the $60 million compensation package as it likes. Sister Cristina was transferred to a town near Santiago. Conama staff that protected the glaciers now work for Barrick monitoring the glaciers. All the glaciologists who evaluated the project work on a monitoring plan they say is not very useful for decision-making. And Huasco’s environmental problems have grown exponentially.

Chapter 6. Dams in Patagonia? Evaluating HidroAysén

A few dozen families live along the Baker river in Aysén, in the Chilean Patagonia. Their children go to school, and their goods to market, on boats subsidized by the government. Few rivers in Aysén are navigable, transforming the Baker river into the economic and cultural artery of this rural, sparsely populated community. Locals do not say "I am from the town of Cochrane" or "the town of Tortel"; they say "I am from the Baker". Threatening this sense of place, two mega dams are projected to be built on the Baker river; Baker 1 would lie just up river from Cochrane (pop. 3000), and Baker 2 would lie about half way between Cochrane and Tortel (pop. 500). These dams are part of the HidroAysén hydroelectric project, that also includes three dams on the Pascua river, where a handful of people live. Will the Baker river be navigable if the dams are built, and how do the relevant actors know? These actors include political and business elites in Santiago, 2,000 kilometers north of Aysén; multinational financial interests; Chilean electricity consumers; and *Ayséninos,* the people of Aysén.

The EIA is responsible for discerning between the potential benefits and costs of HidroAysén. Submitted in 2008 and approved in 2011, HidroAysén provoked enormous social protest. Many Chileans did not want to see Aysén, a deeply rural region, industrialized in this way, while many others wanted the energy to continue to expand mines, factories and cities. The controversy about environment versus growth was accompanied by a controversy over the EIA itself: is this the right policy tool to legitimate such a large, disruptive project, and to respond to the range of environmental concerns Chileans today have? More simply, did the EIA resolve the state's concerns about the project in a publicly credible way?

HidroAysén is a good case to examine these questions because of its size and timing. Frequently touted as the largest EIA project ever in Chile, HidroAysén broke all the scales (table 1). Its EIA amounted to "one cubic meter" of information, prepared by eight universities and an international consulting consortium, Poch-Sweco-EPS. Endesa, the parent company, invested US$12 million in studies in one of Chile's least studied regions.[1] More than 3,000 observations from state agencies and several thousand from citizens were submitted. Staff had to be re-assigned and new software installed so state agencies could evaluate the project. If the EIA failed to legitimate HidroAysén, it would be placing an upper limit on Chile's economic growth possibilities. This is as large a project as Chilean state institutions can permit.

In terms of timing, HidroAysén is a good case because it came just after the 2010 reforms that created an autonomous, more technical EIA Agency. Endesa learned from the controversies at Celco Valdivia and Pascua Lama (chapters 4 & 5) and invested in "more science" from the beginning to avoid controversy. They hired more scientists, individuals whose main position is at a university, to work on HidroAysén's EIA than any company before them in Chile.

[1] The total cost was US$12 million, or 0.34% of the total investment. This compares favorably to the estimated average spent on EIAs in Chile, estimated to be less than 0.05% of total investment.

Table 1. HidroAysén's EIA compared to Pascua Lama and Celco Valdivia					
	EIA length in pages	**Universities hired for EIA**	**Observations**	**Question-Answer rounds**	**Permit (pages)**
HidroAysén 2008	Thousands	8	Few thousand	3	2000
Pascua Lama 2004	Hundreds	0	Few hundred	3 (+ an earlier EIA)	178
Celco Valdivia 1998	Eleven	1	Few dozen	1 (+ an earlier EIA)	73

How well did the EIA process resolve those 3,000 observations by state agencies, and other thousands by citizens, following the reforms of 2010? The public outcry and debates that happened before and after the project's approval indicate it did not resolve these in a way that was credible to large groups of the public. For example, it failed to inform relevant actors of straightforward impacts that would affect them. As I toured Aysén in March 2011, *Ayséninos* could not tell me if the Baker river would continue to be navigable if the dams are built. A boat driver employed by the Ministry of Public Works replied "That's what they say, but you need to see it to believe it." Another boat driver who makes a living from a government concession replied "those who are in favor of the dams say the boats will run. Those who are against, say they won't." The staff at HidroAysén's open house in Cochrane did not know any specifics and concluded: "The people here have a culture of adapting to what exists."

This anecdote about navigability foreshadows unresolved questions about representation that are embedded in debates about the technical versus the political, the public versus the private, and the scientific versus the practical. The EIA itself became an object of controversy. The 2010 reforms, far from providing solutions to those problems, deepened the controversy by expanding the gap between what the EIA is legally empowered to do and the political questions it is asked to resolve. In the case of large projects like HidroAysén, the EIA could not provide what are seen to be technical answers to what are considered political questions. While everyone agrees on the need for "more technical" decision-making, the meaning of technical is left ambiguous and therefore varies enormously. In contrast, "politics" is usually understood as partisan and best avoided. The disputes that followed HidroAysén's approval, however, point to the need for "politics" to help answer questions about Chileans' desired development path.

The first section introduces the reader to the region of Aysén and the environmental conflict there. The following three sections - participants, illegibility and standards of proof - examine the EIA's practices in detail to illustrate how these produce erroneous, missing and unrepresentative data of the region and the impacts it may endure. The section on standards of proof concludes the analysis with a discussion of the three questions raised by this case: how well did HidroAysén's EIA resolve agencies' concerns, how well does the EIA evaluate such large projects, and how well

does it answer to the public's environmental concerns. The EIA process reveals important things about representation, participation and accountability in Chilean democracy.[2]

I. Stakes: who guides development?

Aysén is the heart of the Chilean Patagonia. The landscapes are an enormous mix of blue and green lakes, mountains, skies and forests. Water dominates. It comes as snow in the mountains, ice fields and glaciers in between, and rain by the coast. Two of South America's largest lakes (General Carrera and O'Higgins), at least five major rivers, and countless waterfalls and brooks collect all this water. The rivers, fed by huge glacial lakes, travel quickly and constantly down from the Andes to the Pacific; less than 200 kilometers. Settled in the first half of the 20th century, Aysén has an identity of pioneers and *gauchos* (cowboys) who live relatively in-communicated with the rest of the country. Phone access and communications are spotty outside the regional capital of Coyhaique (pop. 50,000), and to travel to Puerto Montt - the next large city to the north - requires either going through Argentina, a three day boat trip, or short plane ride.

Aysén's economy, however, has always been linked to the strategic maneuverings of the state. Small and large land-holdings were distributed by the state to reaffirm its territorial claims against Argentina (Ivanoff, 2007). Four million hectares of forests were torched to make room for ranching.[3] The state made far fewer investments in infrastructure. Construction of a highway began only in 1976. The largest industrial project attempted so far in Aysén, only a fraction of the road's 1,200 kilometers are paved.[4] The 300 kilometers (186 miles) that separate Coyhaique from Cochrane are

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[2] The material in this chapter proceeds from interviews conducted with staff at Endesa and HidroAysén, the two companies responsible for the project; at government evaluating agencies both in Aysén and Santiago (Forestry, Water, Agriculture, Geology and Mining, Fisheries); at the EIA Agency in Aysén and Santiago; at municipalities with the staff responsible for commenting on the EIA (Cochrane and Tortel); staff employed at the consulting company POCH who worked on the project; activists opposed to the project based in Santiago and Aysén, working from multiple organizations; residents of Aysén I met during my travels there; and above all, the scientists who worked (and, sometimes, did not work) on the project, from the following universities and groups: University of Chile, of Concepción, Austral, CIEP, EULA, and the hydrology consulting company CEA. Interviews were conducted between October 2010 and May 2011. A few respondents refused to have their interview recorded. Reviewers in state agencies were most reluctant to participate. The position and date of the interview is provided for long quotes. In light of human subjects review, anonymity is protected. Personal names are only used if the material comes from public sources. Gender pronouns are all in the masculine to protect the identities of the few women I interviewed. I spent six weeks in Aysén, between February and March 2011. I also draw from the EIA documents themselves and media articles. Quotes are used to reproduce direct speech. Spanish words are italicized.

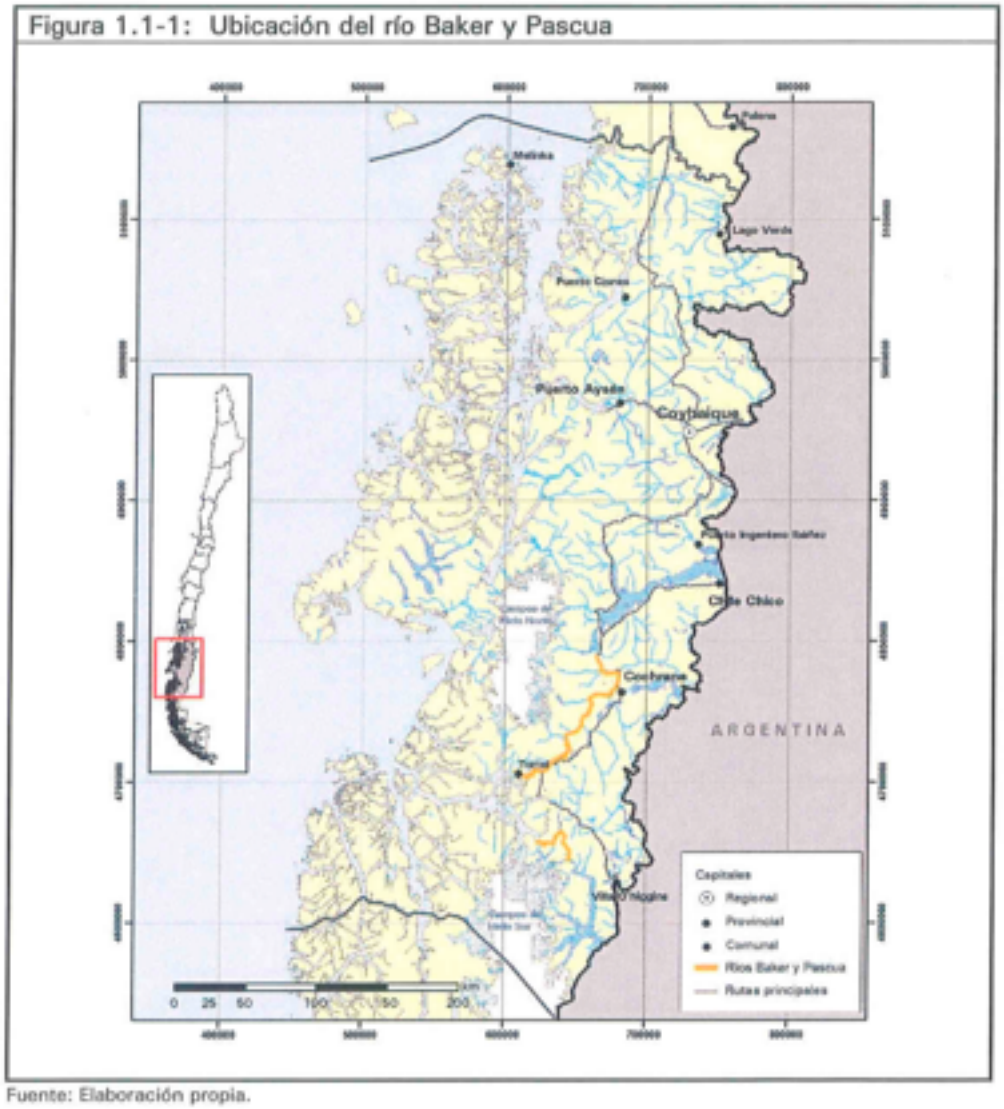
[3] Some of the large ranches are owned by millionaires Victor Puchi and Douglas Thompkins, who have supported the opposition to HidroAysén. Puchi is from Cochrane and owns AquaChile, a large salmon farming company. Thompkins founded clothing companies *The North Face* and *Esprit* before turning to deep ecology and conservation in Chile and Argentina, where he trained as a skiier in his youth.

[4] The *carretera austral* is the largest industrial project ever attempted in Aysén, with an investment of US $200 million. Thousands of workers came to work, many of them young soldiers in forced labor, with a high death rate. http://www.tourismchile.com/guide/austral_north_road/articles/675

covered in eight hours in good weather. Electricity generation infrastructure is sparse and expensive. *Ayséninos* pay the highest electricity prices of the country.

Map 1. Region of Aysén, with the Baker and Pascua rivers marked in yellow. Source: HidroAysén EIA (2008)

La Figura 1.1-1 siguiente muestra la ubicación relativa del río Baker y Pascua con respecto al territorio nacional.



Fuente: Elaboración propia.

Recently Aysén's regional government adopted a long-term development plan based on tourism and conservation, and appended "Reserve for Life" to the region's name. *Ayséninos* make their living from ranching, specialized agriculture (e.g., berries), small-scale forestry, expanding salmon farming, and tourism. Many *Ayséninos* long for

development like they see in neighboring Argentina, where the government subsidizes local natural gas prices and has built a real highway system. They are also wary, however, of large companies given how few operate in the region.

How compatible is "Aysén, Reserve for Life" with HidroAysén? Would HidroAysén deliver development like they have in Argentina? The only thing for certain is that the first hydroelectric project would be followed by many more, and that HydroAysén is a large project relative to the rurality of Aysén.[5] Just 5,000 people live in the area most impacted by the dams. To this area, HidroAysén would bring: four camps to house 5,000 workers from outside the region, each with their commodities and services that need to be trucked in or built; smaller power plants for construction; expansion of the Port of Yungay which today supports one small ferry; a landfill adjacent to Cochrane for toxic construction wastes; mineral and sand quarries for concrete; and road improvements. Fourteen families would need to relocate to accommodate the Baker 2 dam. As the area along the Baker river becomes further depopulated, and the Baker less navigable, the total population in the area is likely to continue falling.

HidroAysén is owned by Endesa (51%), a multinational firm owned mostly by the Italian government, and Colbún (49%), a Chilean family business group. But its an old project, first formulated in the 1970s with Japanese government aid. The distance to consumers in the center and north of Chile made the dams cost-inefficient until 2005, when Argentina interrupted cheap gas imports to Chile. With a declared investment of US$3.2 billion, the dams would send 2.750 Mw of installed power over 2,000 kilometers to central Chile.[6] HidroAysén would pour enormous amounts of concrete into a region where currently there is no concrete, and build a 2,000 kilometer high-voltage transmission line across half of Chile.

HidroAysén is controversial because it pits two visions of development against each other. Hydroelectricity is favored by existing legal conditions, even if there is no policy guiding energy choices (Prieto & Bauer, 2012). A state company until 1989, Endesa was privatized as part of neoliberal reforms and left a void in state knowledge, capacity and policy planning that the new Energy Commission never filled (Tironi & Barandiarán, forthcoming).[7] Endesa hastily received water rights for electricity on the Baker river for a fraction of their market value. The only value these "assets" have is for hydroelectricity. Due to reforms in 2005 intended to stimulate a market for unused rights, companies are fined for not using their water rights. As a result of all these policies, Chile's energy laws are a well studied case of private actors leading policy

[5] Hydroelectric project Rio Cuervo was approved in May 2012 and the Water Agency is reviewing more water rights applications for hydropower on the Baker.

[6] The transmission line is the most expensive – economically, ecologically and socially – aspect of the project. Endesa decided to submit the transmission line as a separate project in the EIA system. To put HidroAysén in perspective, the Hoover Dam produces 2,080 Mw, the Aswan Dam 2,100 Mw, and the Three Gorges Dam 18,200 Mw. The longest transmission line exists in the D.R. Congo (1700 km), completed in 1982 after 10 years of construction. There are plans to build a 2,000 km line in China (from Xingjiabia on the Yangtze River to Shanghai).

[7] Since the position of Energy Minister was created five years ago, there have been six ministers, some of them with a double appointment in Mining. Prior to this, there was only an Energy Commission within the Mining Ministry and responsible for forecasting electricity supply and demand.

through a regulated market that sees little trading (Bauer, 1998; Budds, 2009; Latta & Cid Aguayo, 2012). Those who support HidroAysén tend to favor hydroelectric projects because they produce renewable, clean energy needed for further economic growth at the local and national levels.

Table 2. Characteristics of each dam in the HidroAysén project

Dam	Height of the dam (meters)	Artificial lake (hectares)	Average annual energy (GwH)	Power (Mw)	Max. water flow (m3/s)	Minimum water flow (m3/s)
Baker 1	102	710	4.420	660	927	260
Baker 2	40	3.600	2.540	360	1.275	380
Pascua 1	69	500	3.020	460	880	250
Pascua 2.1	114	990	5.110	770	980	280
Pascua 2.2	79	110	3.340	500	980	280

Source: http://www.hidroAysén.cl/site/descripcion_pha.html and EIA.

To others, in addition to destruction of nature and communities, HidroAysén is a symbol of Chile's inequitable and neoliberal development path. Endesa will benefit from a monopoly of rights it got for almost nothing, while *Ayséninos* will bear the costs. Short-term wage labor does not replace long-term self-employment and partial employment in a diversified economy, they argue. As the EIA was coming to an end, a majority of Chileans opposed HidroAysén and tensions were rising, with constant media attention, multiple accusations of wrongdoings and violence.

EIA projects are approved by an Evaluating Committee composed mostly of ministerial representatives. A few days before the vote, a Coyhaique NGO put up photos of the individuals on the committee in the public square, with their names, office telephone numbers, and signs imploring them to "vote with their conscience...to avoid this catastrophe" and asking citizens to call their state representatives to pressure them. The information was public, but many denounced this as a personal attack on the privacy of these individuals. As pressure mounted, the EIA Agency director suddenly resigned for "personal reasons".[8]

Violence erupted outside the EIA offices in Coyhaique after the vote: demonstrators yelled "murderers" to the public officials as they entered a police car, "projectiles" were fired onto the building, and the police used water canons and tear gas on protestors. Demonstrations against HidroAysén continued every week for the next month.

[8] He was replaced by Bolivar Ruiz Adaros who had experience with other controversial EIA projects.

Figure 1. Campaign imploring public employees on the Evaluating Committee to "vote with their conscience" to reject HidroAysén. The title says "Wanted...They want to sell the Patagonia"

What explains this violence and political tension? Energy Minister Laurence Golborne best captured the spirit of the crisis when he said "the people are empowered but they are not well informed, because they are asking things of the government that are outside it's capacities."[9] For environmentalists that was precisely the question: what are the government's capacities, if not to ensure a sustainable energy future that is compatible with different development projects? Was this not the role of the EIA? These questions are examined next.

II. Participants

Never before had so many academic scientists, from so many universities, participated in such a large scientific effort for an EIA as was the case with HidroAysén. One participating scientist said the effort was equivalent to eight to ten years of scientific research projects funded through regular government sources.[10] Just the biology team was composed of 30 scientists who flew around Aysén by helicopter to do their studies. This was replicated by teams in geology, forestry, hydrology, sociology, etc. For scientists, this was an exciting opportunity to have access to an area and resources normally well beyond their reach.

This section outlines the different expectations companies, consultants, NGOs and scientists have of scientific participation in EIA studies. Expectations are so varied that scientists face a tough decision when it comes to participating in the EIA - to accept makes them relevant and provides access to places, data and funding, but risks

[9] http://www.emol.com/noticias/economia/2011/05/13/481361/golborne-e-hidroAysén-la-ciudadania-esta-empoderada-pero-no-bien-informada.html

[10] *El Divisadero,* 16 January 2008. Citing social scientist Pablo Osses.

undermining their public integrity. This occurs at the individual and institutional level, as illustrated in the final section by the experience of the Center for Research on Patagonian Ecosystems, forced to sit out of HidroAysén's EIA due to a perceived conflict of interest.

Why hire scientists to work in the EIA?

Scientists mostly believe they are hired to participate in the EIA because only they know how to do this kind of complex study well. Environmental consultants and Endesa, however, have a starkly different perspective. Endesa hired scientists to "invest in prestige", in what appears to be a tacit recognition that the knowledge market (for consultants) fails to provide sufficient credibility to legitimate the EIA. In contrast, consultants and NGOs do not hold science in high esteem and see their participation in the EIA as counter-productive.

Consulting companies criticize the hiring of scientists for EIAs. Useful only when very little has been published about a topic or something very specific – like the vulnerability of a species – is at stake, scientists "do not think strategically". Consultants complain that scientists "complicate EIAs" and do not know how to craft an EIA that will be approved with few questions from the authorities. Their science is also not that good because they lack access to the latest technologies or methods. Consultants traced HidroAysén's EIA troubles to the scientists who had "opened up too many windows [through which to question the project]" and asked unnecessary questions. They did "ridiculous studies" of things like lichens and moths. Endesa, however, was precisely after this type of novelty.

Rather than rely on their in-house engineers, Endesa hired the universities to signal their commitment "to doing things well."[11] This characteristically Chilean phrase signals a job done without cutting corners and in its ambiguity captures the range of Endesa's expectations, as told by an Endesa employee with responsibility over the EIA: science signaled transparency, good faith in efforts to be comprehensive and accurate, and a commitment to Chile and its nature by supporting research in little known areas, like lichens and moths. To turn to science and pour financial resources into Chile's (small) scientific community was to be a testament of Endesa's faith in the EIA and its capacity to legitimate their controversial project. In-house engineers, in contrast, would be suspect of lacking sufficient autonomy to put quality over expediency. Anticipating the controversy, Endesa invested in science.

Many consultants, scientists and NGOs, however, had a less benevolent view of Endesa's turn to science. More than good faith, Endesa wanted to co-opt possible opposition: if all universities are on board, there is no one to criticize the project later. Thus, "in Chile there is no such thing as an independent expert", as an activist said. Some scientists echo this sentiment and are highly critical of participating in the EIA.

[11] "Doing things well" contrasts to "doing things the Chilean way", meaning sloppily and cutting corners to save a few pesos. See chapter 1 for a discussion of the Chilean Way.

The politics of baselines

Consultants are hired to produce the EIA report that is submitted to the EIA Agency, and scientists - when they are hired - produce the baselines. The division of labor between scientists and consultants produces a conceptual distinction between "baseline conditions" and "impact evaluations". What are baselines? A characterization, survey or inventory of the ecological, biological, geological and social conditions of an area where a future project is expected to have environmental impacts. Baselines register a landscape before the coming intervention. According to HidroAysén, baselines are like a "photograph" over which "there isn't much to discuss".

Yet observing and commenting HidroAysén's baselines occupied most reviewers' time. Baselines are the basis of accountability, according to the reviewers who work in the state. A cautious and thorough evaluator sees an "accurate baseline" as his best guarantee that accountability will be possible should an impact occur.

Scientists hide behind baselines to hedge their responsibility. They contrast baselines to impact evaluation, which is "more complicated", "messy" or outright "political", involving "questions of values". According to a geologist, baselines are "so technical, we did not even know where the dams would go when we collected data from the Baker river." Here technical implies scientific. Some scientists also claimed Endesa's contract specified where, how and what to examine. This quote from the geology baseline report speaks to this:

> This study was based on the recompilation, revision and critical analysis of *existing geological information*, principally that available in the Geology Department of the University of Chile. Furthermore, and *following the terms of reference*, *special attention* was paid to the results of the geology study developed by AURUM INGEROC Consultants Ltd. (Vogel, et al. 2006). It is important to note that at the time of writing this report, only reports on compiled and photo-interpreted preliminary geology of the Baker river, XI Region of Aysén, and of the Pascua river, XI Region of Aysén, were available. According to the authors (Vogel, et al. 2006), this has the character of a *preliminary* geological map due to the form in which the data was generated and the *lack of validation through fieldwork*." (emphasis added)[12]

Scientists here are limiting their responsibility by pointing to their use of outdated and vague data, when fieldwork and new data are needed, and the constraints imposed by the firm (the terms of reference). While they try to render the consultants' work scientific by using a scientific citation, they also disqualify it for not using fieldwork-based scientific methods. The geologists are trying to have it all ways: they got to work for HidroAysén but do not want to assume responsibility for producing work that is not up to their scientific standards.

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[12] HidroAysén Geological Baseline reports (2008), by the Geology Department, University of Chile: 5.

Another common tactic used by scientists was to blame the consultants for practicing what many scientists called "cut & paste". According to this young scientist and part-time consultant:

> Baselines produce technical information…there is no politics to it. The thing with the EIA system is that the consulting firms are in a vicious circle because the company pays you to do a study to evaluate the company's project's environmental impacts. The company is judge and jury in its own cause. [Our consulting firm also doesn't do EIAs] because of an ethical issue. We don't want to be involved with drying out a river where there are otters, and you tell the company and they say 'this can't go in the report because they won't let me build my thing'. I know they go and remove the otters and hand in their report… The company-consultant relationship is toxic.[13]

In this view, it is not the scientist's responsibility to ensure the integrity of his research results. What happens to "baseline science" once it leaves the scientist's hands is the consultant's responsibility. Companies are also let off the hook.

Endesa staff had an entirely different perspective. According to them, scientists had freedom to set the terms of the contract and make all decisions about what, where and how to examine the project's area of impacts. To Endesa, the conceptual distinction between baselines and impact evaluation was real and reflects the nature of science: "To prepare baselines is a more pure scientific study, like taking a photo, to see what there is. To evaluate environmental impacts is different". Impact evaluation is "more delicate" because it requires capacity to integrate disparate information, prioritize things and make decisions. It requires experience only a consulting company, working with Ingendesa, has. In contrast, "it is very appropriate for universities to characterize the current environment".

On the question of financial and scientific independence, an Endesa employee with responsibility over the EIA rejected the idea that the source of funding shapes scientific results:

> When you hire someone you reduce their objectivity. We don't believe that. We believe, and we have seen, how scientific independence grows each day and is not up for sale…You can just ask the scientists and they…can be quite critical, which is very valid for the process. I don't need to hire people who agree with the project, I need to hire the right people to certain studies. But they need to be sensible and give pure scientific opinions, not mixing them up with thoughts and things that are not part of their know-how.[14]

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[13] Scientist, interview by the author, October 2010.
[14] Endesa staff, interview by the author, May 2011.

Companies who have to do EIAs share this opinion. Denial of a problem scientists and many others recognize to exist, however, only accentuates the problem. Some scientists offered solutions: require that every scientist sign their work and make it public, in addition to sending it to the company and consultants, and improve contracts to recognize and manage questions of secrecy, independence and accountability. But these were isolated voices compared to the majority of scientists who draw a boundary between "technical" baselines and "political" impact evaluations to protect themselves from a threatening marketplace.

What makes the marketplace for baselines so threatening to scientists that they hedge their responsibility in these ways? On the one hand there are formal conventions that exist in other countries that are not used in Chile. This includes greater contractual protections for scientific autonomy, as well as simple things like publishing authorship. The EIA currently erases authorship by listing participating scientists in the appendix, a practice that facilitates unaccountable science like that described above. The absence of these conventions points to prevalent misconceptions of science. Endesa and other companies, for example, would never understand why scientists say that "the wife of the Cesar must be chaste and pure and also appear to be so".[15]

The threats also speak to scientists' vulnerability. Scientists want funding and access to data, nature and equipment. Given low levels of funding for science, together with a high rate of privatization of resources, scientists can only access these things through companies. Research funding is so scarce that "the river with the most biodiversity in Chile is always the most recent river to be studied, and this is the next one slated for dam-construction," according to a hydrologist. EIA baseline contracts - from any company - present a type of Faustian bargain for Chilean scientists: work on baselines for funding and access to hard-to-obtain data, in exchange for loosing control over the results. This poses a personal ethical dilemma each scientist resolves alone with his or her own conscience. Added to a context where accountability in general is weak, and where scientists do not occupy positions of influence or power, the bargain seems manageable and low-stakes from an individual's point of view.

Finally, the threats stem from the nature of accountability and baselines in the EIA process itself. Baselines are seen as highly technical - because they are scientific, a "photo" or "inventory" - at the same time that they can not be regulated. Rules and regulations will never be enough to specify and account for every aspect of where, how and why to register any possible landscape that may receive any possible future project. In other words, from an evaluator's perspective, there is no quality roof. What is acceptable needs to be renegotiated for each project. In contrast, every other aspect of the EIA is regulated: environmental impacts, compensation and mitigation measures, what projects to review, and when to grant or deny a permit are all specified by rules and regulations. In a highly legalistic culture, baselines afford rare degrees of freedom that reviewers can use to try to protect the public interest beyond the limited reach of environmental rules.

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[15] In Spanish, "*La mujer del Cesar no solo tiene que ser casta y pura sino que tambien tiene que parecerlo*". This adage was often expressed by scientists worried about these issues.

For all these reasons, these practices are common far beyond HidroAysén's EIA and some scientists have said "never again" to the EIA. They criticize their colleagues who "wash their hands" of the poor quality of many baselines, and called baselines a *cahuín*, Chilean slang for a sham or charade; a "random pile of data"; not fit to publish, because "baselines produce data, but not information"; or simply, "baselines are not science". When I asked about doing a baseline without knowing where the dam would go, several said it was "stupid" to believe you could produce "a good baseline without knowing where the dams would go". Outside of academia critics also exist. A consultant explained scientists do this "because Chilean universities have no prestige to protect", while others simply shrugged that "Chilean scientists are desperate to do anything", so dire is their funding situation. As these practices persist, the credibility and prestige of Chilean science is eroded further among the public.

The market for baselines: pushing out local experts at CIEP

Baselines, as the previous sections argue, have a politics and a market that are threatening to science. For example, Center for Research on Patagonian Ecosystems (CIEP, or *Centro de Investigación en Ecosistemas de la Patagonia*) was hired by Endesa to do HidroAysén's baselines but forced to rescind the contract due to a "conflict of interest". This represents a general loss: local scientists have a vested interest in the long-term quality of the data and the dams, as they will live with the consequences. Their local experience and outlook should make them sensitive to local realities that may be overlooked by those unfamiliar or unattached to the region. Finally, the only scientists who live and work in Aysén all year lost the opportunity to gain amazing experience in their own backyard, which they would likely use to inform new research and better understand Patagonia's ecosystems. For CIEP to do HidroAysén's baseline seemed like a perfect collaboration.

In practice, however, CIEP's status as "local experts" was too tenuous. Far from bringing prestige, HidroAysén risked undermining the nascent scientific group. CIEP was created in 2005 to kick-start science in Chile's regions, outside the capital. With public and private funding, CIEP was the first permanent scientific presence in Aysén. The regional government of Aysén provides 24% of CIEP's funding and the rest is roughly equally distributed between different sources.[16] Like its cousin institution in La Serena, the Center for the Study of Arid Zones (CEAZA, chapter 5), CIEP is part of a new push to connect science and innovation to development goals. As a result, its expertise in productive areas like salmon and tourism has grown faster than in ecology. Five years after opening, only one hydrologist, one glaciologist and two forest ecologists had been hired. CIEP's team is young, academic and international - PhD scientists have come from the United States, Japan, Argentina and France, and many of the Chilean scientists trained abroad (CEAZA's experience is very similar). Researchers are humble about "being local"; this is a status they have yet to gain.

[16] Concicyt (May 2010), Evaluation of CIEP.

The opportunity to lead the largest data collection effort Aysén has ever seen might appear like an excellent opportunity to become more local. However, the contract with Endesa was cancelled because:

> The Regional Governor chairs the CIEP. Therefore, strictly speaking, the CIEP could not participate in HidroAysén's EIA because the Governor also chairs the committee that votes on the project. So it couldn't be seen as a technical, scientific group.[17]

Arguing they wanted to use CIEP as advisors to review the EIA, the regional government objected to CIEP doing the baselines. If CIEP did both - collect the baseline data and then review the EIA - it would have a conflict of interest because it would be reluctant to criticize its own work. The regional government, however, never called on CIEP for advice. "The government has no interest in knowing things that may raise questions about some projects," as a government evaluator said. Like in the controversies over paper and pulp pollution at Valdivia or the moving of glaciers at Pascua Lama, different arms of the Chilean government (e.g., agencies, regional governments, central government) often do not call on scientists for advice.

In the meantime, CIEP organized a public workshop in Aysén to present the baseline results. Endesa co-sponsored the event.[18] Environmental NGOs quickly criticized CIEP's participation: "it is delicate and somewhat reckless that the CIEP appear as a participant in HidroAysén's information dissemination campaign."[19] Peter Hartmann, who directed the local campaign against the dams, argued:

> CIEP was created to be at the service of scientific knowledge in our region, and today we see how this original idea is being corrupted as CIEP is giving its support and image to research for a project that still has not been subject to environmental evaluation. It would be interesting to know what the other organizations that participate in CIEP think of this turn of events, including the Regional Government and the universities Austral of Chile, Montana, Siena [Italy] and Conicyt [state science agency].[20]

Hartmann's argument reflects Bozeman's definition of "publicness", where organizations are "public" if they receive even one cent of public funding (Bozeman 1987). In Chile this is true of "privateness", and produces ambivalent and contradictory expectations. Hartmann concluded: "It is not healthy for part of the State's resources go to promotional activities for projects that the State itself has to evaluate".[21]

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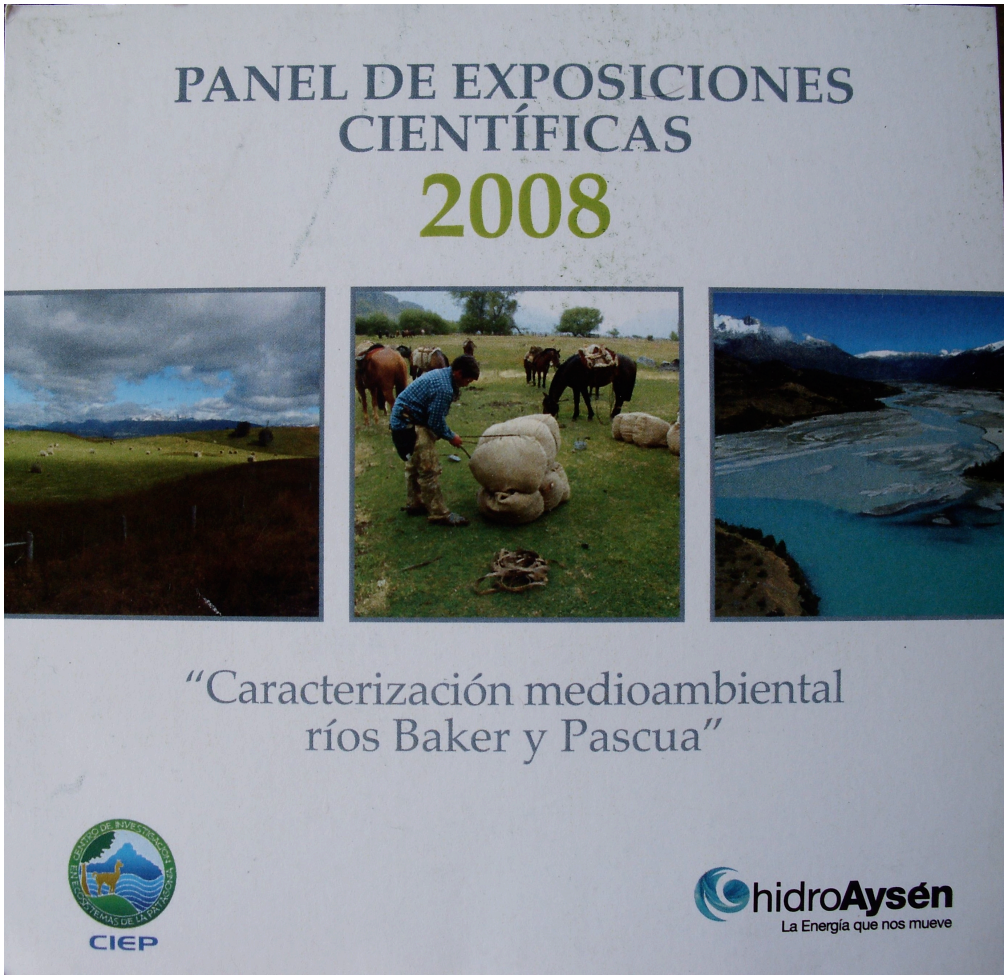
[17] CIEP Scientist, interview by the author, March 2011.
[18] *El Divisadero,* 12 January 2008.
[19] *El Divisadero,* 15 January 2008.
[20] Ibid.
[21] Ibid.

Figure 2. Brochure advertising the co-sponsored CIEP-HidroAysén event



CIEP replied the next day with a linear view of science. CIEP's then Director, Eduardo Vera, argued that CIEP's participation was ideal because they are local experts and that once the science is out anyone can assess its value:

> Vera emphasized that baselines are based on validated scientific methods validated to establish beyond doubt the current inventory of flora and fauna existing today in the Baker river and its surroundings, as well as the status quo of the waters, river banks, channel and atmosphere of this beloved river and its surroundings. If the execution of these studies has been given to CIEP and/or the universities associated to the Center, this is ideal, because it implies that these baselines have been undertaken by excellent and virtuous scientists, who provide a guarantee that the data they submit to the environmental authorities are fully trustworthy.

> [Vera] also stated that to suppose spurious partnerships between CIEP and any company goes against the prestige, nobility and integrity of the institutions and scientists part of CIEP. To insinuate that CIEP is an ally of HidroAysén's corporate interests for the mere act of attending a seminar, to receive, present and discuss scientifically obtained data that the informed community will be able to freely deliberate, is like presuming that the political authorities should receive and participate only in events organized by persons from the [ruling party], or be subject to the accusation of being [opposition party].... What the interested community should observe is what representatives from CIEP present and subscribe to, so as to comment on what companies and the authorities should resolve to do or not do based on [CIEP's] research; thus judging in this way those who make decisions based on scientific data, but not politically admonishing those who have scientifically obtained that data.[22]

Vera's response is representative of a tone and type of argument commonly used to defend science in Chile. Using a pompous and dismissive tone, he defends a role for science that it has never played in Chilean politics, as the three cases in this dissertation attest to.[23] He also does not address Hartmann's argument. Hartmann questioned the use of public funds to promote a private interest, but Vera is concerned with freedom of association.

This kind of dispute will be familiar to many who work in Chilean science and politics. While Hartmann blurs public and private boundaries, projecting a common political-scientific front, Vera keeps these distinctly separate, following a "speak truth to power" tradition. Interestingly, the foreign comes in not through the government or the scientists - Vera does not appeal to the foreign for legitimacy. Rather it is through the NGOs, in this case, Hartmann. While often it is scientific facts that need to be embedded in a global network of allies to be credible, in this case it is the whole scientific institution that needs to be so embedded to have public credibility.[24]

CIEP's foiled participation in HidroAysén's EIA was the subject of intense speculation. Rumors abounded: some thought Endesa hired CIEP's parent universities (Austral and Concepción) to have similar control over data collection; others thought that CIEP was like a consulting firm desperate for funding; and others saw CIEP as prey to conflicts of interest because "it is forced to compete with universities for public funds". When pressed, many could not explain why exactly public funding produced a conflict of interest. Those who could explain pointed to the untrustworthiness of the government: because the government is a political institution (as opposed to the technical state agencies), it would necessarily undermine science. These opinions also blur public and

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[22] *El Divisadero,* 16 January 2008.
[23] In Spanish expressions and words like "en aras", "mero hecho", "probidad" are pompous, and "insinuar", "debiera hacer" are dismissive.
[24] The intended contrast here is with Latour's description of the credibility economy of facts (Latour 1979). See also Anderson (2008), who describes a similar phenomenon with evidence and how this transformed outsider "kuru scientists" into "white men" with power at the U.S. National Institutes of Health.

private boundaries and ignore the original dilemma - how to connect the government to quality and credible experts. Finally, for CIEP, it too came out weakened from the episode. No one thought it was a testament to its integrity that they pulled out of the contract with HidroAysén. In this sense, CIEP's experience speaks to the vulnerability of scientists given Chile's conventions around scientific participation in public spaces.

III. Illegibility

HidroAysén's EIA was the most ambitious in Chile's history in one of Chile's least documented regions. It pushed against "the limits of the knowable" according to many participants and observers, and left few satisfied despite the enormous efforts and expenses. Large parts of the EIA were literally and metaphorically illegible, as described in the first part of this section, due to an over-reliance on acrobat reader and an under-reliance on meteorological stations. Illegibility is pushed further as information is lost between the original and edited baseline reports. Original baselines are prepared by scientists, and edited baselines are prepared by consultants. Original baselines consist of ten volumes that occupy an entire shelf and are available only on paper in HidroAysén's open houses in Coyhaique and Cochrane.[25] Edited baselines are published online in the EIA report, with impact evaluations and compensation measures.

Nearly everyone says "baselines are public" and that the EIA "makes data public". But this is only partially true, as this section documents. Original baselines are in practice inaccessible and a lot of data remains within Endesa's private property, released only partially and after petition by the state. Actors in the state, science, Endesa and NGOs frequently confused the public and the private, increasing a sense of chaos and further reducing the state's potential control. Furthermore, it is in the impact evaluation - a very private part of the EIA process - that nature is transformed into a manageable entity. Through the EIA's impact-ranking methods, changes to the landscape and losses in flora and fauna rose to the top in political importance, while changes to the river and water systems sunk the middle or bottom. Even when something officially important like reforestation was challenged, environmental harms from things like pesticides were less important than economic arguments about cost.

[25] When I asked the baselines were not available in Endesa's offices in Santiago.

Map 2. HidroAysén's Area of Impacts for the EIA.
Source: HidroAysén EIA (2008)

Fuente: Elaboración propia.

Literally, its illegible

The EIA contained many illegible documents and errors. Maps were submitted as acrobat reader (pdf) documents with poor on-paper and on-screen resolution. Maps were too zoomed out to make the important elements visible. Pdf documents could not be searched and were too large. Only paid versions of acrobat can fix this problem, and Endesa supplied ArcView reader to government offices to view the corrected maps. My computer regularly over-heated and stalled trying to handle HidroAysén's EIA documents.

This was all a misunderstanding, according to staff Endesa and its consulting office. They thought everything had be submitted in the same format. State reviewers

lost weeks of work, when they have only 60 days to review the EIA, and dedicated much of their attention in the first evaluation to asking for new, legible maps. It was a costly misunderstanding for the state.[26] Even the public participation process was, in some sense, wasted time because of illegibility. One participant observed: "The graphic description of the drawings and maps needs to be improved because they are illegible. They have no legend, and no references to areas or places to identify where along the Baker or Pascua river they are referring to, for example. If the intent is to do a public participation process, at a minimum there should be an effort to make the graphic material easily readable and legible to the people."[27] Every document is online but accessible only to those with good computers and a strong will. This is how many Chileans experience transparency.

Illegibility due to poorly constructed pdf documents became mixed up with discrepancies about content, as these three quotes from the public participation portion of HidroAysén's EIA show. The sense that the EIA was literally illegible and wasted citizens' and reviewers time eroded public credibility and the meaning of transparency.

> The documents mention a specific report about the *Guaitecas* Cypress tree. Despite many attempts to find this report, this was absolutely impossible…It literally says "the *Guaitecas* cypress is not a very abundant tree in the area of study…". However, figure 5.24 of the same document (Distribution of forest types, page 95), it is clear to anyone that forests of *Guaitecas* cypress are by far the most important in the entire basin.... Clearly, there is an attempt to 'lower the profile' of the amount of cypress that will be impacted within the areas of impact.[28]

> There is no attempt to verify if the GPS coastal data contains errors or not. The best I have seen in geo-referenced data is 20 meters [*sic*]. I was not able to identify in any part of the report any attempt to validate the information or correct errors.[29]

> Amphibians: The reports indicate a low diversity and abundance due to the cold climate (sampling was done in May and August with snow and cold), and in addition they measured in the incorrect places. Seventeen species are present in the region, of which 13 are threatened and one is in danger [of extinction]. They found four species: Bufo variegatus, Butrachyla aff. Nibaldo (endemic, low population density), Eupsophus aff. colcaratus (endemic), Pleurodema bufoni (insufficiently known). The report says and recognizes that there must be more species than they found in

[26] Business criticizes the EIA for being slow but always fail to mention how businesses, by submitting bad EIAs like this, contribute to this.
[27] HidroAysén Environmental Permit (May 2011): 777. The government also produces unmanageable pdf documents. The permit is 2,000 pages long and my computer over-heats and slows when viewing it.
[28] HidroAysén Environmental Permit (May 2011): 1233.
[29] HidroAysén Environmental Permit (May 2011): 1415.

> the area of study. Both the results and their declarations in the study are evidence that the quality of the results is irregular, inconsistent and frankly induces to error.[30]

Guesstimating climate data

Aysén is known for its weather: cold, rainy, snowy, windy. Across Chile these conditions makes Aysén "inhospitable", yet we know remarkably little about how these conditions compare to other places.[31] No studies exist of Aysén's famous winds and all forty weather stations in the region are located below 800 meters above sea level. Three state organizations manage the stations, resulting in incompatible trend data. Data is collected by hand in old stations and online, every hour, in new ones. These online meters were placed where they can be toppled by the wind, according to a glaciologist who uses this data. Rain and snow fall may be underestimated by as much as half, he says.

Scientists from the University of Chile used this data to prepare HidroAysén's climate baseline. As a result, they emphasize that the statistics are "not robust" and "should be used with caution". This report is Endesa's private property and they make it available as they like.[32]

The EIA, prepared by consultants, is available online. This report obscures the sparseness of the data. It never clarifies for the reader that all stations are below 800 meters. Only the attentive reader will notice that data graphs do not report any weather stations over 800 meters. The analysis is necessarily based on assumptions and simplifications.[33] Temperature, humidity, winds and snowfall are essentially unknown for the Baker river. Each instance of illegibility increases uncertainties in predicted impacts on air quality, waves in the new reservoir, risks of flooding, and others. When data quality was questioned, Endesa replied with a categorization that conflated quality with quantity. If more than 25% of data was missing, it was "bad quality". Quality in relation to errors, estimates, representativity or robustness, as the University of Chile scientists pointed out, are skirted.

Data quality also gets conflated with questions of origin: is the data public or private? In the 1950s and 1960s the Chilean government invested in producing public statistics, as part of a state-led development regime (Medina, 2011). This is reflected in Aysén; a remote region with large amounts of state-owned land, Aysén was particularly susceptible to the state's statistical gaze. This is reflected in the bibliography of the climate section. About half the references were published before or shortly after the

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[30] HidroAysén Environmental Permit (May 2011): 1452.

[31] My first day back in Santiago after six weeks in Aysén, an environmental activist greeted me with a characteristically Chilean question: *"¿súper inhóspito, no?"*.

[32] It was available at Endesa's open house in Cochrane.

[33] For example: snow was estimated from the co-occurrence of precipitation and below zero temperatures, where temperature at high altitudes was estimated from weather stations in cities as far as Puerto Montt and Punta Arenas. Data from stations in Argentina was also used. How quickly the temperature falls above 800 meters was subject to debate. Wind data from two stations not particularly close the dam sites were used to impute west-to-east winds for the whole region, etc.

transition to democracy (Table 2; references #1 - #9/#10). The state played a large role in industrialization and this is reflected in the studies it authored, like the one about winds to estimate the potential for electricity generation (#9).

Bibliographic references change after the transition to democracy. Foreign references increase and Chilean ones decrease. State-authored studies fall, and scientific research increases. Descriptive, text-book titles like "Bioclimate of Chile" (1976) are replaced by specific studies like "Meteorological and climatological aspects of the Southern Patagonia Ice Fields" (2002). In the 1990s, consultant's reports also increase pointing to how self-referential a lot of EIA consultant science is. Overall, the character of the data owned by the state shifted enormously. Whereas in the 1960s the state had data to build dams itself, today the Water Agency's data is "only useful for granting water rights, but not for studying river ecology", as a former employee said.[34]

State-owned data has fallen because the state stopped producing data and because state-owned data was privatized. In the 1970s state-owned Endesa studied the Baker river and developed the original HidroAysén project. As a result, the Baker has "the best streamflow data series in the country". This mantra however did not stand up to closer inspection: today the series is incomplete and largely private. Data reflect some years (1963-1990; 1975-2003) and places within the river, and only flow, not water quality. When Endesa was privatized in 1989, the data series was privatized with it. The raw data series was not published in the EIA reports. Only weekly averages were published with a bibliographic citation to an unpublished report by Ingendesa[35]. Nonetheless, many of those who worked with this data claimed it "was made public through the EIA" and only when questioned recognized this was only partially true. Without raw data, they could not replicate Endesa's analysis. Those opposed to HidroAysén and distrustful of the entire EIA process were under no confusion; they saw the privatization of data as an impediment to contesting the project.

As state-owned data has fallen, EIA estimates rely on unpublished, privately-owned data.[36] The Water Agency complained estimated climate changes, calculated from data from stations owned by Endesa, were based on insufficient sampling and from the wrong places, and asked Endesa to release the raw data and locations of their stations. They asked Endesa to justify why they preferred their own data to that available from nearby public stations. The Water Agency was tacitly questioning the credibility of private data and trying to gain access to it, while Endesa tried to protect its property until they acquiesced. They justified the release of data in terms of credibility: "only to demonstrate that we proceed with the utmost caution in interpreting the data…"[37]

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[34] Arguably, the state does not do this very well either, because in many rivers more rights have been awarded than there is water in the river.
[35] HidroAysén EIA (2008), Annex D, Appendix 4: bibliography, 61.
[36] HidroAysén EIA (2008), Chapter 4: 33. Winds were measured once and from far-away; they reported 72 kilometer per hour winds by the Baker river but the measurement was from near Cochrane, several kilometers and hills away. Endesa did not reveal where its water stations were along the Baker river.
[37] HidroAysén Second Addenda (2010): 772.

Table 3. Summary of Bibliography to Climate section of EIA Source: HidroAysén EIA (2008), Chapter 4: 44-46; and Second Addenda (2010): 755

#	Year	Author	Chilean?	Type of text
1	1971	Scientists	Yes	Textbook type
2	1971	State Development Agency (Corfo)	Yes	State statistics
3	1976	Scientists	Yes	Textbook type
4	1976	Scientists	Yes	Textbook type
5	1979	State Development Agency (Corfo)	Yes	State production
6	1982	Scientists	Yes	Textbook type
7	1985	Military	Yes	Military information
8	1989	Geography textbook	No	
9	1993	State Development Agency (Corfo)	Yes	State production
10	1994	Climate impact of dams	No	
11	1995	Climate impact of dams	No	
12	1996	Climate statistics	No	
13	1998	Ingendesa	Yes	Consultants
14	1998	Climate on Ice Fields	Yes	Science
15	1999	Climate Textbook	?	
16	2001	Meteorological Center	Yes	State statistics
17	2001	Climate science	No	
18	2002	Climate on Ice Fields	Yes	Science
19	2004	Precipitation variation (thesis)	Yes	Science
20	2007	U. Chile (baselines)	Yes	Consultants
21	2007	Consultant	Yes	Consultants

As state resources for data production have fallen, state agencies further privatize data by requesting companies to fill the gap. In response to the Water Agency's requests, Endesa installed new snow meters and released the data but denied a request to study the Patagonian ice fields and inventory glaciers in the area. The Agency needed the inventory for the new national glacier inventory, but in a region

full of glaciers had no funding to inventory them all (chapter 5). The inventory was a real bargaining chip between the Agency and Endesa, until Endesa's view - this is the state's responsibility - prevailed.[38]

A staff at Endesa called this a "philosophical problem": which responsibilities belong to the state and which to Endesa? Endesa did not want to undertake investments in science and infrastructure (e.g., road paving) they thought are the state's responsibility. From the perspective of state agencies, this was an opportunity to overcome their scarce resources and experience. They did not, however, seem to consider long-term consequences like how credible an Endesa-funded glacier inventory would be in the public sphere.

Finally, the state also blurs public and private distinctions, including property. Here, in response to a public comment, the EIA Agency confuses public and private property and what this means for data access:

> The information about meteorological stations used in the EIA are found in publicly available publications, available in offices of different Ministries, Research Centers and Institutes of Higher Education. Furthermore, this information is protected by intellectual property rights, so the company is not allowed to distribute it on paper or digitally. They can only make references to it.[39]

Evaluating impacts on the Baker river

Impact evaluation translates nature into decision-making priorities. Evidence of the "strategic" component of impact evaluation is that one of HidroAysén's most significant impacts - the loss of habitat to the reservoirs - is also one of its strengths - because the reservoirs are small relative to the amount of electricity generated, making it a very efficient project according to its supporters.[40] Development goals are also expected "positive impacts": twelve positive impacts relate to jobs, commerce, improved climate, and new habitats and lakes for tourism. To many who opposed the dams, several of these were offensive. In a region full of stunning lakes, two new lakes hardly seem necessary. Where climate change threatens the region's glaciers, a warmer climate hardly seems an improvement to quality of life.

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[38] A similar dispute occurred over estimates of sediment accumulation. The Water Agency requested field measurements that Endesa argued were impossible to collect, given the strength of the current in the Baker river. Though several of Chile's top hydrologists were involved, the dispute was finally arbitrated by foreign scientists. The Water Agency brought one U.S. expert who said field data could be collected, and Endesa brought several who said it could not.

[39] HidroAysén Environmental Permit (2011): 1364.

[40] Negative impacts include: changes to surface runoff water, impacts on downstream habitat (these two are the only related to the Baker), a smaller cluster of significant negative impacts have to do with downstream effects, e.g., loss of habitat, barrier effects caused by the dams that will impact fish species, etc. The rest are a heterogeneous list: loss of areas of scientific interest, loss of landscapes important for tourism, changes in soil erosion and water run-off patterns, and social impacts from the arrival of workers from other regions.

The "modified Leopold matrix" used to rank-order impacts privileges conservation of flora and fauna that are rare, important and well conserved, and space-effects of impacts over time-impacts (table 4).[41] One third of HidroAysén's most significant impacts relate to losses of flora, fauna and habitat, while nearly all impacts on the Baker river (hydrology, water quality, hydrogeology or oceanography) are classed as of medium or mild importance.[42] HidroAysén's dams, like most in Chile, will operate with hydro-peaking, which "produces summer and winter conditions every day, twice a day. This produces total confusion to animal and plant species that depend on the river", as explained by a consultant who produced these numbers. Hydro-peaking maximizes profits by holding water during hours of low electricity consumption and releasing it during hours of high consumption. Every eight hours, Baker 1 will fluctuate from 927 to 280 cubic meters of released water and Baker 2 will fluctuate from 1275 to 380.

How impacts are constructed from baselines is illustrated with examples from hydro-peaking. This example was chosen because of its importance and because the baseline information was prepared by consulting firm CEA, which strives to protect the integrity of its work. CEA sends their reports directly to the state agencies to avoid any manipulation of the results during the EIA process, and only work if they have direct access to the company's decision-makers who are more likely to see the "bigger picture" and be willing to invest in the environment than middle level managers, according to a CEA consultant.

Table 4. Construction of "modified Leopold Matrix" in EIA
Scale is 0 -100 = (Importance)*(Magnitude)*(Nature)

	Scale	Definition	Who defines it
Nature	+ or -	Is it a positive or negative impact?	Unclear
Importance	0-10	Privileges rare elements, relevant to others in nature and in a good state of preservation. Privileges the conservation of fauna and flora, more than habitat or water.	"Expert opinion"
Magnitude	0-10	Probability of the impact occurring multiplied by the sum of how extensive, intense, reversible and long it will be. Privileges space (extensiveness, intenseness) over time (reversibility, long).	"Expert opinion"

According to CEA's baseline report, hydro-peaking will vary the Baker river's level between one and three meters twice a day, continuously exposing and inundating areas along the river banks, producing erosion and habitat destruction and making navigation

[41] The Leopold matrix was developed in 1971 by the U.S. Geological Society. The Chilean EIA regularly talks of a "modified" matrix, but I haven't been able to find what "modified" means.
[42] The Leopold matrix ranks impacts of mild (21-40), medium (41-60) and high (61-100) importance.

more difficult, all the way to the mouth of the river.[43] They urge security measures to keep locals informed and avoid boating accidents.

What happens to all these risks when they are translated through the Leopold matrix? First, risks from hydro-peaking assume a generic title: "changes to the water flow regime" and are classed as "mild" (40 or below) or "medium" (41 plus) (figure 3). Second, risks are also broken down into multiple categories. For example, impacts to fish are disaggregated into hydro-peaking impacts on native fish, impacts on fish from dams acting as a barrier, and on habitats. Impacts on native fish are mild because there are few native fish. As impacts are broken down, each one becomes less important.

Figure 3. Hydro-peaking impacts: "Changes to the Water Flow Regime" HidroAysén EIA (2008), Chapter 5: 209.

Cuadro 5.3.5-9: Impacto MF-HID-OPE-O2 - Alteración del régimen de caudales

Origen y características de los impactos				Valoración impactos (*)								
				Indicadores								Valor
Instalaciones asociadas	Obra o faena	Lugar del impacto	Período del impacto	C	P	E	I	D	R	M	VA	IT
Centrales hidroeléctricas												
Central Baker 1	Sector de presa	Desde zona de restitución de caudales hasta el punto donde ingresan los caudales del río Cochrane y Del Salto.	Desde el 2° Trimestre año 6	-	0,7	0	1	2	1	2,8	9	-25
Central Pascua 2.2	Sector de presa	Desde el pie de muro y/o zona de restitución de caudales por un tramo de aproximadamente 6,5 km., o hasta la confluencia con el desagüe lago Quetru.	Desde 2° Trimestre año 7	-	0,8	0	1	2	2	4,8	8	-38
Central Pascua 2.1	Sector de presa	Zona de embalse asociada a Pascua 2.2	Desde 2° Trimestre año 9	-	1,0	0	2	2	2	6,0	7	-42
Central Pascua 1	Sector de presa	Desde zona de restitución de caudales hasta el comienzo de la cola del embalse de Pascua 2.1.	Desde 2° Trimestre año 11	-	1,0	0	1	2	2	5,0	7	-35
Central Baker 2	Sector de presa	Desde la zona de restitución hasta la junta con el río Ventisquero.	Desde el 3er Trimestre año 12	-	0,9	1	1	2	2	5,4	9	-49

(*) Carácter (C): +/-; Probabilidad (P): 0-1; Extensión (E): 0-2; Intensidad (I): 0-3; Duración (D): 0-2; Reversibilidad (R): 0-2; Magnitud (M): 0-10; Relevancia componente (VA): 0-10; Impacto Total (IT): 0 +/-100.

Risks to navigability are also "mildly significant" (figure 4). Only risks from two of the five dams are assessed. Navigation impacts are considered to not be extensive (score 0), although everyone that needs to or wants to navigate would be affected. Interruptions to navigability caused by the Baker 1 dam are just one point more relevant than interruptions caused by the Pascua 2.2 dam because many more people will be affected by the Baker than the Pascua dams. "Many more" people here refers to orders of magnitude more, taking residents and tourists into account. Neither score is really justified nor is a method for assigning these values specified.

Hydrology impact evaluations also contained a major error in the formula - it was missing one point. Compared to the general formula, reversibility lost a point (from 3 to 2) so the scale for hydrology impacts is 0-90, not 0-100 (figure 3). This is not the only error; the formula in the introduction is not the one used to evaluate most impacts. Reversibility gains a point and extension looses one without explanation.

For a number of reasons, impact evaluation privileges losses to flora, fauna and habitat to impacts suffered by the rivers. The reasons range from the values embedded

[43] HidroAysén EIA (2008), Annex D, Appendix 4.

in the Leopold matrix, where space is privileged to time, as well as to errors in the process (e.g., loosing a whole point to supposed carelessness) and to breaking impacts into multiple constituent parts. Just one page is dedicated to evaluating synergistic or cumulative impacts. This all points to the "strategic" character of impact evaluations. To focus on fish again - impact evaluations obscure impacts on native fish because these are few, and highlight impacts on habitat because the losses here are supposedly off-set by the technical feat of these very efficient dams (measured as a high ratio of energy to reservoir size).[44] This analysis resonates with other findings that the Chilean EIA under-values impacts on human uses of rivers (Prieto & Bauer, 2012).

Figure 4. Navigability Impacts
HidroAysén EIA (2008), Chapter 5: 989.

Cuadro 5.5.2-28 : Impacto MH-DGE-OPE-01: Alteración de prácticas de navegación en los ríos Baker y Pascua por variación de caudal durante la operación de las centrales

Origen y características de los impactos					Valoración impactos (*)								
Instalaciones asociadas	Obra o faena	Actividades	Lugar del impacto	Período del impacto	Indicadores								Valor
					C	P	E	I	D	R	M	VA	IT
Centrales hidroeléctricas													
Central Baker 1	Sector de Presa	Regulación de Caudal	Prácticas de Navegación en Río Baker. Sector Baker 1	1° trimestre año 6 en adelante	-1	0,9	0	2	2	2	6	7	-37,8
Central Pascua 2.2	Sector de Presa	Regulación de Caudal	Prácticas de Navegación en Río Pascua. Sector Pascua 2.2	4° trimestre año 6 en adelante	-1	0,9	0	2	2	2	6	6	-27

(*) Carácter (C): +/-; Probabilidad (P): 0-1; Extensión (E): 0-2; Intensidad (I): 0-3; Duración (D): 0-2; Reversibilidad (R): 0-3; Magnitud (M): 0-10; Relevancia componente (VA): 0-10; Impacto Total (IT): 0+/-100

An episode that says it all: contesting reforestation in Aysén

One episode above all others speaks to the themes discussed so far: the dispute over how to compensate the loss of native forests. Scientists, Endesa and the Forest Agency had different ideas of science and expectations of what it can do in environmental management. Baseline forest data was collected by the country's most prestigious forest ecologists, but impact evaluations and compensation (e.g., the reforestation plan) were done by unnamed consultants. Public scientists produced private baseline data, while private consultants produced public EIA data. Throughout, the public and private are confused in ways that undermined the credibility of science to speak to environmental policies.

To compensate the loss of habitat, HidroAysén proposed to forest 11,000 hectares with native plants, as required by Chilean law.[45] The largest reforestation

[44] I was told a native species of fish was discovered during baseline research, and this motivated HidroAysén's CEO to raise the Baker's minimum water flow by a factor of four. I could not corroborate this in interviews with consultants or Endesa staff or in the EIA documents, pointing to another possible "gap" between scientists expectations and the realities of EIA approval.
[45] Article 102 of the EIA's Rules and Regulations (Decree 95).

project ever imagined in Chile, it came under criticism by two forest ecologists at CIEP. They argued the reforestation plan relied on outdated plans from regions with warmer climates. The plan recommended excessive use of pesticides and would "reforest" wetlands and steppes that had never had forests. "If the reforestation plan contains so many errors and is fundamentally a lie, how can we trust the rest of the project?", they argued. Thriving native forests would not fill Aysén's landscape as HidroAysén promised.

This was a rare case of outspoken critical scientists. They overcame the "strong pressure to not speak up" because of their personal conviction and professional good luck: their research is sufficiently low-cost that they do not risk loosing future funding if they become "tainted" for opposing HidroAysén. They also looked after their scientific credentials by speaking up in scientific journals (including *Science* (23 July 2010: 384) and *Frontiers in Ecology,* (March 2011, vol. 9, issue 2)). Foreign academic journals, of course, would not reach decision-makers in Chile, so they prepared a memo to circulate locally. CIEP's director handed the memo in hand to the regional governor, who never called CIEP for a formal advisory opinion. Local radio, however, did call them for interviews.

HidroAysén's staff in Aysén heard the radio reports and decided to "rise to the challenge". The scientists' criticisms were "defeatist", they thought. "Just because something has never been attempted does not mean it will fail" and to think like this "is to oppose progress". They undertook a reforestation "experiment" on 30 acres by the Pascua river. A year later the Forest Agency certified over 90% of trees were "reforested and growing." Pleased with the results, they published them in "academic journals". A two-page article appeared in three industry magazines: *Lignum* (01/26/11); *Buscagro* (no date); and the magazine of Uruguay's forestry industry association (02/01/11).

Staff that oversee EIA evaluations at the Forest Agency were sympathetic to the scientists' criticisms but unable to react. According to the Forest Agency staff, the rules say companies must reforest "similar soils" to those impacted, and the Agency's forest engineers can not interpret this ambiguous phrase as they see fit.[46] The Agency can only check up to one year later to certify the new trees as "reforested and growing".[47]

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[46] It was difficult to find the exact legal requirement and it is possible it does not exist. The rules and regulations of the EIA (D.S. 95, art. 102) require a "permit to cut or use native forests" and that the EIA must, in this case, "consider" reforesting an area at least the same size as that cut down. It refers the read to Decreto Ley No. 701 of 1974 (art. 21) for more information, but this law was replaced in 2008 and I could not find the relevant article in the new law.
The Forest Agency's impact evaluation guidelines provide more detailed information on how to issue this permit. The company must submit to the Forest Agency a "management plant" with information about the reforestation plan (D.S. No. 93 of 2008, art. 19 letter g); which should use the same type of forest (defined in Law 20.281, art. 2, number 26, and in D.S. No. 93); and "similar soils" (page 53 of guidelines). However, the "similar soils" "requirement" is not followed up with a legal citation and is not mentioned again in the guidelines. This raises multiple possibilities, from capture and corruption to a strategy of 'hiding' behind rules to manage workloads, to almost anything else. It is interesting however that despite the press coverage this issue got and its importance of Aysén no one challenged the "similar soils" requirement.

[47] HidroAysén has said it will monitor the new forests for 20 years. This is a voluntary measure.

Whatever limits the law imposes on the Agency's power, forest engineers supplement their weakness by focusing blame on "stingy" companies that do the minimum possible.

Could science, like that by CIEP, help the Agency have stronger arguments to impose higher reforestation standards? It was doubtful the Agency staff said, because "No one can say right now how the reforestation plan should be done, with what methods, trees, management protocols, etc. There is no experience with this…No one can say what is best…The companies have to do 'trial and error' to produce this information… Without experience, there is no evaluation." Furthermore, CIEP "is not a government entity, it relies on external funding" and participated "in some way" in the baseline studies. CIEP is actually a public institute and was forced out of the baseline studies so it could participate in the review process. Agency staff misunderstood CIEP's story completely although a CIEP mug sat on the desk in front of us.

This episode illustrates different ideas of what science is. What to HidroAysén was an "experiment", to the Forest Agency was a "legal requirement" and to scientists an "experience".[48] HidroAysén's "scientific publications" did not meet any scientific conventions like peer review or a description of methods. Forest Agency staff failed to grasp the differences between HidroAysén's "trial and error" approach and the scientist's "experiments", expecting from science an unequivocal result rather than a systematic process from which lessons could be learned. The state again did not turn to science for help when it could have done so.

Public and private were again blurred to undermine credibility. Trust in CIEP was low among HidroAysén and the Forest Agency due to confusing misrepresentations of its status as a public institute with public and private funding. Likewise, the credibility of HidroAysén's "experiment" was low among the public because industrial interests executed the experiment.[49] "The best forestry nursery of the country" and "the best forest engineer of the region" participated in HidroAysén's experiment. These produced confidence for the company but not for the public. The nursery Mininco belongs to the same parent company as HidroAysén, so has an enormous vested interest in the reforestation contract. The unnamed forest engineer came from the National Forestry Institute that industrialized forestry in Chile.[50] Endesa withheld his name because "the company is responsible for the results". But again, erasing authorship breaks personal accountability.

Like weather, climate and maps, the reforestation plan was in parts illegible and suffered from lack of background data - there are very few documented experiences of reforesting with native trees, in addition to how little is known about Aysén's soils and climate. A rule-bounded approach dominated the Forest Agency's evaluation. They did not push the interpretation of "similar soils", but required Endesa to repeat several

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[48] HidroAysén had to reforest the 30 acres by the Pascua because they had impacted the area during exploratory work there.

[49] This is inferred from the popularity of the CIEP forest ecologists and patterns of suspicion in Chile. Most likely, those in favor of HidroAysén's dams will trust the "experiment" and those against the dams will not.

[50] Forest engineers, as a whole, are treated with some distrust by environmental activists. The Association for Forest Engineers for the Native Forest has been working for years to make forest engineers more ecological. See work by Jennifer Baca (forthcoming) and Antonio Lara.

studies of tree cover because the baseline methodology was not the one defined by law. The state never asked environmental questions about the effects of reforesting so much land with pesticides, in a region with very little industrial agriculture, or of land-use change as steppes become forested. Even the critical scientists who raised these issues emphasized the inefficiency of pesticides over ecological or environmental arguments. Environmental quality was conflated with quantity - the quality of reforestation mattered less than the 11,000 hectares to be covered.

IV. Standards of proof

Chile's EIA process strives to determine the "technical" opinion of state agencies with regards to a project. Agencies initially raised thousands of objections to HidroAysén. In the legal context of the EIA the question is: do the final documents prepared by the EIA Agency give credible and legitimate indication that the objections raised by the agencies have been adequately resolved? In short, they do not, and this undermines credibility in the EIA and its capacity to legitimate large projects like HidroAysén and respond to contemporary environmental demands. This section begins by reviewing some formal aspects of these final decision documents. Overall, they obscure the process: impacts are not prioritized, disputes are not represented and resolved, and improvements are not clearly identified. In part because it is so difficult to reconstruct the debates that occur within the EIA, as some scientists openly complained after HidroAysén was approved, representations of nature (and the local) are too weak to support a credible regulatory process. Calls to "technify" the EIA are really calls to change "representation" within the Chilean state.

Approving HidroAysén: impact evaluation comes to a formal end

After so many studies and thousands of pages, what were HidroAysén's most important impacts? It is hard to say. The EIA Agency's technical report does not synthesize much, though many accuse them of leaving important things out.[51] With one exception - hydro-peaking, mentioned by three hydrologists - respondents in government, business or science were not able to prioritize HidroAysén's impacts or even name the top three or the top five.[52] One former Conama employee answered that there was no information about HidroAysén he trusted. As a result, the Leopold matrix alone prioritizes impacts. The environmental permit reads like a seamless document of egalitarian impacts.

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[51] The Forest and Geology Agencies both accused their bosses in Santiago of leaving out reservations about the HidroAysén from the final round of comments. For example, HidroAysén will flood about a few square miles of Laguna San Rafael National Park. The final EIA document seems to say this may be illegal but it is not important.

[52] Frustrated by the lack of answers to what I thought was a straightforward question to anyone who'd been steeped in the project for years, I asked the same thing in different ways. Still there was no response.

Except for the thousands of pages of citizens' comments, discussed below, disputes or improvements are hard to identify in the permit. The Water Agency's concerns about climate warming and how this might affect glaciers were dropped and do not appear in the permit. Reforestation protocols in the permit do not reflect any part of the dispute between the CIEP scientists, the Forest Agency and the company. The protocols require pesticides and weed control and the bibliography includes sources identified as ill-suited to Aysén.[53] It does say reforestation must occur in every impacted ecosystem. This may be an attempt to control the meaning of "similar soils", but it is difficult to know.

Navigability is prominent in the permit, although it generated close to zero public discussion and had a rather low Leopold matrix score. The permit requires many measures to prevent accidents and new infrastructure to ensure navigability. Were these there from the beginning, or were safety measures expanded thanks to the EIA? Why were people whose livelihoods depend on the river so uninformed about these measures and efforts? There are no clear answers to either question. Water flow data for the Baker river was extensively debated, but the estimates were adjusted only slightly (table 5). In sum, the Agency's technical report nor the environmental permit synthesize the process, the debates that ensued or solutions proposed to solve the problems that arose. Neither prioritizes impacts.[54]

Table 5. Water flow data for Baker 1 and Baker 2 dams before and after evaluation

	Baker 1		Baker 2	
	Before	**After**	**Before**	**After**
Baseline water flow (annual average)	663	642	948	948
Recommended water flow for navigability	212/365	212/365	305	305
Minimum water flow (40% of annual average)	280	260	380	380

Source: Before data is from HidroAysén EIA (2008), Annex D Appendix 4, and Chapter 4. After data is from Environmental Permit (2011). There are two numbers for navigability for the Baker 1 because one is for small boats and the other for a large ferry that currently takes people, cars and animals across.

The voice of discord in the environmental permit comes from the public. Public participation took place in 2008 but citizens' comments were only answered at the end of the process in the environmental permit. Public comments are wide ranging, from

[53] Environmental Permit (2011): 303. The permit cites "Donoso 2006", this is a foundational work of Chilean forest ecology for forests north of the 42nd parallel, where its warmer and rainier in areas.
[54] Geisse (2006) echoes these complaints.

very detailed questions about impacts on someone's house to how the presence of flora or fauna was counted. Observations do not come easily to everyone. Many families living along the Baker river refused to submit questions about their land or access to it because they felt that "to ask a question is to protest". Among the many who did take the opportunity "to protest", comments challenge a technical idea of the EIA and demand that it take a political stance. Here are examples from three individuals:

> As it is implemented now, public participation tends to whitewash this unfair process and give the company free reign to act under a false appearance of legitimacy.
>
> What does Aysén really gain in the long term from this project?
>
> As a citizen and part of Chile and Aysén, I don't want this project to be built, I have no desire to see any impacts in one of the few places on earth where there still is a wild ecosystem. Enough of distorting sustainable development. HidroAysén will finish off one of the most pure identities of our nation.[55]

The EIA Agency often answers comments like these with a legal formula:

> This Commission takes these observations to not be open to consideration because they refer to elements alien to the environmental evaluation of this EIA, in conformity with the General Environmental Law.[56]

Citizens pose a political challenge and the EIA replies in technical-speak. To compare with the case of Pascua Lama (chapter 5), political challenges to that EIA led the environmental authorities to recognize glaciers as part of the community's natural patrimony and deserving of protection in the environmental permit. Five years later, in the name of the technical, the community's concerns about preserving nature and a rural way of life are dismissed as value judgements outside the state's area of concerns. Why then do environmentalists and activists call for more a technical decision-making process, when this is likely to push their concerns even further out of the EIA Agency's purview? The answers are complex and detailed below.

Protesting HidroAysén, the EIA and democracy

By May 2011 time was running out to finish HidroAysén's evaluation. In a televised debate, Daniel Fernández, Executive Vice-President of HidroAysén, and Patricio Rodrigo, director of the opposition organization *Patagonia Sin Represas*, agreed on only one thing: the need for a more technical evaluation process. Fernández

[55] Environmental Permit (2011): 677, 696 and 691.
[56] Environmental Permit (2011): 677.

talked of a "clean and technical" decision that recognizes that the project meets all applicable laws. Rodrigo hoped the government would "stay neutral and evaluate the project well" and emphasized the "irregularities" - missing, omitted or erroneous information, proposed flooding of part of a national park, etc. In a time when the country was divided for and against HidroAysén, "technical decision-making" seemed like a rallying point everyone could agree on.

Just over a year earlier the EIA had been reformed to be more technical. An autonomous EIA Agency was created to coordinate and write up a "technical summary report", but not approve or reject projects. This is done by the Evaluating Committee, reconfigured to exclude indirectly elected regional counsellors and include only "technical" voices that represent state interests and the regional governor. Drawing on the experiences of Celco Valdivia and Pascua Lama, during the reform process "technical" was taken to mean not related to a political party. The reasoning behind these reforms is discussed at length in chapter 3.

During HidroAysén's controversial final decision moments, "technical" came to be defined as "legal" or "rule-bound". The day HidroAysén was approved, the Minister for Mining and Energy Laurence Golborne said "Every project that meets all applicable laws is good for Chile."[57] The statement verges on the tautological and makes it clear that legal standards are all that matters; nothing else defines the public good. The interim director of Aysén's EIA Agency confirmed this reading of "technical":

> We do our work remaining attached to what the law dictates. We are governed by public law that tells us that we can only do what the law allows us, not what we are forbidden from doing, as is the case with the private sector. Everything we do occurs within this regulated framework, that is why rather than voting with our conscience we must vote following the letter of the law.[58]

The ideal evaluator is a discretion-less certification machine. The former head of Aysén's EIA Agency concurred:

> We do not do anything outside the EIA's rules and regulations or the law. We want to narrow things down, so nothing is subjective in any sense. We want to narrow the gaps. Instructions, guides, admission tests, we want these to be more regulated and based on conventions.[59]

These changing notions of technical through the 2000s along with the seemingly quick failure of the 2010 reforms point to broader questions about what the EIA can and can not do. HidroAysén's immediate after-math points to three questions about the EIA, each answered in the negative by the public debates that took place in May 2011. First, does the EIA credibly represent and resolve state agencies' concerns about a project,

[57] 11 May 2011 *La Tercera*
[58] 28 Abril 2011, *Diario de Aysén*.
[59] Former EIA Agency director, interview by the author, March 2011.

where these concerns are based on existing rules governing natural resource use (aka, are technical)? Second, can the EIA's narrow rule-bounded vision adequately legitimate every project? Third, related to the second question, can this EIA adequately respond to the range of environmental demands present in Chile? Each of these is examined in turn.

Question #1 Did the EIA credibly resolve agencies' initial reservations?

In the case of HidroAysén, the EIA did not credibly resolve state agencies' concerns, and this is the simplest core of the dispute between those for and against HidroAysén. Many opposed to HidroAysén would agree with statements like this: "There have been many administrative irregularities and possibly wrongdoings during this [EIA] process. We think all kinds of pressure has been applied to break environmental institutions to approve the project...They have tried to do environmental fast-track, tampering reports and ignoring technical opinion."[60] As a result, legislators, including some from the President's own party, promised to investigate HidroAysén's EIA to halt the project. Whereas those in favor would agree with statements like this: "Let's hope that institutions, technical criteria and reason impose themselves over irrational emotions and an anti-development ideology."[61] The EIA process failed to convince many that it adequately resolved agencies' concerns between 2008 and 2011.[62]

As discussed in chapter 3, the 2010 reforms hoped to make the EIA more technical, at least in part to convince the public that the EIA could resolve agencies' concerns. HidroAysén's EIA troubles indicate these reforms may have failed quickly. The EIA Agency's "technical report" did not convince anyone of increased adherence to the rules, and the Evaluating Committee - freed of the political voice of indirectly elected local representatives - became an expression of the "vices of Chilean centralism".[63] Environmentalists fell into a contradiction. Just a few years earlier, under the leadership of former Environment Minister Ana Lya Uriarte, environmentalists advocated to technify the evaluating committee in this way, but running up to HidroAysén's vote implored committee members "to vote with their conscience". The efforts to technify reflected a belief that technical knowledge lay with state institutions rather than with the data itself.

A number of scientists joined in this type of critique of the EIA process. On the pages of *Nature*, of all inaccessible places to the Chilean public and policy-makers, Chilean scientists wrote comments like "there is no real science behind the approval of HidroAysén", "if the studies were exhaustive, then, why not expose the knowledge in a form that can be widely discussed?", or "the lack of environmental experts in the

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[60] 05 May 2011, *El Mostrador*. Citing Congressman Gabriel Silber.
[61] Martínez, Carlos, 11 May 2011. "Un rechazo ideológico", *La Tercera.*
[62] For the clearest exposition of this position see Mena, Marcelo and Pedro Rivera, "Operación HidroAysén", 10 May 2011, *La Tercera.*
[63] http://www.biobiochile.cl/2011/05/09/tomas-mosciatti-las-razones-para-no-aprobar-hidroAysén.shtml

approval of the hidroAysén proyect generates distrust in the citizenship." *(sic)*[64] Ecologists criticized that the government did not consult its "personnel of excellence" which work in Chile's five publicly-funded ecology research institutes, of which CIEP would be an example. This letter to the editor, signed by prestigious scientists from the Catholic University's Ecology Institute, concluded: "we reject HidroAysén and stand in solidarity with the demonstrators," a bold move by Chilean scientists.[65] An engineer who worked on HidroAysén's EIA sent a letter to the editor arguing to "sacrifice" the Pascua river to "save" the Baker.[66]

An experienced hydraulic engineer emailed an open letter that spread word-of-mouth like and raised several detailed criticisms of HidroAysén and the EIA: Kafka could not have come up with a better way to develop hydroelectric power, he says. In 20 pages, he details the authorities' limited environmental knowledge, the poor quality of baselines, the dishonesty of many scientists who participate in EIAs, the lack of meteorological data that produces reliance on hypothetical estimates, and the rigidity of the EIA, where the three most important decisions – location, design, and operating method (e.g., hydro-peaking) – are made prior to the process and can not be revised. The engineer, Claudio Meier, goes on to propose state funded studies; prioritization of rivers best-suited for hydropower, and protection of others as dam-free; state control of the baseline and EIA terms of reference; and higher technological and end-of-life standards. These are all recommendations from the World Commission on Dams. In light of current EIA practices, and following the relative failure of an ambitious reform process, these solutions seem impracticable in the current Chilean setting. Like the use of DNA testing of indicator species in the Cruces river (chapter 4), these measures sound like science fiction in today's Chile.

Any idea that the Chilean state would rely on personnel of excellence, public studies, or any other basis of expertise requires profoundly reconfiguring representations of nature and the local. The 2010 reforms sought to "technify" via eliminating electoral politics, but the scientists seek to "technify" via producing public, credible and quality data. The description of the EIA's workings - including how scientists participate, the forces that led to the exclusion of CIEP, and the misunderstandings and distrust that exists - lend credence to scientists' criticisms of the state (e.g., that it failed to call its "personnel of excellence"). This dissertation, however, is the first description of why the state does not act in these ways and it points to a crisis of representation: following the 2010 reforms, there are neither local politicians nor data nor experts to represent the local, meaning communities and nature in a broad sense.

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[64] See comments to the article "Massive Chilean dams approved" by Elie Gardner, 17 May 2011, *Nature.* Accessible here: http://www.nature.com/news/2011/110517/full/news.2011.297.html. I assume the comments are mostly from scientists because the names are in Spanish, most of them argue for more scientific representation and because only a few universities have access to *Nature* in Chile.

[65] They took care to couch themselves in international legitimacy: "they are scientists attending a meeting at the prestigious Cary Institute of Ecosystems Studies, Millbrook, U.S." and submitted this letter "together with their foreign colleagues". La Tercera, 28 May 2011.

[66] Letter from James McPhee of the University of Chile, 27 May 2011, *La Tercera.*

Question #2 Is the EIA appropriate for such large projects?

A larger question that dominated debates around HidroAysén was whether the EIA was the appropriate tool with which to make a decision over a project as large, irreversible and disruptive as HidroAysén. Former Environment Minister Ana Lya Uriarte, who led the 2010 reforms, argued such large projects should be approved by political decree.[67] Others criticized an over-reliance on market mechanisms and the private sector to decide energy policy, and the lack of a guiding "state vision".[68] This was echoed on national television on the day of the vote by Tomas Mosciatti, an influential journalist, who added he did not trust the government.[69] The idea of a democratic deficit and governance failures dominated discussions. Democratic failures refers to the feeling - also criticized by Manuel Ossa for Pascua Lama - that the whole process occurs under false pretenses because a decision has already been made; the project will go ahead. Governance failures refers to the supposed energy shortages that forced HidroAysén on Chileans. The EIA, as a process that derives its legitimacy from being "technical", can not respond to these "political" challenges. Quite simply, "this is the result of a long history of avoided debates, half truths and reiterated lies"; democratic failure at its most complete.[70]

There was, of course, a partisan background to this debate. Members from the left-wing Fundación 21 published an editorial arguing that the government, in its disdain for politics, forgets "...that an integrated vision of the State...is not easily the result of summing the power-points prepared by his ministers."[71] In contrast, many who published articles in favor of HidroAysén identified with the (right-wing) government of the time and argued the EIA was perfectly capable of legitimating such a large project: the EIA is transparent, "with an online system almost without parallel in the world", that tells the truth, like "without HidroAysén there will be blackouts."[72] A former HidroAysén manager wrote to dispel "myths and truths about Aysén" to complement the work they had already done through the EIA process.[73]

The conservative newspaper *El Mercurio* published a number of articles and opinion pieces echoing one of HidroAysén's main arguments: no good alternatives to HidroAysén existed and, in light of electricity needs for further growth, the project had to be approved. It was in response to this argument that others, like Mosciatti or Uriarte referenced above, argued that better state decision-making mechanisms were needed to assess if alternatives existed. During these months there was just one public and

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[67] http://www.eldivisadero.cl/noticias/?task=show&id=25136. In a seminar, I asked the former Minister about the elimination of local politicians from the committee, and she confirmed that they (Congress) had seen this as a viable way to "technify" it.
[68] Mansuy, Daniel, "Diálogo de Sordos", 18 May 2011, *La Tercera*; Navarrete, Pablo, "Es la sociedad civil, estúpido!", 29 May 2011, *La Tercera*.
[69] http://www.biobiochile.cl/2011/05/09/tomas-mosciatti-las-razones-para-no-aprobar-hidroAysén.shtml
[70] Soto, Hector, "La Ultima Utopia", 15 May 2011, *La Tercera*; see also Aguila, Ernesto "Deficit Democrático", 11 May 2011, *La Tercera*.
[71] Fernandez, Maria and Eugenio Rivera, "Un gobierno disociado", 09 May 2011, *La Tercera.*
[72] Martínez, Carlos, 11 May 2011. "Un rechazo ideológico", *La Tercera.*
[73] 21 May 2011, *El Mercurio*.

frequent scientific voice opposing HidroAysén: Roberto Román, a professor at the University of Chile's College of Math and Physics. Aside from Román, who has dedicated himself to promoting solar energy in Chile, few scientific voices weighed in. Scientists generally preferred to comment only on the much narrower first question discussed above, than on this broader question about alternative paths Chile could take. What debate about this occurred was largely through the letters to the editor of *El Mercurio*.[74] These questions remained largely unresolved.

Question # 3 Does the EIA capture current environmental goals?

The final question raised in the after-math to HidroAysén is arguably the most interesting because it points to broader social change: can the EIA, as it has been implemented in Chile, with its narrow rule-bounded procedures and fragmented results, adequately respond to the range of environmental demands that exist in Chile today? An overwhelming majority of 70% opposed HidroAysén, according to opinion surveys.

Not since the plebiscite to boot Pinochet from power in 1989 had so many thousands of people demonstrated through downtown Santiago. Within days of HidroAysén's approval, an estimated 40,000 rallied, plus thousands more in cities across the country. Every Friday for one month protests continued, until they integrated into the student movement that paralyzed Chile in 2011-2012.[75] HidroAysén was not alone in raising multiple questions about environmental goals and values in need of protection during the short years of 2010-2011. This section focuses on debates about the environment raised by HidroAysén.

Elites struggled to make sense of the discontent. Former President Lagos, presumably used to environmental conflict (see chapters 3 through 5), exemplified elites' confusion with his "flip-flop". One day he endorsed HidroAysén on national television as "necessary for the country's growth and development" and the very next day he denounced it. The government of President Piñera sent the police to stop protests and staged its own flip-flop over the use of tear-gas against demonstrators. President Piñera promised to invest US$1.5 billion in infrastructure in Aysén, but this was not well received because many suspected the money came from HidroAysén.

In addition, skepticism greeted the President's development plan because of disagreements over what Aysén's development priorities should be. Both within the region and nationally, views split into what can be called traditional development goals and sustainable development goals. Most Chilean elites in government, business and political parties assumed traditional positions that see growth at the expense of the environment: President Piñera stated simply, "it is more important to protect people than

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[74] *El Mercurio*'s website works so poorly it was difficult to keep copies of articles and letters that appeared there. See issue from 8 June 2011 for this letter exchange. A few other voices wrote to El Mercurio about these things, including solar energy industry representatives, in response to editorials in the paper that made inaccurate estimates of the space and costs needed to produce solar electricity.

[75] On June 16, 2011 an estimated 100,000 marched through Santiago to protest the state of education. By then, HidroAysén had largely disappeared from the marches. Members of the student movement worked with Patagonia Sin Represas and, to some extent, were able to capitalize on the energy around HidroAysén to launch the student movement. Personal conversation with student leader, November 2011.

trees."[76] Chileans who "protest the dams on their computers" were criticized for participating in "...an activism based on an anti-development ideology that the public needs to know about."[77] Many others called for "realism" and urged the young Chileans they thought were demonstrating to stop seeing the world through green-tinted glasses. The implication is that a new generation of comfortable Chileans are not just anti-development but also ungrateful for the well-being they have enjoyed thanks to government efforts since the transition to democracy.

That Chilean society was changing can be exemplified through the pages of just one issue of the satirical newspaper *The Clinic.*[78] On one page the paper attributed opposition to the lower classes who saw HidroAysén as part of an inequitable growth model, and called for a parody pro-HidroAysén demonstration to take place in Vitacura, an exclusive Santiago neighborhood, complete with taxis to take demonstrators downtown to the presidential palace so they would not get lost. Just some columns over, journalist Pedro Cayuqueo, a member of the Mapuche indigenous community, recalled the opposition to a dam project in the 1990s that devastated a Mapuche community (Ralco). His article berated upper class environmentalists interested in protecting their adventure wonderland for kayaking and mountaineering, without concern for poor people's interests in the land.

In a highly unequal country, are environmentalists in Chile upper or lower class? Some argue that as the country has developed and progressed, citizens are making more demands on government, among them for environmental protection. Its an argument that harkens to Inglehart's notion of post-materialism, where the environment becomes affordable only with certain levels of growth and development (Inglehart, 1990). But this is not what environmentalists are saying. Rather, they point to inequality as a driver of discontent among across different socio-economic classes.

Seasoned environmentalist and policy analyst, Nicolo Gligo argued this clearly in an article about the dams: "In the pursuit of a likely economic growth that they know will reach them little if at all, those opposed to HidroAysén do not want to sacrifice part of their territories' natural identity."[79] Another opinion-maker, Jorge Navarrete wrote: Chileans "no longer want to be treated as beneficiary, consumer or client, but as a partner." Opposition to HidroAysén, he argues, has to do with the end of the paternalistic and neoliberal states that treated Chileans as beneficiaries and consumers, and the rise of a new, associational state.[80] Both opinion-makers are raising questions about access to resources, growth, democracy and rights.

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[76] *El Mercurio*, 29 May 2011. This comment reflects years' of editorials in the Mercurio portraying Aysén as a backward region in need of industrial development through projects like HidroAysén.
[77] First part about the computers is from Buchheister, Alex "HydroAysén y el rol del gobierno", 15 May 2011, *La Tercera*; the second part is from Martínez, Carlos, 11 May 2011. "Un rechazo ideológico", *La Tercera.*
[78] 12 May 2011, *The Clinic*.
[79] June 2011, University of Chile website.
[80] Navarrete, Jorge, "Es la Sociedad Civil, Estupido!", 29 May 2011, *La Tercera.* Interestingly, Navarrete does not use the terms rights or citizenship. Is this a deference to Chile's neoliberal state that he denounces?

Kayakists help to highlight the changes from the 1990s that Cayuqueo sadly remembered to the 2010s. As President Piñera was set to inaugurate an open air museum that projected images of Chilean landscapes with massive bright lights onto the Mapocho river in Santiago, he was intercepted by kayakists with a banner asking: "President, will you reject HidroAysén?"[81] The protest simultaneously transported an iconic adventure tourist, seen as integral to Aysén's regional development plan based on nature tourism, from the Baker river to downtown Santiago, while satirizing Chile's "energy needs".

The EIA failed to provide answers to these political questions. As long as environmental protection is considered antagonistic to economic growth, these forces will be in competition. HidroAysén's debates show an erosion of consensus on the need to develop as well as frustration with democratic accountability. Expectations have not been met. The debates exposed a feeling among many that companies like Endesa alone set policy. But the private sector is by definition unaccountable, just like the EIA is by definition a poor substitute to energy policy. HidroAysén exposed the lack of state institutions with the authority, experience and credibility to set energy policy.

V. Conclusions

HidroAysén was a controversy over development goals, state control of natural resources, and state competence. How did the state know HidroAysén's impacts would be manageable? How did it know Chile's real energy needs? And how could it convince the public of these things? That the EIA failed to certify the credibility of the state's knowledge and methods for knowing is evidenced in the fall-out of HidroAysén. The project was approved but with a repeat of the EIA: the whole thing needed to be audited by an external organization. Furthermore, in contrast to the fall-out from the Celco Valdivia and Pascua Lama controversies, "more politics" emerged as a solution. The President appointed an advisory committee for electricity development to advise on Chile's long-term energy needs and goals. The EIA was not the right policy tool for legitimating such a large, disruptive project or addressing the range of environmental concerns Chileans today have.

Through 2012 things continued to deteriorate for Aysén, President Piñera's government and Chile's environment. The President's advisory committee lacked legitimacy. Too many members were linked to past governments led by Christian Democrats or the military and too few represented a fresh perspective (just one works directly with renewable energies).[82] In February a "Social Movement for Aysén" blocked Aysén off from the rest of the country for three weeks, until gas and food began to run out. Among other things, the movement demanded a locally-controlled referendum to

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[81] http://tele13.13.cl/nacional/ambientalistas-navegaron-el-mapocho-en-plena-inauguracion-del-museo-arte-luz.

[82] The committee was packed by voices from the private sector (half the commission), nuclear energy (3 of 16), economists (6 of 16) and authors of the 1982 electricity code (3 of 16). See http://antiguo.minenergia.cl/minwww/opencms/02_Noticias/index/noticia_detalle.jsp?noticia=/02_Noticias/10.0.1.6.noticias_anteriores/f_noticia_03_05_2011.html&nom=.

approve hydroelectric projects in the region. They failed to impose their demands but radically altered the conversation: a few months later, Endesa's partner, Colbún, put the project on hold "until an energy policy exists, that has people's broad consent and that outlines the country's energy needs."[83] Furthermore, the Supreme Court ruled against a large coal-powered plant (Castilla) and other courts are investigating other projects (Rio Cuervo and Punta Alcalde). The latter project, Punta Alcalde, was rejected through the EIA process but the decision over-turned by the Council of Ministers for Sustainability that supervise the Environment Ministry (chapter 3).[84] Mining companies are nervous that electricity costs and shortages will limit their growth.[85]

The stakes of HidroAysén are stark for Aysén, but even starker for Chile as a whole. The EIA introduced the environment and scientists into decision-making, but in ways that kept both weak and undermined. A series of misleading binaries organize environmental impact evaluation: public/private, baseline/impact evaluation, science/strategy, technical/political. All of these obscure the conflicts of representation at the center of the controversy. EIA institutions do not adequately represent local communities or citizens, and technical knowledge (including data, models, graphs, monitoring stations) do not adequately represent local notions of nature. Calls for more "technical" decision-making, however, have obscured both of these. On the contrary, reforms to make evaluation more technical undermined both forms of representation. Actors in government, business, NGOs and science talk at cross-purposes.

[83] http://www.emol.com/noticias/economia/2012/05/30/543190/colbun-suspende-el-estudio-de-impacto-ambiental-de-hydroAysén.html; see also http://www.bostonreview.net/BR38.1/carlota_mcallister_chile_hidroAysén_dam_patagonia.php

[84] http://www.latercera.com/noticia/nacional/2012/12/680-496614-9-punta-alcalde-la-termoelectrica-que-pretende-generar-740-mw-de-energia-en.shtml

[85] http://www.4-traders.com/ORIGIN-ENERGY-LIMITED-6491419/news/Chile-Power-Cos-Worried-About-Environmental-Permitting-Framework-15195336/

Conclusion

Less than three years after its reform in 2010, the EIA is not evaluating the environmental impacts of large projects in ways that meet Chilean's expectations for accountability, credibility and environmental performance. As energy projects are stalled by the EIA, energy is becoming a "bottleneck" to continued growth.[1] In this way, the EIA sets Chile's limits to growth; even with environmental approval projects lack legitimacy and protests are frequent. This dissertation tells the story of how Chile got to this point.

Technocratic solutions to large-scale environmental problems failed on the ground in Chile. Contrary to explanations that rely on stories of capture, this dissertation argues that disagreements over credibility have undermined the Chilean state's capacity to regulate the environment. These disagreements are expressed in two related sites: the boundary between political and technical decisions and disagreements over scientists and their proper role in society. Both disputes are about different visions of the state. Many in government believe good government means the state plays the role of a neutral broker that facilitates consensus and negotiation. Such a state has no tolerance for stubborn positions like those scientists or environmentalists might adopt, but a penchant for rules and regulations - its main job, after all, is to "draw the lines on the soccer pitch". Others, including many concerned about social outcomes, disagree with this vision and promote strong versions of democracy instead.

This kind of facilitator state runs into a governance problem. Without regulatory science or robust local politics, it can only promote accountability through direct public participation, a hopeful solution that is popular with many of the detractors of the facilitator state. Yet direct participation requires an empowered state that can respond to public demands. Otherwise, the state faces a widening governance gap. The trajectory of the EIA shows that expanding transparency does not promote accountability. Though transparency would be greatly improved if original EIA baseline studies and the raw data were public, accountability would only be improved if critical communities existed to review this information and if the EIA were embedded in a range of conventions that organize how the Chilean state comes to know about environmental risks and harms.

This is one of the bigger findings of this dissertation: the study of bureaucracies from the perspective of expertise and knowledge is a window into complex notions of statehood that are otherwise difficult to identify or remain abstract. Bureaucratic knowledge practices taps into this and is also empirically rich, yielding information about who wins and who looses from a policy.

This is a case of unexpectedly failed technocracy. Technocracy because the EIA is a knowledge-intensive tool premised on the idea that expert knowledge, combined with public input, can speak ecological truth to business power to improve the environmental performance of everyday economic projects. Failed because the EIA in Chile often approves projects that are environmentally bad projects in ways that citizens find increasingly suspect. Unexpected because of all developing countries, Chile was among the most likely to succeed with a credible and legitimate EIA. Given strong

[1] Ernst & Young's Emerging Markets Center, http://emergingmarkets.ey.com/worldmap/chile/.

growth and institutions, where the new environmental authorities quickly and expediently learned how to administer the EIA and could draw on a relatively educated and diverse community of outside experts, Chile had everything to implement good government following global recommendations. This dissertation shows that capacity is a necessary but not sufficient condition for good technocratic government.

The "unexpected" part of the story leads to another insight from this dissertation: states in developing countries are development actors in ways that are not constrained just to their interactions with global development or financial institutions or to opposition by different marginalized groups. States are neither monolithically powerful nor do they hold a monopoly on knowledge and representation (Matthews, 2011; Mitchell, 2002). But in Chile and other small and medium developing countries, states also have infrastructure, capacity, legacies and their own political imperatives. In Chile, development is a national project, technocracy has cultural appeal, and markets are favored and environmentalism feared by most. Development that changes identities rather than just incomes requires understanding how these local realities interact with global notions of good government, challenging and adapting them, in ways that take both seriously rather than assume one-way channels of influence. To transition towards a more equitable and sustainable global society requires these kinds of local changes.

The rest of this conclusion summarizes some of the main findings from this dissertation. The first part narrates the evolution of Chilean environmental politics. The sections put the different notions and definitions of the technical, political and scientific together so that the three controversies may speak to each other.

The environmental problem

Between 1980 and 2010 Chile regulated the environment, its economy and government following global best practices. Chile diligently adopted orthodox policies to facilitate free trade, strong property rights, a small regulatory effort and, since 1990, democratic government. To answer to social and global demands for environmental protections, the new democracy turned to what quickly became the global standard: Environmental Impact Assessments. In the 1990s many hoped that impact evaluations would avoid really harmful projects like Alumysa and Trillium and protect communities like the Pehuenche Indians who were forced to relocate to build new dams on the Bío Bío river. As the first generation of large EIA projects were approved and came into operation, however, many became concerned.

Although Conama's capacity grew, bad projects still received EIA approval, including the Valdivia paper and pulp mill and Pascua Lama gold mine projects. The environmental authorities at Conama tried to raise environmental standards; for example Conama required additional waste treatment and a glacier management plan. But constrained by fairly lax quality and emission standards and a legalistic culture, Conama approved the Valdivia mill despite its delicate location and Barrick's plan to move the glaciers under the fiction that this would preserve them. Chapters 4 and 5 show that Conama's reasoning about toxicity and precaution left much to be desired and helped precipitate the crisis that followed. Conama's behavior appeared erratic and

many concluded that Arauco and Barrick - powerful companies - had captured the process. Presidents Eduardo Frei (1994-2000) and Ricardo Lagos (2000-2006) were too close to industry, and political and business forces derailed an otherwise "technical" evaluation.

In response, many legislators and civil society actors - including environmentalists - argued the EIA had to be "more technical". This motivated the 2010 reform process but "technical" turned out to have very different meanings for different groups. The variety of "technical" senses in Chile point to deep disagreements about what makes claims credible and certain people experts, as discussed below. The reforms backfired quickly. In 2011 the new EIA Agency and Evaluating Committee faced the final stretch of HidroAysén's three-year long evaluation. Despite the reforms towards the "technical", activists implored committee members to "vote with their conscience" to reject the project. With 70% against the project and thousands protesting on the streets, many criticized that there was too little politics. Neither companies like Endesa, nor the EIA, could set energy policy. Now "more politics" was needed.

Concerns about capture and the corrupting role of political and business interests shaped Conama and the EIA since their inception in the early 1990s. The technocratic rationality of the EIA, administered by a transversal office, with trained staff who underwent capacity building following global standards, were supposed to be antidotes to these corrupting forces. When the EIA's legitimacy was tested by high-profile cases like the Valdivia mill and Pascua Lama, legislators, communities, activists and others responded by redoubling efforts to exclude corrupting political forces and protect technical rationality. The case of HidroAysén is early evidence that to see the EIA's troubles as a problem of capture did not address its shortcomings.

By examining the EIA since its inception and through three cases approved under different political administrations, proposed by different companies operating in different industry sectors, and located in different regions of the country, this dissertation makes two claims about Chilean environmental politics. First, if the EIA's main challenge is illicit capture, then this occurs on a large-scale and with the connivance of hundreds of individuals who work in different institutions. In light of the 2010 reforms, if capture is still the main challenge, must technical decision-making be further isolated? This seems unlikely, and the events leading up to and the fallout from HidroAysén point to the importance of deeper questions about politics, statehood and democracy. Second, one of the EIA's main challenges is an entrenched anti-environmentalism. At Valdivia, Pascua Lama and HidroAysén, anyone associated with an environmental position was dismissed as a passionate zealot who wants to be a hero.

Scientists and government staff were careful to not veer too close to environmentalism. Many complained "environmentalism is a bad word in Chile". To accuse someone of being an environmentalist is the fastest way to discredit them. One former government employee who lost his job after being branded an environmentalist had his answer ready for future job interviews: "I care about the environment, but that is not all I care about." Since the conflicts at Valdivia, Pascua Lama and Aysén perceptions about the environment have shifted, but Conama arguably has played a role more by omission than by action. Conflicts and crisis are raising environmental

awareness, not education. This entrenched anti-environmentalism provides another rationale for seeking to make environmental regulatory politics more technical: to make environmental protection more palatable to Chilean government, where the technical carries a legitimacy that "political" positions lack.

The disputes over what counts as political and technical in Chile are indicative of disagreements over what role if any science should have in state affairs. For many in or close to government, the technical/political boundary is co-constitutive with a conception of the state as a neutral broker. In this neutral state, environmentalism - like any other position for or against something - is dangerous. Because government employees do not see their role to be the defense of nature, the state's natural patrimony, the public's health, or any other kind of environmental good, nature is left with minimal legal or political voice. But this view of the state is not shared by everyone; environmentalists and activists in particular contest it. The forms of contestation are fairly similar, but the content and spirit of contestation varies widely, ranging from democratic to technocratic fantasies to many intermediate imaginaries. Scientists contest the conditions in which they participate in public affairs, but refrain from extending their disagreements to questions of politics. These differences are discussed in further detail below.

First a note on the role of industry. The expected arguments from industry certainly exist - e.g., regulatory requirements are cumbersome, there is too much uncertainty, the process is inefficient - but in other fora industry applauds Chile's environmental regulatory politics. "Everyone except the communities loves the EIA", said one respondent from a large mining company. At the eighth CIPMA encounter in April 2011, industry man Wolf von Appen declared for environmental regulatory politics should continue as is because "things are going well". Von Appen works for big business (Ultramar) and Chile's largest industry association (Sofofa). As in the Valdivia mill and Pascua Lama cases, industry prefers its own private solutions to environmental problems. The challenges at Valdivia led to new collaborative "science for corporate defense" and at Pascua Lama to an unprecedented negotiation with the other large industry group, the Irrigators Association.

That the current arrangements work well for industry does not necessarily mean industry has captured the process. The problem of capture is far more subtle: one respondent who works in government said, "there is a lot of pressure on the EIA, not from industry, but from the executive government." Figures like Presidents Eduardo Frei and Ricardo Lagos are paradigmatic of a traditional closeness between politics and business in Chile (Ross Schneider, 2004). Reprehensible it may be, but this closeness is not unique to Chile nor is it the kind of capture global donors fret about. Rather, this closeness has historical roots traced to the government's role in enrolling everything, including science, into a larger development project (chapter 2). This closeness is suspect now that support for the government's development agenda is eroding. While the president's main responsibility was growth, closeness to industry was an asset. As it ceases to be so, technical solutions to government are increasingly preferred.

The technical solution

A more technical EIA process was an antidote to excessive partisan politics in a context where elected politicians are seen to be too close to companies. As political parties essentially share the same economic agenda for export-led growth (Nef, 1995; P. Silva, 2009), technical politics is seen as a way to buffer the state from elite interests rather than to buffer parties from each other, as Patricio Silva described (2009). Examining environmental politics between 1993 and 2010, technical politics retained its appeal but changed its specific forms. Very few succinct definitions of the technical were provided by respondents. Indeed, most respondents had difficulty answering what they meant by technical when I asked them to clarify. Attempts to delimit technical from non-technical decision-making were observed in multiple places - government agencies, the legislature, EIA studies, and labs - and each delivered a different delineation of the concept:

Follow the rules Bureaucrats in ministries, agencies or offices, in Santiago or regions, had a remarkably homogenous understanding of the "technical": it means legal, bound to the rules, where decisions are made without exercising discretion. It took me a while to understand the significance of these answers (and they were often vague), and it became apparent only in the aftermath of HidroAysén's approval. Then, government officials' statements to the press confirmed this ideal: "We do our work remaining attached to what the law dictates." The importance of this attachment to the rules becomes clear when considered together with another comment made around the same time by then Minister Laurence Golborne: "the people are empowered but they are not well informed, because they are asking things of the government that are outside it's capacities." The government's capacities are defined by the rules, reflected in the frequently stated ideal that the state can only do what it is explicitly allowed to do, while the private sector can do anything not explicitly forbidden.

Centralize power Legislators and members of Bachelet's government, during the 2010 reform, had a different view of the "technical" which prevailed during the reforms. In their view, technical authority lies with state institutions which legislators identified with ministries. As a result, the evaluating committee that approves or rejects EIA projects was reconfigured to represent only ministerial voices, in a reform that greatly increased central executive government authority to the detriment of local politics and representation. As a result and in synergy with the rule-based definition of the technical, *técnicos* in government are driven to act more like bureaucrats than experts who can exercise discretion. That the Bachelet government, and Minister Uriarte in particular, oversaw this centralization of power in the name of the technical is surprising. Many environmentalists do not see ministries as technical bodies; on the contrary, ministries are the apparatus of executive authority. Minister Uriarte, who cut her teeth on the state's legal defense team against Arauco on the Valdivia paper and pulp mill case, is likely aware of these kinds of critiques. The dislocation between the motivations of the reforms and the adopted solution refers again to conceptions of the state, discussed

below. For now, it is important to note furthermore that this reform was combined with an expansion of direct public participation in the EIA. Yet empowering the people without empowering the state to be able to meet their demands threatens to expand the governance gap Minister Golborne identified.

Inventories The Valdivia mill case was a watershed not just because of the scale and visibility of the crisis, but because it was a lesson to Chilean industry on the uses of the EIA. A well crafted and comprehensive EIA baseline is an insurance against accusations of wrongdoing in case something happens. HidroAysén took this lesson to heart and invested heavily in a comprehensive and prestigious EIA baseline. Likewise, as part of the 2010 reforms to make environmental politics more technical, the new Environment Ministry and EIA Agency were given authority and responsibility to produce, maintain and disseminate information about the country in a master, country-long baseline. From the point of view of EIA reviewers in government, however, there is a danger here because baselines are their last frontier to exercise some discretion. Reviewers concerned to hold a project to a higher standard or to be more sensitive to local conditions identified the baseline as their only chance to push the company further. This explains part of the "hyper exhaustivity" many complain about.

Another challenge with baselines has to do with their credibility. Respondents in industry and scientists who worked on HidroAysén's baseline called baselines "technical", "like a photograph" or an "inventory". These scientists were keen to define baselines as technical against the project itself. The project, its impacts and evaluations were "strategic", meaning they were goal-oriented towards approval as fast and with as few conditions as possible. This distinction between baselines and assessments was crucial to scientists concerned about their perceived integrity.

The idea of a master baseline for the country, promoted by many environmentalists, represents a sort of technical fantasy where complete ecological knowledge will finally turn the tide towards greater environmental concern. It also reflects frustration with EIA baselines that are produced through market relationships that expose scientists to the suspicion of conflicts of interest. The role of markets in knowledge production is discussed further below.

Science in the public interest Since the return to democracy there have been recurrent efforts to produce science in the public interest, as discussed in chapter 2. The National Center for the Environment, CENMA, is the largest effort of this kind but as recently as 2009 the state development agency Corfo launched a new program with this name. Chapter 2 shows that the Chilean state never saw the usefulness of a public laboratory, and preferred to leave the production of knowledge to market mechanisms constrained by strict cost considerations - in Chilean public tenders, science is only cheap or expensive. No other criteria are seemingly used to adjudicate a tender. CENMA's trajectory illustrates the negative consequences of this policy, but it also shows the importance of other obstacles in CENMA's quest to become a national reference laboratory. Above all, despite all the investments and in all the forms that CENMA took - as reference laboratory, commercial laboratory, academic science

laboratory - it never aspired to be a public interest laboratory. This too is a site where environmentalism as a "bad word" is operationalized: not even environmental scientists see room for a little advocacy.

As spaces where attempts to delineate technical from political aspects of environmental decision-making are made, each of these moments appears disconnected from the others. Furthermore, in each space the environmental component seems always to be left behind. Science in the public interest can not prioritize any goal, like environmentalism, and inventories are imagined to be static landscape portraits more than a dynamic corpus of ecosystem knowledge. In each four of these spaces, technical has little do with scientific research as a creative process.

Is there a role for scientists?

The historical marginalization of scientists and reliance on market mechanisms today should not be interpreted as a sign that science has no role in Chilean environmental politics. On the contrary, the persistent calls for more technical decision-making, the programs for a science in the public interest, the maintenance of CENMA despite everything, and the centrality of debates about information in the legislature during the 2010 reforms all point to a continued interest - perhaps a need? - for scientists to play a role in decision-making. At the first meeting about environment, science and politics organized by the think tank CIPMA in 1983, physicist Igor Saavedra saw in the environment a special opportunity for Chilean scientists to prove their relevance to the man on the street. In 2011 ecologists editorialized against HidroAysén and implored the government to consult with its "personnel of excellence", meaning scientists like themselves and their colleagues at CIEP in Aysén. This dissertation argues that in twenty years of democracy, the Chilean state has not figured out how to undo a legacy of marginalized science. Scientists and non-scientists alike do not agree on what the proper role of science in decision-making is, so the historical challenges of the creole scientist persist.

In environmental politics scientists often play the role of mediators. Their data, concepts and equipment produce bridging objects that actors in government, industry and civil society can agree on and recognize (Wilkening, 2004), and they sustain negotiations among interests in conflict (Carey, 2010). As bilateral activists, scientists were critical in shaping Bolivia's pioneering conservation policies. Scientists represent nature in ways that become universally valid and mobile (Knorr-Cetina, 1999; Latour, 1983) and so bridge local and universal spheres. In the fights for independence from Spain, Latin American creole scientists took on this role by integrating their European roots and training with a local outlook. Building on the work of historians McCook (2002), Cushman (2011) and Edgerton (2007), this dissertation argues that creole science is important to a nation building project and can be recognized in three spaces - practices, context and use.

Practices Scientists who participate in public disputes risk high levels of criticism, particularly from their scientific colleagues. Criticisms come from taking on environmentalist positions, being too close to industry, reaching the expected results, or reaching the unexpected results. Scientific prestige is accrued only through publications in peer reviewed journals, preferably those listed in the ISI index, and to a lesser extent by winning Fondecyt grants (similar to NSF grants but much smaller). Because only publications in peer reviewed journals deliver prestige, scientists who participated in environmental controversies sought to publish the results, as in the Valdivia mill and in HidroAysén cases. There are no alternative ways to assess public credibility, so a very narrow kind of academic science dominates. Chilean scientific practices, in this sense, would be familiar to any scientist around the world.

Pascua Lama provides a counter-example. Although the glaciologists were also very critical of each other, each was comfortable working for NGOs, government or industry. As discussed in chapter 5, although glaciology in Chile does not have a particularly cohesive tradition, glaciologists function more like a community than the other scientific communities I studied. Perhaps it is well funded for its size or just too small to allow rivalries to overwhelm cooperation (there are probably no more than twenty practicing glaciologists in the country, compared to a few hundred ecologists or zoologists). Personal knowledge and experience on the mountain substituted for ISI publications among glaciologists.

Saavedra in 1983 contrasted First World and Third World scientists where the latter had to be a master of all trades: produce both basic and applied science. Though the distinction between basic and applied science, and the idea of two distinct communities, is suspect, Saavedra's comment resonates with Vessuri's observation that Latin American governments have never been good at evaluating science (Vessuri, 2007). This task was often left to foreign donors, like the Rockefeller Foundation (Cueto, 1994). The over-reliance on the ISI index is an expression of this - both the angst expressed by Saavedra that Chilean scientists must never sacrifice on scientific quality, and Vessuri's conundrum about how a government like Chile, concerned with climbing out of poverty, could evaluate science.

Context Chilean scientists face a challenging context because there are multiple common misunderstandings about scientific work. First, they face constant suspicion of conflicts of interest. The only reliable way to deal with the suspicion is to stay out of public matters: "the wife of the Cesar must be chaste and pure and also appear to be so." But baselines or other consulting work was not the only source of suspicion, as the experience of CIEP in chapter 6 shows. In this case, as with CEAZA (chapter 5) and CENMA (chapter 2), many respondents in government had the wrong impression about where their funding came from and how this shaped the institute. This leads to a second challenge - through these chapters academic and consulting science are conflated, blurred and mixed up. Even legislators either promoted or let pass (it is unclear from the legislative history) the use of the title "academic" to apply to consulting companies (chapter 3).

Third, the nature of the scientific method was unclear to many. This is exemplified by Endesa's forestation "experience" in chapter 6, which the company called an "experiment". Though the staff at the Forest Agency recognized it was not so, they did not show much concern for the arguments the forest ecologists at CIEP made about a trial and error versus an experimental approach. These kinds of disputes were echoed loudly in the Valdivia courts. It relates too to Conama's (now the EIA Agency's) seeming lack of concern about the uncertainties that result from the lack of weather data in Chile. Data about rain, snow, temperature, and winds, as well as measurements from rivers, is pretty thin and methods to estimate data gaps seem like a prime site for some critical vetting.

Finally, the context is not favorable in that many respondents in government, industry and NGOs could not remember the names, training or institutional affiliations of scientists they worked with. There is a certain contradiction too in that the signal of prestige - ISI publications - was never part of the reasons for working with one scientist or group of scientists over another. In the Valdivia case Conama largely turned to local experts who knew about animals, while Arauco turned to chemists and ecologists with better access to the latest technologies. At Pascua Lama and for HidroAysén, the criteria for choosing varied widely, but in both cases NGOs chose scientists who were "untainted" by any work with industry. As part of its environmental strategy, Arauco now creates research consortia that have credibility on three fronts: among the local community because they employ local universities; among activists because it is unlikely 5 or 6 universities would all be colluded with the company; and among shareholders because they employ foreign universities. For all the reasons described so far, foreign credentials are the most reliable source of credibility for a scientist among government, industry and NGOs, but not so among communities who value scientists familiar and engaged with their local ecologies (e.g., chapter 5, where the French glaciologists were considered arrogant by locals).

Use The state's use of low-cost public tenders has already been discussed. Beyond this, there is a consistent unwillingness to pay for science in Chile that affects state and private institutions. This is best represented in the demise of CENMA's effort to become a national center of reference, where the Canadian government's quality standards were just too expensive for Chile's competitive market for lab reports. HidroAysén is exceptional in this regard: of all the actors that appear in this dissertation, Endesa was the only one that sought out a scientific voice. Conama hired three scientific studies of the disaster near the Valdivia mill, but arguably it was pushed into this by the Union for the Conservation of Nature that advocated from the get-go for a Ramsar delegation of scientists to study the issue. In this context, it is fascinating that HidroAysén's initiative - to invest in science and the best EIA baseline seen in Chile - failed so dramatically that even a current university professor who formerly worked in Conama said, "there is no information about HidroAysén I can trust".

In terms of a creole science, scientists are held largely to universal scientific standards while the local element of their work - including what is relevant and needed

science, what is credible and reliable - are ambiguous. Taking each of the three controversies in this dissertation as short experiments in collective epistemology, the results are disheartening. Because science is largely left out of disputes about the technical/political, its proper role in public affairs is not well defined. While academic, peer-reviewed science for consumption through indexed journals has a clear place in Chilean society, other forms of science - like regulatory science - do not.

Does the state need science, why and what for?

Regulatory science is a type of science that combines scientific evidence and expertise with political and social judgement, to make stable decisions about acceptable levels of risks and harms (Jasanoff, 1990). Regulatory science is, for example, compatible with the idea that environmental quality and emission standards represent a "social agreement" about acceptable risks, as described by staff at Chile's Environment Ministry. But there is a difference between the regulatory science practices Jasanoff and Keller (2009) describe for the U.S., and that practiced in Chile. This difference has to do with the role of experts, and understanding it can generate insights into the character of Chilean democracy today.

Regulatory science promotes accountability (Ezrahi, 1990). Scientific evidence produces public proofs that state institutions use to make public their rationale for choosing one policy over another. So what would public life without regulatory science be like? The likelihood of stable or conflictive decisions seems equally likely, given the multiple demands public decisions of any kind receive from social groups, organized interests, and state idiosyncrasies. But how would groups be persuasive? Perhaps by adhering to rules and procedures; by bargaining over material goods (interests); by appealing to common values and goals. Its a decision process that lends itself easily to decision by consensus by force (authoritarian decision-making) or consensus by reason (negotiated decision-making), where reason can be anything. In the best sense of the word, it means the kind of secular humanism Chilean positivists advocated in the 19th century. Chile's motto, on its coat of arms, echoes this: "by force or by reason". In a world without regulatory science, the state has no clear rationale for choosing a policy or decision to report back to citizens.

Contemporary global markets and institutions increasingly require democracy, accountability, transparency and even some environmental standards to participate in global trade and institutions, as Chile does. Consensus by force or reason is not viable in light of this global pressure towards transparency and accountability. Chile's response so far, like many other countries, has been to rely on imported policies - global best practices, universal policy recipes or conditional policies imposed by donor agencies. These are the origins of the Chilean EIA, but as this dissertation has shown, policies may become universal as countries adopt them, but there are no universal ways to make them locally legitimate. Technocratic solutions fail on the ground because expertise, technical know-how, procedures and standards of decision-making derive their legitimacy from local politics. Global policies that remain technocratic and outside the sphere of local politics fail; in the case of the Chilean EIA, with disappointing results

for sustainable development and the environmental burdens suffered by many communities.

The civic epistemologies framework highlights those ways in which technical know-how, expertise or technocratic policies become embedded in local politics. What the preferred forms of trust, proof and debate in a society are can be located in institutionalized pathways. For example, the EIA itself in Chile operates like one of these pathways: the EIA registers objectivity, turning private knowledge into official, public knowledge that can be used to hold companies accountable for environmental damages. As chapters 4 through 6 showed, it often does not do this very well because the knowledge fails to be credible to broad groups in society. In other words, the other dimensions of civic epistemology do not sufficiently support the EIA. Each section on illegibility documents the consequences this has on the ground: environmental impacts are fragmented and not prioritized to reflect their importance to local communities; risk, vulnerabilities and uncertainties in the data are ignored in favor of an appearance of certainty; and central questions of evaluation - like how much water do the glaciers produce, will the Baker be navigable, what will be the impact on local fish - receive ambiguous answers or answers that are never used to inform communities. The process works so that some questions - like had Barrick's and previous owners' operations in the Pascua Lama area already destroyed these glaciers beyond recovery? - are obscured in favor of questions the executive government is willing to take on.

The instrumental use of science by states faces challenges from two sources, publics and markets, according to STS scholars. The participatory-turn is meant to make technocratic decision-making more accountable and, ideally, make experts more embedded in social concerns. Public participation in the EIA in Chile is high - few other areas of policy have public participation - and was expanded in 2010. But expanding participation without empowering the state to be able to answer to people's demands is dangerous. This gap exits, as pointed out by Minister Golborne, and the popular idea of a legally binding public participation process is proposed as a way to close the gap in favor of communities. The state is weak in part because of the second contemporary challenge: markets. The "Great Society" where liberal democracies used science instrumentally to make informed decisions in an accountable way is giving way to a "Facilitator State" that manages a cacophony of informed voices (Ezrahi, 1990).

In the Facilitator State, the market produces knowledge as another product in response to short term needs and by private (unaccountable) actors. These actors are increasingly a new class of professionals: the "policy expert". No longer does the state "know best", but now policy knowledge lies in private think tanks and everyone is increasingly aware of the limits to knowledge. These characteristics describe Chile very well. Since the 1980s think tanks manned with technocrats have flourished, to the point that Chile's state institutions are no longer staffed with technocrats; these have all gone to work in the private sector and from there influence political parties (P. Silva, 2009). Respondents nearly unanimously had low trust in science as a whole. Scientific knowledge does not have the answers, many said. A participant in the Valdivia mill controversy stated it succinctly when he said "I trust an agreement more than a technological silver bullet." Reflecting the character of the Facilitator State, many

Chilean elites do not believe in the special authority of science, and this runs contrary to so much that is written about science and the state.

The state as neutral broker

Disbelief in science and privatized knowledge production co-exist in Chile with a view of the state as a neutral broker. Metaphors used to describe this kind of state included: "being the net on the tennis court", "drawing the lines on the soccer pitch", that Conama failed because it administered the EIA like "an orchestra without a director", or that "our role is just to coordinate", "move the process along", and "schedule meetings". State employees who review EIAs defined their job as narrowly apply the rules, not to defend the common good or even the state's interest in preserving or exploiting natural resources. Though there are margins of discretion - for example, Conama exercised some discretion in how it defined toxicity or in choosing to hire glaciologists to assess Barrick's second EIA - government employees do not see these as discretion. Instead, throughout my fieldwork, government employees emphasized that their job is to apply the rules and, compared to everyone else, were more likely to ask that I not record the interview. In other words, government employees are careful to stick to the script and shelter their authority in rules (like in Mexico, see Matthews, 2011). Reviewers' vision of good government coincides with their definition of "technical", as discussed above.

Nothing could be further from how activists see the government: as politicized and ignorant of the "technical" truth which would presumably favor environmentalism. This view was on display at an event on conflict resolution organized by the Consensus Building Institute from Cambridge, Massachusetts.[2] One of the takeaways was that, compared to the U.S., the Chilean state is more important and civil society less so to environmental governance. An experienced activist, Ximena Abogabir, enumerated graver differences: compared to the U.S., Chile has deeper inequality and power asymmetries, distrust (she had a slide that said "all universities are sell outs"), incoherent standards and rules, and a weak and highly suspect enforcement capacity. Though the Consensus Building Institute seemed to imply the Chilean state could act like a neutral broker - like the Institute does in the U.S. - participants rejected this idea because the state was responsible for legacies of inequality and injustice, and thus highly suspect. The challenge environmentalists and activists face is that, in a context where everything is distrusted as reflected in Abogabir's list, where the environment is radical as shown in this dissertation, and where the idea of the "technical" continues to have appeal, activists too must push environmental goals through the technical/political boundary.

Unlike Ezrahi's Facilitator State, the Chilean neutral broker state is not only the result of neoliberal policies. The state kept scientific advisors at arm's length well before the neoliberal turn of the 1970s, as discussed in chapter 2. Again, in contrast to so much that is written about science and the state, the Chilean state never had a

[2] Held April 1, 2011 at Diego Portales University, the conference was titled " Chile Conference on Dialogue, Collaboration and Conflict Resolution Among Communities, Companies and Government"

monopoly on knowledge or on representation. Science has always been weakly institutionalized and representation has been contested in Chile's democracy prior to 1973. Neoliberalism may have exacerbated existing tendencies, or may help recognize observed patterns, but does not fully explain the Chilean state's relationship to science. Likewise, mapping out the controversies to identify actors and their shifting identities, alliances and information flows, is not very useful when the center of the controversy is empty: there is a soccer pitch, referees, players, a ball but no goal markers. A different theory of the state is needed to describe these patterns.

Chilean politicians, environmentalists and other professionals return to the need for "a long term vision". This was one of the recurrent demands at CIPMA's eighth Congress for the Environment (the first one was in 1983, chapter 2). The event synthesized many of the changes described in this dissertation: thirty years after the first town hall style meeting, "science" had been dropped from the title and no scientists were invited to speak; industry was the major sponsor, including Arauco and several large mining companies; and the theme was "green options" to identify market opportunities for greener products. Only political voices were present - Senators, a mayor - but hardly any supposedly "technical" voices were present. It was all politics and business at the meeting.

Speeches followed a common pattern: most begun with a short inventory of Chile's beauties north to south and concluded with the need for a long-term vision. The state's role was to act as the catalyst and facilitator of "decisions democratically made by the community", but needed to be strengthened so it could speak as an equal to the private sector and adequately "draw the lines on the soccer pitch." Reflecting Chile's changing identity from developing to developed, some speakers called Chile resource-poor (there is no natural gas) and others called it privileged (only the will is lacking). Some were very critical of the EIA and existing institutions, and others were laudatory. Nearly everyone repeated, however, that there is a need for a long-term vision. The trouble is that the markets that dominate Chilean life do not require a long-term vision. Neither does a facilitator state whose main task is to draw the lines on the pitch. If it had a long-term vision, it may be tempted to play the game. Neutral brokers can not have long-term visions beyond ideals of consensus and negotiation.

A further problem is where would the facilitator state get the long-term vision from? Some speakers spoke of "decisions democratically made by the community", an idea that is reminiscent of the democratic fantasy for a legally binding public participation process. Activists and progressives are not alone in making these kinds of romantic statements about social consensus; at the third CIPMA encounter in 1989 industry hoped to get a list of "what society wants" with regard to environmental goods and a scientist called on his colleagues to produce a list of sustainable projects for every industry sector so as to project a clear goal that reflects a consensus over what direction the country should take. Consensus consistently appears as the dominant goal.

Another potential source of long-term visions is science. A few speakers called to strengthen the state's capacity "with solid science". Senator Guido Girardi said he would propose to create a group of scientific advisors for the legislature, arguing that in

Germany thousands of scientists advise Parliament but not one does so in Chile. As the event was coming to a close with a panel discussion with one representative each from government, civil society, the Church, small business and big business, disagreement about the proper role of science became explicit. The government speaker argued "scientists need to let us discuss in peace", without cryptic, technocratic language, the NGO speaker retorted that without information there is no serious dialogue. Interestingly, the role of science divided what until then had been two of the most cohesive voices on stage. Furthermore, the government speaker objected to scientific participation arguing that "when you look for an arbiter – a Nobel prize winner – you don't build consensus". The statement reflects the absence of regulatory science and over-reliance on academic science, combined with a good dose of misunderstanding science, as discussed earlier.[3] Above all, it signals out the fundamental tension around science: like an environmentalist, a scientist is dangerous because he or she will not negotiate. Consensus is only possible among flexible actors.

Successful regulatory science requires credibility, achieved through negotiations around the technical/political boundary. This boundary is very contested in Chile, as documented here, to the extent that different groups and communities draw the boundary in different places. The disputes are deep because the stakes are high: the role and responsibilities of the state to protect the environment and livelihood of many communities. Scientists have been largely excluded from the entire process, and so have critical communities, identified by scholars as important in this regard. In political science terms, critical communities could be called veto players - actors who have the authority and capacity to destabilize a decision. In the EIA, the veto players would theoretically be government reviewers. In Chile, however, reviewers are too bound by the rules to play this role. Criticism requires discretion and authority.

[3] It should be noted that the speaker is a prestigious social scientist, who held top positions in universities as well as high positions in the Ministry of Education and the State Department.

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