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NEW BATTLEGROUNDS OVER SCIENCE, RISK, AND ENVIRONMENTAL JUSTICE: FACTORS INFLUENCING THE CLEANUP OF MILITARY SUPERFUND SITES

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NEW BATTLEGROUNDS OVER SCIENCE, RISK, AND ENVIRONMENTAL JUSTICE: FACTORS INFLUENCING THE CLEANUP OF MILITARY SUPERFUND SITES

Jennie Liss Ohayon

Abstract

Combining quantitative and qualitative approaches, I examine the implementation of the Superfund Act on former US military bases, which represent the nation's most hazardous waste sites. First, I used data from 127 military Superfund sites for a quantitative analysis of how technical (e.g., the severity of contamination), political (e.g., budgetary priorities), and socioeconomic (e.g., race and income) factors contribute to how quickly sites are remediated. I found that the most contaminated sites do get tackled first, contrary to criticisms of Superfund as an inefficient and overly bureaucratic program. Although socioeconomic factors such as race and income seemingly have little effect on the pace of military site cleanups, qualitative fieldwork shows that economically and ethnically marginalized communities can be particularly vulnerable to the residual effects of a history of militarism. My qualitative fieldwork in California and Puerto Rico examines how widely adopted federal policies on environmental justice and community participation influence site cleanups and finds that (1) Communities may suffer from disproportionately poor health status, yet it is outside the jurisdiction of Superfund to redress any lingering effects from historical exposures to military activities. (2) Public participation is low in part because there are no formal mechanisms to ensure agencies are responsive to public input. Furthermore, participation programs are similarly restricted in addressing health concerns or any social impacts related to past military activities. (3) A lack of historical data on military activities and small and mobile populations make it difficult to reconstruct past health exposures. Taken together, these issues confound the ability of the military to implement its own adopted environmental justice strategies and diversify public participation, as well as respond to the broader

health, ecological, and social concerns of affected communities. I conclude with policy recommendations, including 1) the implementation of peer-reviewed evaluations of citizen advisory boards, 2) an increase in community capacity to participate in and influence cleanup programs, 3) better coordination of Superfund cleanup programs with existing government initiatives to assess and address disproportionate health impacts, and 4) the orientation of public health studies not at proving a causal relationship between poor health status and military toxins but rather at establishing what basic healthcare and health surveillance is needed at present.

Dedication

To my parents, Josephine Liss Ohayon and Arie Ohayon. For teaching me by example to go out on my own in the world and take risks, but who are always thinking and worrying about me while I am out there.

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And to my siblings Jonathan and Elan, who without any seeming hestitation will take on Olympian feats, literally, and seek to change entire fields.

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Chapter 1: Introduction

1.1. General description of the problem

Large amounts of US land were appropriated by the Department of Defense during the 20th century as the nation prepared and trained for significant military engagements, including two world wars and the Cold War. By the close of World War II, the land mass of the Department of Defense was 60 million acres, a land mass approximately equivalent to the size of Oregon[1]. While the rhetoric of national security underlay this expansion, this military legacy posed serious risks to domestic lives and resources. Before the 1980s, millions of acres of soil and water were contaminated in and around Department of Defense sites in the United States and its territories; a widespread lack of record keeping has made it difficult to exhaustively delineate the extent of that contamination. The Department of Defense has approximately 39,000 contaminated sites across the nation, although some may be as small as a single building (Nazaryan 2014). In the 1980s, estimates of the amount of pollution produced by the U.S. military were more than the combined amount of the largest 5 U.S. chemical companies (Baver 2006). In some cases, contamination spreads far beyond their points of origin in military sites, through transport by wind currents, leaching in drinking water supplies, or bioaccumulation in food webs. This puts surrounding communities at elevated risks of

[1] Currently, the Department of Defense has 4,127 installations spread across 19 million acres of American soil (Nazaryan 2014). The Department of Defense dwarfs private land managers and is the fifth largest manager of federal lands.

cancers, respiratory illness, and other diseases, and can cause harm to wildlife (Hall et al. 1995, Hu et al. 2007, Currie et al. 2011)[2].

Until the late 1970s, few laws regulated the disposal of hazardous wastes by private industry and none applied to the military.[3] In 1980, the passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund Act, gave the EPA authority to compel polluters to remediate land with substances hazardous to public health and ecosystems. The Superfund Act was passed by the United States Congress in a flurry of action after the declaration of a federal and state emergency at the Love Canal, New York.[4] The Superfund Act, however, did not originally cover federal properties, and the military was at first exempt from environmental regulation. Congress passed the Superfund Amendments and Reauthorization Act ("SARA") in 1986, which requires the Department of Defense to comply with the Superfund Act and with other state and federal environmental statutes and regulations.[5,6].

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[2] For example, Currie e al. (2011) found that living near a Superfund site can increase congenital anomalies in newborns between 20 to 25%, underscoring the importance of remediation.

[3] Some states pursued limited pollution control against the military. For example, the State of California began regulating environmental conditions at military installations in the early 1970s, mainly through water pollution laws and discharge permits administered by the Regional Water Quality Control Boards.

[4] In the case of the Love Canal, New York, homeowners called for relocation and compensation after connecting high rates of illnesses, birth defects, and miscarriages in their community to their homes and schools being located above an abandoned toxic waste dump in Love Canal, New York. The Superfund Act was passed in response to their environmental activism.

[5] In addition to bringing federal agencies under Superfund purview, SARA required greater coordination between Superfund and other environmental laws, mandated greater public participation in environmental decision-making, increased state involvement in cleanup activities, and provided new enforcement authorities and settlement tools.

While the passage of the Superfund Act compelled the military to address the issue of toxic waste at their sites, this process was facilitated by the closure of military bases around the country throughout the last two decades. Since 1988, the DOD has streamlined its domestic operations by shutting down over a hundred major bases in five rounds of base closures governed by the Base Realignment and Closure Commission (BRAC). With the closure of bases, these installations are subject to new forms of public and scientific scrutiny and political and legislative oversight from federal, state, and local governments, including under the Superfund Act. Although remediation occurs at operational bases as well, base closures necessitate addressing environmental contamination in order to transfer land to new property owners; cleanup activities thus generally receive greater attention once a base has been selected for closure (GAO 2007).

The Department of Defense (DOD) ranks among the nation's top polluters. Within the Superfund Program, the EPA developed a National Priorities List (NPL) of

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[6] From 2003 to 2008, the DOD repeatedly sought broad exemptions from several federal environmental laws arguing that it needed to maintain training flexibility and military readiness. Congress enacted certain exemptions to the Migratory Bird Treaty Act, the Marine Mammal Protection Act, and the Endangered Species Act, but denied exemptions to the Superfund Act, the Resource Conservation and Recovery Act (another hazardous waste law), and the Clean Air Act (Sislin 2005, Bearden 2008). The DOD requested exemptions despite leniencies already built into the laws (e.g., the military is only required to address munitions on their lands if they are abandoned and no longer serving intended purposes) and existing provisions to allow the U.S. president to grant case-by-case exemptions from each of the laws. If the exemptions to hazardous waste and clean air legislation had been granted, it would have reduced opportunities for government and public oversight of hazardous material management at DOD sites. There is a lack of evidence that environmental compliance requirements negatively impact military readiness. No president has ever denied a DOD request for exemptions from environmental statutes. The few extraordinary cases where hazardous waste cleanup requirements or litigation affected military operations, for example at the Massachusetts Military Reservation, occurred when the DOD did not respond to widespread contamination migrating off-range and severe public health threats; this then necessitated federal regulatory invention (Sislin 2005).

the most contaminated and hazardous sites. As of December 2013, of the listed 1313 NPL sites, 130 are military sites; military Superfund sites thus comprise approximately 10% of the overall most hazardous sites in the United States[7]. Of the NPL sites in which the responsible party is a federal agency, the DOD comprises 83% of these sites (or 130 of 156) (see Fig. 1-1). Military Superfund sites are located across the United States, occuring in almost 80% of states (see Fig. 1-2) and in the U.S. territories of Guam and Puerto Rico. They are largely concentrated in densely populated coastal areas. California alone has over 15% of Superfund mlitary sites. Approximately 1 in 10 Americans, or around 29 million, live within 10 miles of a military site that is listed as a national priority for hazardous waste remediation under the Superfund program (Eisler 2004).

Beyond proprietary DOD installations, land owned by other federal agencies and private entities are also affected by military munitions and contaminants. Defense contractors and other private corporations are often responsible for manufacturing weapons, such as explosives, for commercial sale to the military. The Department of Energy sites host nuclear waste contamination linked to military research and war efforts. In total, about 900 of 1200 Superfund sites are either abandoned military sites or facilities that produced materials for the military, were used to landfill military waste, or otherwise supported war efforts (President's Cancer Panel 2010). [8] As there are

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[7] The no longer active Military Toxics Project estimated that contaminated sites under the jurisdiction of the military numbered in the several thousands in the U.S., much more than the number of sites on the National Priorities List (NPL) of Superfund sites.

[8] For example, Pinette's Salvage Yard in New England hosts hazardous waste and toxic materials from Loring Air Force Base. Sites such as this one are on Superfund's NPL, but the military is not listed as a responsible party.

additional sites with cleanup and remediation projects governed by regulatory frameworks other than the Superfund Act, such as the Resource Conservation and Recovery Act[9,10], the true extent of military contamination extends beyond that strictly associated with military Superfund sites. This dissertation, however, restricts itself to the analysis of military Superfund sites in order to examine the level of equitability and the decision-making dynamics inherent in the program's implementation. Military Superfund sites encompass the most contaminated land in the U.S. and its territories, and provide good testing grounds for interactions among responsible parties, key regulatory agencies, and communities.

Due to this lack of environmental regulations for much of the 20th century, few provisions were made to manage the large quantities of chemically and radioactively contaminated wastes. Hazardous waste was disposed of directly into wetlands, surface ponds, and lagoons, in burn areas, and in unlined trenches, shallow pits, and landfills.

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[9] While there are many similarities between the Resource Conservation and Recovery Act, enacted in 1976, and the Superfund Act, they are not identical statutes. RCRA addresses hazardous materials intended for imminent disposal or recycling at facilities currently in operation, while CERCA addresses hazardous materials and contaminated sites that are no longer in use. The requirements for the public participation process are more comprehensive under the Superfund process, as the Superfund process anticipates and encourages public involvement throughout the investigation and cleanup actions. Superfund also requires a community relations plan and information repository and communities can apply for assistance to hire independent technical advice through the Technical Assistance Grant (TAG) program.

[10] Hazardous waste laws in the United States, such as the Resource Conservation and Recovery Act and Superfund Act, are focused on end-of-stream management. These laws do not restrict the quantity of hazardous waste that can be generated, but rather focus on the management and disposal of wastes or hazardous waste remediation. Some wastes, such as heavy metals or radioisotopes, cannot be broken down, reduced or eliminated with known technologies but can only be excavated and disposed of in an offsite landfill or contained *in situ* and subject to long-term stewardship. Both of these options have risks, either for communities living adjacent to the site or for communities where hazardous waste is transported.

Some of the wastes generated were vented directly into the environment as volatile gases. Massive tanks and small drums that housed wastes can currently be found in a variety of conditions ranging from leaking to better contained.

This improper disposal and containment of chemicals has consequences for public health and wildlife. For example, the Rocky Mountain Arsenal, a former military base just north of Denver, Colorado, served as a major sarin stockpile and place of pesticide production. Estimates are at least 20,000 ducks died in a 10-year span after exposure to highly contaminated waste in open disposal basins.

At Camp LeJeune Marine Corps Base in North Carolina, water sampling tests during 1982 indicated the presence of volatile organic compounds at up to 280 times the amount considered safe for drinking water consumption (Roig-Franzia and Skipp 2004). An estimated 50,000 people came into contact with that water before the closure of the base's wells in 1985 (ibid). Since then, hundreds of related tort cases have been filed against the Marine Corps, with plaintiffs accusing health exposures at Camp LeJeune to be responsible for elevated rates of childhood cancers, birth defects, and male breast cancer.

In 1997, at the Massachusetts Military Reservation on Cape Cod, the EPA suspended training activities and ordered comprehensive cleanup activities after carcinogenic munitions-related chemicals migrated from the installation into an aquifer that provided drinking water for hundreds of thousands of residents. Major Pentagon pollutants, such as perchlorate, Royal Demolition Explosive, trinitrotoluene, and dinitrotoluene, were found in public water wells at concentrations far above safe drinking water standards.

The above illustrates just a few examples of the nature of military contamination and how it can spread beyond base boundaries and affect adjacent communities and ecology. Military sites pose a challenge to environmental management approaches that are used to focusing on relatively small sites, with few contaminants and few contaminated environmental media. In contrast, military Superfund sites tend to be spread over vast physical terrain and have extensive and complex contaminant profiles.

Most sites have widespread contamination of multiple environmental media, including soil, water and air. Practically all sites have problems with groundwater contamination and soil contamination (94 and 97% respectively; see Fig. 1-4).

Contamination results from typical "industrial" uses and includes petroleum products, volatile organic compounds (e.g., industrial solvents), metals, flame retardants, pesticides, and polychlorinated biphenyls (Fig. 1-3). It can also include more "exotic" military compounds used in training exercises and experimentation, such as explosives (e.g., perchlorate, trinitrotoluene, dinitrotoluene), unexploded ordnances (including bombs, rockets, guided missiles, grenades, and landmines), radiological materials, nerve agents, mustard gas, napalm, and Agent Orange. With respect to active and closed military installations, over 15 million acres of U.S. land is contaminated with unexploded ordnance, munitions, and munitions constituents such as propellants (GAO 2003). The cleanup of these military munition sites alone is estimated to cost between $8 billion to $35 billion (ibid); this variance in range estimates is due to uncertainty in the extent of contamination and the costs to remediate.

The cleanup task for remediating former military sites is enormous. Most military Superfund sites are thousands of acres in size (median size in acres is 4,458, with the

range being 8 to 76,800). Cleanup costs are also high; the average cost per year spent on all military sites is $948 million.[11] Cleanup costs are projected to total billions of dollars and extend over many decades. The Government Accounting Office (2004) projected that the costs for cleaning up of all contaminated installations ranges between $16 billion and $165 billion. Contamination often tends to be much more extensive, and expensive, than original estimates. Overall the Department of Defense's task of cleaning up contaminated installations has been deemed "daunting" (GAO 2007).[12]

It is impossible to undo some of the harms to ecosystems, other species, and past generations, as well as eliminate all harms to current and future ecological and public health. The term "cleanup" can be a misnomer as some contaminants and risks are managed rather than eliminated. Hazardous wastes that cannot be destroyed, such as metals and radionuclides, are merely contained within landfills, barrels, or behind fences. When sites, or portions of sites, are not remediated to levels that allow for unrestricted access, long-term monitoring is required to restrict human access or guard against further environmental releases. The effectiveness of these initiatives will rely to a great extent on the willingness and ability of future institutions to manage the hazard, factors which current cleanup programs have little influence over.

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[11] Statistics compiled by author based on DOD Congress Report (FY2010) and EPA site summary pages.

[12] In military site summaries to congress it is typical to see statements that reference how there is far more contamination than originally imagined and cleanup costs will be significantly higher. For example, at Fort McClellan, a 2002 estimate for an area of the base projected a cost of clearing the lands of munitions at $11,390,250. A subsequent cost estimate in 2003 anticipated a cost that had almost doubled to be $22,562,200 (GAO 2003). Cleanup costs can also increase if there is political pressure to clean larger areas of contamination.

Nevertheless, the Superfund Act made identifying and remediating contaminated sites a national priority and remains the primary resource to do so despite expiration of the original legislation that financed cleanup with a tax on the chemical and oil industries and repeated political attacks.

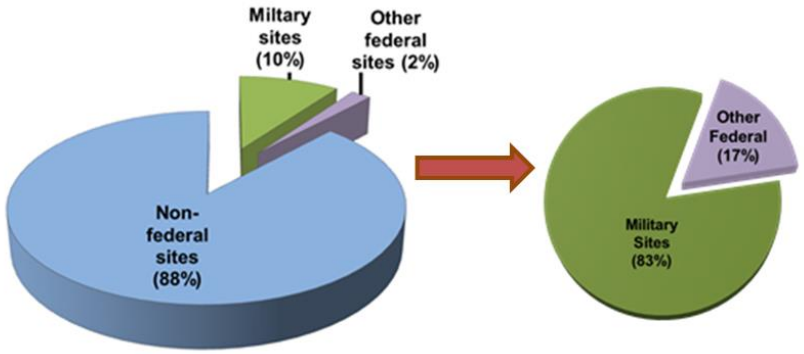

Fig. 1-1 Proportion of Superfund sites that are military sites

The larger pie graph displays the percentage of total sites (n=1313) on the National Priorities List that are non-federal sites, military sites, and other federal sites (the 2% of non-military federal sites are made up of sites where the responsible party is either the Department of Energy, Department of Agriculture, Department of Transport, National Aeronautics and Space Administration, Department of Interior, or the Environmental Protection Agency). The smaller pie graph demonstrates the portion of federal sites on the NPL where the military is the responsible party.

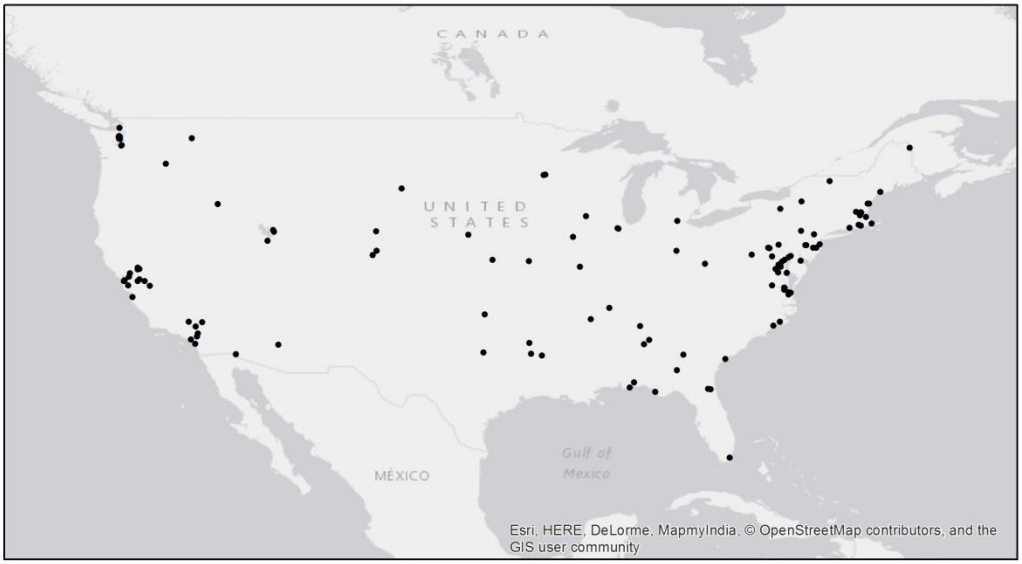

Fig. 1-2 Map of U.S. military Superfund sites in the 48 contiguous states

In addition, there are 5 military Superfund sites in Alaska, two in Hawaii, and one each in the U.S. territories of Guam and Puerto Rico. (Map created by author in ArcGIS)

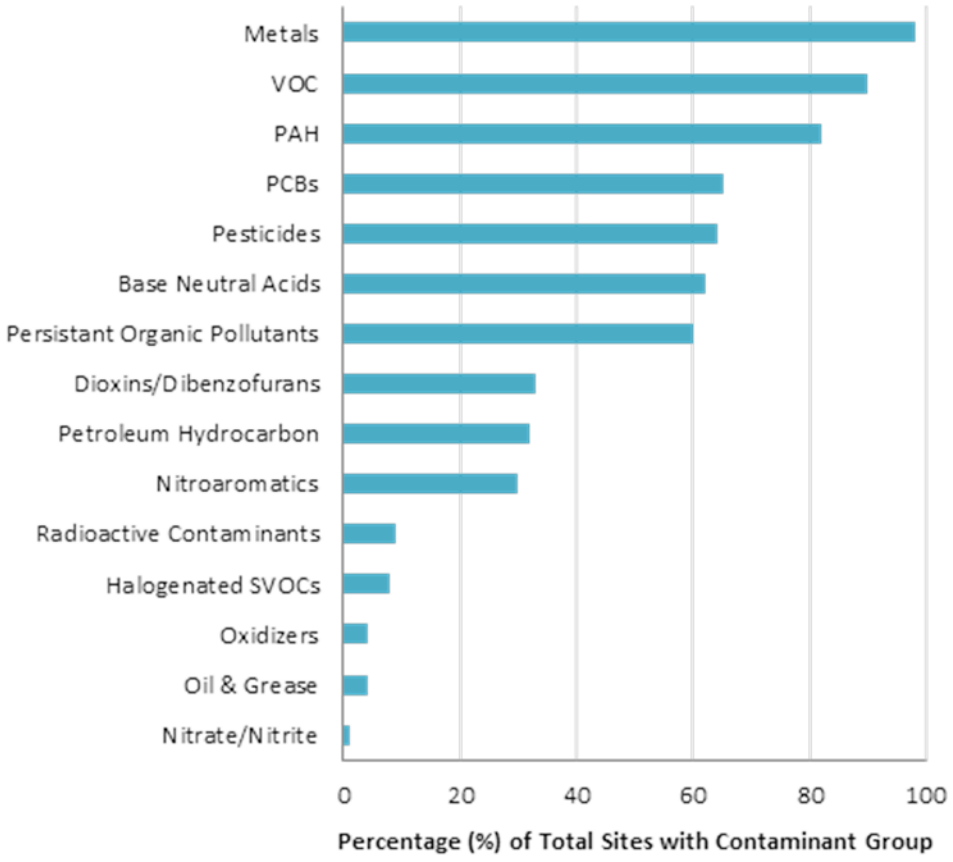

Fig. 1-3 Percentage of total sites with presence of contaminant groups

N=123. 7 NPL military sites were omitted as the EPA currently lists these sites as having insufficient information on the extent and nature of contamination. Some sites that include information on contamination still have ongoing investigations, so figure represents best available data to date. Data compiled and summarized by the author from information on EPA site profiles.

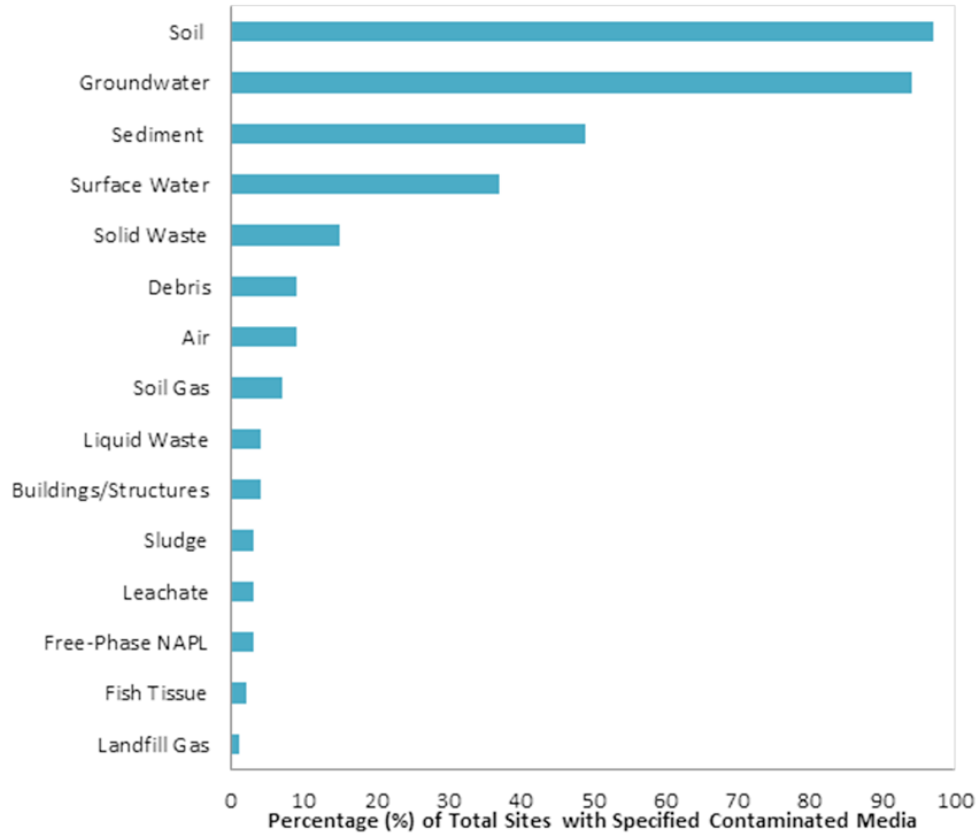

Fig. 1-4 Percentage of total sites (n=124) with problems of contaminated media

Percentage of total sites (n=124) with problems of contaminated media. 6 NPL military sites were omitted as the EPA currently lists these sites as having insufficient information regarding contaminated on-site media. NAPL refers to non-aqueous phase liquid. Data compiled and summarized by the author from EPA CERCLIS databases.

1.2. The multiple actors and factors influencing cleanup

The implementation of the Superfund Act brought together a variety of actors to negotiate and mediate the cleanup and reuse processes. Among these diverse actors what constitutes a comprehensive investigation and monitoring into site conditions, an appropriate pace of remediation, and sufficiently protective cleanup goals can be highly contested. Given the complexity of environmental and health hazards, issues rarely lend themselves to exact measurements, predictions, and control. Cleanup decisions are often made in light of incomplete knowledge about the nature and extent of contamination (e.g., affected land acreage, types of contaminants, and quantity of contaminants) and the health and ecological risks that may arise from exposures. The presence of an extended peer community to interrogate remedial decisions, including regulators and public participants, is particularly important when the science is uncertain, decision-making stakes are high, and values are in dispute (Funtowicz and Ravetz 1993). In the following section, I highlight how scientific and political issues inform each other in military Superfund cleanups and justify the importance of multiple actor participation, including participants from the public.

The Department of Defense is the Lead Agency during Superfund cleanup. This means that the military determines the resources it is willing to spend on cleanup, and can select its own cleanup methods, investigation strategies, and post-remedial monitoring approach. The Superfund Act, however, gives the EPA oversight of investigations, cleanup, and plans for long-term operation and maintenance for sites on the National Priorities List and has the final authority to select a remedial action if it

disagrees with the Department of Defense's selection. The Department of Defense must comply with cleanup standards and processes under all applicable laws, regulations, and executive orders, although the use of risk-based cleanup processes means that cleanup alternatives are negotiable based on site reuse objectives (e.g., institutional controls which limit human activities or access to property typically have lower cleanup standards). The 1986 amendments to the Superfund Act also strengthened state involvement in the cleanup process. States have authority to recommend sites for placement on the National Priorities List and can become members of cleanup teams and consult on remedial activities. They can also sue the DOD if they do not agree with a remedial program. While local governmental entities have a limited role under the Superfund program, remediated land is often transferred to cities or counties and the military will enter into negotiations with these actors over acceptable cleanup standards.

Since the late 1980s, a spate of policy initiatives led to a dramatic increase in federal agencies soliciting community input into remediation processes (Charnley and Engelbert 2005). When the Superfund Act was amended in 1986, in addition to the Department of Defense coming under its purview, there were provisions to expand public participation. These amendments required federal agencies to discuss with the public the range of possible cleanup alternatives and justify alternatives selected (e.g., through public meetings and public comment periods). In 1994, military sites went beyond these requirements by also establishing citizen advisory boards at most closing bases through a DOD/EPA partnership. The Restoration Advisory Boards (RAB) allow for local residents and community groups to have ongoing communication with the

military and regulatory agencies over cleanup activities. By 2003, less than ten years after their establishment, there were already almost 300 active RABs.

Academic scholars, activists, and practitioners called for extending public participation in scientific and technological decision-making due to the chronic uncertainty and value judgments that underlay calculations of environmental risk and remedial programs, and in order to increase accountability and incorporate the priorities of communities in decision-making (Funtowicz and Ravetz 1993. Shrader-Frechette 1993, Brown 2000, Dryzek and Tucker 2008). In the case of the remediation of contaminated military sites, the institutional function of the DOD is not one of environmental management and a main objective is to remediate the site inexpensively and transfer the land to a new owner. DOD cleanups have been criticized as being slow, and lacking specific goals and performance measures to track progress (GAO 2003) Citizens, regulatory agencies, or other actors may prioritize efficient and comprehensive site cleanup and demand increased accountability and transparency concerning cleanup progress. They also may display more precaution with respect to cleanup, attracting attention to environmental risks previously neglected (Brown 2000).

Superfund itself was the legislative legacy of Love Canal, New York. While the community in Love Canal was only one of many affected by hazardous waste, effective community organizing catapulted the site to the national consciousness and precipitated a paradigm shift in hazardous waste legislation. Within the military context, stories abound of the Department of Defense expanding investigations or cleanup activities as a result of prodding by concerned citizens and regulators. The military often does not actively responded to health problems associated with its operations absent significant

pressure from those affected, advocacy groups, or the media (President's Cancer Panel 2010). For example, Camp Lejeune received nationwide attention due to highly publicized stories of residents of the base suffering miscarriages, stillbirths, birth defects, child illnesses, and what is believed to be the largest known cluster of male breast cancer. The military responded after years of allegations and significant public pressure, including public participation in Restoration Advisory Boards and a large class-action lawsuit. As a result, the Department of Defense established a registry of potentially affected people, a website, and an information call center for those seeking information about possible exposure or exposure-related health problems.

Moreover, diverse stakeholder participation can be important not only to ensure accountability, transparency, and thoroughness in cleanup activities, but also given the political and social dimensions of environmental risks. The analysis of environmental risks have traditionally been restricted to engineering or other technical traditions or theorized as social constructs (Jasanoff 1993). This bifurcation is an inadequate formulation for understanding the remediation of hazardous wastes and toxic chemicals. In the remediation of military sites, controversial environmental decisions, such as waste disposal strategies, residual risk levels, and what technology to utilize, are not purely scientific issues but rather choices that entail complex interactions between technical considerations and sociopolitical values and ethics. These choices are influenced by conflicting accounts of acceptable environmental and social risks (e.g., "how clean is clean?", "what level of residual risk is acceptable?"), how cleanup levels will affect possibilities and restrictions for future land use, what remedial methods and technologies

are available, and agency assessments regarding the political, policy, and budgetary feasibility and desirability of various alternatives and investigations[13].

In the early days of Superfund, the prevailing view was that contaminated site remediation should be comprehensive and permanent; the original objective was to remediate sites to pre-contamination levels and return them to productive use (Ruckelshaus 1983, Burger et al. 2004). This objective has been replaced with an approach that favors cleanup standards for health and environmental risks that are associated with the future use of a site; cleanup standards can be lower if a site is slated for non-residential uses (Borinksy 2011). With the focus on a risk-based approach to cleanup, the emphasis is often on onsite engineering control activities (for example, *in situ* containment measures through installing cement caps over contaminants and constructing slurry walls), institutional control activities (e.g., fences, warning signs, deed and access restrictions, monitoring, and declaring contaminated groundwater and well water as non-potable), and natural attenuation rather than complete excavation and disposal off-site or reduction by treatment of hazardous substances[14].

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[13] One of the first steps in Superfund remediation is to develop the Remedial Investigation and Feasibility Study, where the Lead Agency delineates what is feasible and influences subsequent scientific investigations and remedial activities.

[14] The 1986 Superfund Amendments and Reauthorization Act (SARA), which amended the original Superfund legislation in a number of ways, underscored the preference for treatment of hazardous waste and permanent remedies to the maximum extent possible rather than restricting exposure through institutional controls. The 1986 Superfund Amendments favor remedies that "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances" (42 U.S.C. 9621(b)(1). A conflict in Superfund arises from its aim for total, permanent cleanup and the procedural aspects of the act that considers multiple remedial alternatives and selects the one most "practical",

Cleanup standards are tied to goals for future land uses, underscoring how remediation is not just an issue of technical precision. Estimating risks requires assumptions about the duration of exposures, frequency at which exposure occurs, ingestion rates for water and soil, and chemical concentration and toxicity. When characterizing the cancer and non-cancer risk pathways at a site, questions pertaining to the current or future use of the site, the populations exposed (residents? workers?), and population location (living onsite or offsite?) determine risk estimates. Industrial land use designations or wildlife refuge designations require less stringent cleanup requirements than future residential land use designations. Lower cleanup standards have formed the justification for conversion to wildlife refuges for dozens of severely contaminated military sites (Havlick 2007). An emphasis on institutional controls, such as restricting access or activity at a site, has been controversial amongst many communities (NRC 2003).

As all risks assessments entail tradeoffs among competing political and social priorities, justification can be made for an extended peer community to deliberate alternatives. There are tradeoffs involved with digging up and removing contamination (e.g., health exposure risks during excavation activities and risks to the communities that

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which is guided in part by cost considerations (Borinsky 2011). Furthermore, since the mid-1990s, the EPA began administrative reforms that emphasized that future land use of a site is an important factor for establishing the level of remediation selected for a site. Engineering and institutional controls are favored for sites in which human exposure will be restricted.

live next to the landfills where waste is relocated) versus the risks associated with leaving containment in place through fences or caps (e.g., deferring of costs and health risks to future generations or potential accidents that might result). The removal of soil and vegetation during remedial activities may be disruptive to particular species, while, in contrast, leaving pollution in place can entail health risks for humans. A purely scientific evaluation of harm is impossible given the number of trade-offs and assumptions that risk assessments entail (e.g., What types of public health, ecological, and cultural damages are worth assessing? Which workers, members of the public, plants, and animals are of concern during risk assessments?). The role of scientific information is thus not just aimed at what is technically possible, but also what is socially desirable.

In addition, to conflicts over future land use, and its relationship to cleanup standards, risk assessments are often fraught with uncertainties about the toxicity of contaminants, alone and in mixtures, their hazardousness over time, hazard transport and fate, realistic exposure scenarios for humans and nonhumans, the location and extent of contamination, appropriate units of measure during investigations, what constitutes comprehensive stewardship monitoring, and so on. These multiple uncertainties mean that cleanup deliberations can be controversial and politically contested among Department of Defense actors, federal and state regulators, local governments, tribal nations, citizen advisory boards, and community members and organizations.

For example, the EPA's efforts to set pollution limits on two common military contaminants, trichloroethylene (TCE), a chlorinated solvent primarily used for metal degreasing, and perchlorate, a munitions ingredient, were aggressively challenged by the

Pentagon.[15] These delays contributed to years of unregulated emissions. For both these contaminants, the participation of regulators and toxic advocacy groups were critical in the battle for stringent regulation[16].

Others, however, are skeptical of the influence of regulators and the public on DOD's cleanups. For example, the Government Accountability Office (2007) has accused regulators of lacking the muscle to compel the Pentagon clean up its many messes.

In summary, the participation of multiple actors can broaden the discussion of environmental and social risks, bring to light assumptions and tradeoffs present in assessments of risk, and ensure increased federal accountability in cleanup programs. Given the complexity of the scientific decision-making processes, and the political backdrop in which they occurs, my dissertation is interested in the factors that influence cleanup of military sites and how policies on public participation and environmental justice shape Superfund cleanup decisions.

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[15] The military is one of the primary contributors to TCE and perchlorate contamination in the nation's groundwater and public water systems (EPA 2014). 90 percent of domestically produced (high grade) perchlorate is manufactured for military or aerospace purposes (ibid). From 1997 to 2009, the Department of Defense reported perchlorate detections at almost 70 percent of its installations sampled (GAO 2010; ITRC 2005). The DOD is responsible for more than 1000 military properties nationwide polluted with TCE (EPA 2011). In 2001, the EPA released a risk assessment draft for TCE that calculated the contaminant to be five to 65 times more toxic than previously estimated. The risk assessment triggered a lengthy battle between the EPA and DOD, as the latter worried that tougher cleanup standards and exposure limits would significantly drive up cleanup up costs. The Pentagon also had a longstanding challenge to EPA regulatory action on perchlorate. These battles both delayed the ability to apply federal regulations to these contaminants.

[16] For example, in 2012, the EPA set the first federal drinking water standard for perchlorate, reversing the stance of the previous administration; the determination to regulate perchlorate was bolstered by almost 39,000 public comments.

1.3. Environmental Justice and military Superfund cleanups

Environmental justice has gained prominence within policy circles in the last two decades. President Clinton's Executive Order of 1994 (#12898) instructs federal agencies to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities." To meet the intent of the Executive Order, a year after its release, the Department of Defense published their 1995 Strategy on Environmental Justice policy report. The outlined goals in the DOD's Strategy largely align with the directives outlined in the Executive Order and include supporting data collection and research on the health effects of its actions on minority and low-income populations, evaluating current risk methodologies as they relate to affected populations, considering cumulative exposures in risk assessments, and ensuring diversity in public participation initiatives.

Given these two decades of policy evolution and grassroots organizing on environmental justice, this dissertation addresses two key issues: 1) Are Superfund cleanups prioritized equitably across communities with different socioeconomic backgrounds?, and 2) How is environmental justice policy translated into actual cleanup programs, health assessments, and public participation programs?

Despite the DOD being a major federal agency, responsible for the majority of contaminated federal lands in the U.S., there is little published on environmental justice in the military context. The links between military contamination and environmental justice has been the subject of little empirical analysis and is largely under-theorized.

A number of studies have demonstrated the presence of racial, ethnic, and income disparities in the geographic distribution of other types of hazardous waste sites (Stretsky and Hogan, 1998, Pastor et al. 2001, Ringquist 2005, Saha and Mohai 2005, Smith 2009, Bullard, Mohai, Saha, and Wright/UCC 2007)[17]. These studies lent academic credibility to a burgeoning environmental justice grassroots movement.

Environmental inequity concerns are not just restricted, however, to the distribution of hazards; there can also be environmental injustices in the designation process, their prioritization, and finally their remediation. In addition to inequalities in the geographic location of Superfund sites, studies found that sites located in poor or ethnically and racially disadvantaged communities are less likely to be placed on the Superfund's National Priorities List (Lavelle and Coyle 1992, Anderton et al. 1997, Sigman 2000, O'Neil 2007), are slower to be remediated once on the NPL, and

[17] While many studies have indicated that hazardous waste sites will be concentrated in socioeconomically disadvantaged communities, findings have been mixed. Some studies have found that race and ethnicity is more strongly related to the location of sites than income (UCC 1987, Mohai and Byrant 1992, Ringquist 1997, Hird and Reese 1998, Campbell 2010). Other studies have found income is a more salient predictor for disproportionate exposures (Asch and Seneca 1978, Anderson et al. 1994, Wolverton 2009). There is evidence that both income and race relate to risks of exposure to toxins (Boer et al. 1997, Downey 1998, Arora and Cason, 1999, Smith 2009). Still other studies have not found any evidence of any patterns of disparate impacts (Anderton et al. 1994, Oakes et al. 1996, Bowen 2002). Studies can come to varied conclusions based on the geographical units of analysis (Anderton et al. 1994, Stretesky and Hogan 1998, Bowen 2002), region (Heitgerd et al. 1995), whether rural or urban (Stretesky and Hogan 1998), the sorts of facilities they study, and if appropriate comparison regions were used to draw contrasting results (Bowen 2002). Furthermore, the number of socioeconomically disadvantaged people living close to toxic sites could be underestimated by biases in Superfund listings or the formal discovery of hazardous waste sites. Hird (1993) found that Superfund sites are more likely to be in counties that are, on average, wealthier and more educated, indicating that the beneficiaries of the program are likely more affluent. Nevertheless, taken as a whole, the literature has provided clear evidence of disproportionate exposures in many disadvantaged communities (Ringquist 2005).

experience lower quality cleanups (Lavelle and Coyle 1992). No one, however, has looked at similar cleanup dynamics for military sites. In Chapter 2, I investigate whether disadvantaged communities are disproportionately located next to military sites, as well as whether socioeconomic and demographic factors affect the progress of military Superfund cleanups.

Furthermore it is unclear whether mandated public participation and environmental justice policies affect cleanup decisions. In Chapter 3, I investigate whether environmental justice has been translated into cleanup programs, public participation programs, and health assessments. As federal policies on environmental justice and public participation became more firmly entrenched in the mid-1990s, this allows for an analysis of the success of policies in meeting their objectives after two decades of implementation. With respect to militarism and environmental justice, work has explored how the military has systematically exposed Native Americans and indigenous lands to military toxins (e.g., see, Ishiyama 2003; Hooks and Smith 2004). Other work has looked at the effects of militarism on the Marshall Islands and the integration of environmental justice principles into social movements challenging militarism (Johnston 2008, Baver 2006). This is, to the author's knowledge, the first work that critically assesses how the military translates federal environmental justice directives and strategies into actual cleanup practices.

1.4. Structure of Dissertation

The central focus of the dissertation is what factors influence the pace of military Superfund cleanups and whether these cleanups take into account community health concerns and the impacts on racial and socioeconomically disadvantaged communities. Little academic attention has been paid to the implementation of the Superfund Act in military properties. The Department of Defense's cleanup efforts are particularly important given that DOD sites comprise the bulk of federal sites on Superfund's National Priorities List and the significant public safety, human health, and ecological risks posed by military pollution. The goal of this dissertation is to identify opportunities for cleanup processes to be improved. Are there certain factors that can stall cleanup processes? Are cleanup processes equitable with respect to the socioeconomic characteristics of adjacent communities? Do military Superfund cleanup programs address community concerns and promote environmental justice? Do public participation programs provide meaningful opportunities for communities to influence cleanup programs? I use a combination of qualitative and quantitative approaches to address these questions.

In Chapter 2, through an analysis of compiled databases for 127 military Superfund sites, I identify and describe patterns in federal Superfund implementation. Specifically, I look at how socioeconomic (e.g., race and class characteristics of adjacent communities), political (e.g., budgetary priorities), and technical (e.g., severity of contamination) factors influence how quickly sites are remediated. Overall, bureaucratic implementation of Superfund has been controversial, with both industry representatives and

environmentalists critique Superfund as being slow and making inconsistent progress (Daley and Layton 2004, Rahm 2008). This chapter answers questions such as, why do some military sites move through the remedial process more quickly than others? Why have some made very little progress? Do sites get cleaned up slower when adjacent communities are poorer and/or communities of color?" **"**Do better funded and larger sites get cleaned up quicker?" "Do more contaminated sites get addressed quicker (e.g., due to urgency) or slower (e.g., as they are more complicated to address)? My study is the first to analyze Superfund program implementation in the context of the military contamination and as such provides insights to what influences the cleanup of a significant amount of contaminated U.S. land.

Contrary to expectations, I did not find evidence that population density, race, or income characteristics for surrounding neighborhoods exert significant influence on how fast a site moves through the Superfund process. Rather the types and severity of contamination most influence the pace of remediation. The more contaminated sites tend to be responded to quicker, while certain types of contamination will prolong the amount of time it takes to reach a later stage of Superfund cleanup. This is contrary to criticisms of the Superfund act as inefficient and overly bureaucratic as the worst contaminated sites do appear to get tackled first.

In Chapter 2, I did not find that the pace of remediation is strongly influenced by the socioeconomic characteristics of surrounding communities. I also found that the distribution of military sites across the country is similar to that of the general population (i.e., military sites are not disproportionately concentrated in low income communities). If poor populations and communities of color are not subjected to slower cleanups than

why would environmental justice policy apply at all? One caveat is that the speed of the cleanup process can be a vague indicator of the justice of remediation (i.e., a faster cleanup can be a result of less comprehensive and permanent remedies rather than a prioritized response). Moreover, as my qualitative work illustrates, multiple factors are important in determining the justice of being adjacent to a military base, including issues of consent, potential health exposures and illnesses, and if the community was socially and economically integrated into the base.

Chapters 3 and 4 focus on how federal policies for environmental justice and community participation influence site cleanups. I employ three case studies, two in California and one in Puerto Rico. All three case studies have complex contamination and wide-ranging cleanup programs. They also have challenges to agency cleanup plans, (including through protests, propositions, and lawsuits), alleged or unexplained illnesses, and active participation from multiple community, governmental, and private-based stakeholders. Examining public participation and environmental justice strategies in areas with high interest and debate over cleanup programs gives insights into the opportunities and barriers for these programs to incorporate public input and environmental justice concerns.

Chapter 3 looks at whether environmental justice policy improves the ability for federal agencies to respond to community health concerns, and other impacts that resulted from being adjacent to a military base. To analyze the DOD's environmental justice practices, I employ a case study of Vieques, Puerto Rico. Due to the nation's status as a territory of the United States, Superfund policy applies to the island. For over six decades, the populated island of Vieques was used as a training base for the Navy,

including intensive bombing from land, air, and sea. Vieques, as a low-income, ethnically marginalized community with evidence of poor public health status, provides an important case study for analyzing environmental justice implementation. While Vieques is undergoing environmental remediation under federal statutes and regulations, there is a contentious political climate over the extent to which military waste and past weaponry testing can be implicated in illnesses and ecological degradation. On one hand, island residents, and the scientists and lawyers representing them, are insistent that elevated mortality and disease rates are because of military waste and weaponry testing on the island. Military and regulatory representatives, including the Agency of Toxic Substances and Disease Registry (ATSDR), however, argue that there is little conclusive evidence of this and have challenged the interpretation of "independent" studies.

In Chapter 3, I describe key restrictions to translating federal environmental justice policies into actual cleanup programs. These include: (1) It is outside the jurisdiction of Superfund to address the residual health effects from past and persistent exposures to military contaminants. Community members, however, are concerned not just with current and future exposure risks, but also with the potential health effects of these past exposures. (2) Despite the increased focus on public participation initiatives for meeting environmental justice goals, public participation is low in part because there are few formal mechanisms or evaluation programs to ensure agencies are responsive to public input. Furthermore, participation programs are restricted in addressing health concerns or other issues related to past military activities. (3) A lack of historical data on military activities and environmental conditions, in conjunction with small and mobile populations, make it difficult to reconstruct past health exposures. Taken together, this

confounds the ability for the military to respond to its own adopted environmental justice strategies, as well as the broader health, ecological, social, and political conditions upon which the movement is based. While legislation and base cleanup teams equate environmental justice with a technological feat of waste removal and containment, and public participation programs that address this, community members and groups are also concerned with the broader, residual effects of military contamination on their health, livelihoods, and social wellbeing.

In chapter 4, I look at how public participation programs have been incorporated into military site cleanups and the impediments there might be for these to influence cleanup programs. While academic literature and policy initiatives emphasize the importance of public participation in environmental decision-making, many sites have experienced little participation, or attrition over time, or significant conflict among agency and community stakeholders. Given the serious challenges this poses to the legitimacy of these programs, alongside the vast resources dedicated to them, it is critical to analyze the barriers that contribute to less than desirable policy outcomes.

In Chapter 4, I employ two Californian case studies to examine institutional approaches to involving communities. The central questions are 1) What are the main institutional and political constraints to citizen influence over decision-making processes? 2) What should the structure of citizen advisory boards be according to different actors? 3) Why have citizen advisory boards failed in particular contexts (i.e., the gap between policy promise and performance)? I focus on two case studies of citizen advisory boards, or RABs, in California that were disbanded by the military due to adversarial climates. While RABs encourage ongoing discussions and discursive

challenges to the ways in which state actors represent and respond to risks, I expand in this chapter on the issue that there are few mechanisms to ensure that public participation results in substantive changes in agency practices. I argue that formal evaluations of agency responsiveness to public participation programs and advisers hired through the EPA's Technical Assistance Grant program are particularly important in sites where long-standing socioeconomic and environmental inequalities have strained government-community relations and made collaborative approaches more difficult.

Chapter 5 consists of concluding remarks. It highlights important areas for future study, as well as makes policy recommendations.

While my quantitative analyses give insights into the factors that influence how quickly sites are cleaned up, the qualitative work allows me to explore the health, social, and political impacts of military waste and how particular policies on public participation and environmental justice are implemented in practice. The qualitative case studies give insights into the lives and livelihoods of affected publics, the types of exposures that are of concern, and the ways in which public input may or may not be incorporated into decision-making structures. Issues such as whether or not environmental decision-making is democratic and reflective of diverse stakeholder participation can be better answered by more in-depth case studies.

1.5. Work Cited (Chapter 1)

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Chapter 2: Factors influencing the pace of environmental remediation at Superfund military sites

2.1. Abstract

Former military sites represent some of the largest, most severely contaminated, and expensive Superfund cleanups in the country. This article analyzes why some military Superfund sites progress through the remediation process quicker than others. I used data from 127 military sites for a quantitative analysis of how technical (e.g., the complexity of contamination), political (e.g., budgetary priorities), and socioeconomic (e.g., race and income) factors contribute to how quickly sites are remediated. Contamination factors tend to exert the most significant effect on how quickly sites progress through several cleanup milestones, while political and socioeconomic factors have less influence on program implementation. I found that the most contaminated sites do get tackled first, contrary to criticisms of Superfund as an inefficient and overly bureaucratic program. While larger proportions of non-white residents and lower median household incomes do not substantially influence cleanup priorities, future studies should examine whether socioeconomically disadvantaged communities receive lower quality cleanups.

2.2. Introduction

Decommissioned military bases are subject to federal, state, and local government oversight and attract various forms of public and scientific scrutiny. Until the late 1970s, few laws regulated the disposal of hazardous wastes by private industry and none applied to the military. Following the declaration of a federal and state emergency at the Love Canal, New York[18], the United States Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund Act, in a flurry of action during the final days of the 96th congress (Skillern et al. 1995). The passage of the Superfund Act in 1980 gave the EPA authority and limited funding to identify and compel responsible parties to remediate land with hazardous substances that may endanger public health and ecosystems. Within the Superfund Program, the EPA developed a National Priorities List (NPL), a list of the most contaminated and riskiest sites.

The program was legislated in the final days of the Carter administration, but the early days of the program took place under the unsupportive Reagan administration. These days were characterized by mismanagement until the resignations of the then-EPA administrator and Superfund Program Administrators (Daley and Layton 2004, Johnson and DeRosa 1997, Rahm 2005). For years congress did not reach an agreement

[18] The Superfund Act itself was passed in response to the environmental activism of homeowners seeking relocation and compensation after becoming aware that their homes and schools were located above an abandoned toxic waste dump in Love Canal, New York. Residents reported high rates of unexplained illnesses, birth defects, and miscarriages and this was corroborated by the Environmental Protection Agency.

to reauthorize the special tax on chemical and petroleum producers, which had created the Superfund's trust fund, leading to dwindling reserves in Superfund's trust fund. This unsupportive political climate and rocky inception to the program mired it in controversy from detractors on all sides of the political spectrum. Business interests repetitively accused the program of being expensive, inefficient, and detrimental to economic development. For their part, environmentalists complained that the program progresses slowly and does not address hazardous waste management effectively (Daley and Layton 2004, Rahm 2005). Given this controversy over program implementation, studies have attempted to elucidate what factors affect the speed of remediation. My analysis is the first to do so with respect to military Superfund sites.

The military was at first exempt from environmental regulation because CERCLA did not originally cover federal properties. Congress passed the Superfund Amendments and Reauthorization Act (SARA) in 1986, which requires the Department of Defense to comply with CERCLA and other state and federal environmental statutes and regulations; these amendments also broadened opportunities for community participation and suggested cleanup standards. To date, the EPA lists 130 military sites among the 1320 Superfund sites as military sites; military sites thus comprise about 10% of the most hazardous designated sites (federal and "private") in the United States[19]. Furthermore, the Department of Defense (DOD) is responsible for over 80% of the

[19] The number of sites on the National Priorities List (NPL) of Superfund sites is a small percentage of the overall number of contaminated sites under the jurisdiction of the military. Other sites might be subject to other environmental regulations such as the Resource Conservation and Recovery Act.

Superfund sites in which the responsible party is a federal agency are DOD sites[20]. Military-related activities are therefore responsible for the majority of contaminated federal lands in the U.S. and a significant portion of overall contaminated lands.[21]

Contamination is typically complex, with many types of contaminants and environmental media being affected. Hazardous substances that may occur include those associated with typical industrial uses, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, volatile and semivolatile organic compounds(VOCs and SVOCs), heavy metals (e.g., mercury, arsenic, copper, lead), and pesticides. The military is also responsible for some of the largest national discharges of certain contaminants and hazardous waste, including unexploded ordnance and other munitions, solvents (e.g., trichloroethylene), explosives, radiological waste, biological warfare material, and chemical weapons (e.g., white phosphorous, napalm, mustard gas, chlorine gas, and sarin nerve agent). These hazardous substances have diverse negative acute and chronic public health effects, including cancer, and hazardous effects on the immune system, reproductive system,

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[20] While over 80% of the federal NPL sites have the DOD as the responsible party, there are several more sites that supported military activity but were shared or transferred to another agency (such as NASA or the EPA); in these cases, the latter agency might currently be the lead agency for cleanup. Moreover, many of the federal NPL sites in which the Department of Energy is the lead agency are contaminated due to the military's radiological defense program (e.g., nuclear weapons were produced in these sites). Finally, several "private" NPL sites have contamination as a result of military activities (e.g., private contractors who were producing weapons for sale to the military). As a result, these statistics underestimate the true impact of military contamination nationally.

[21] Statistics were generated by the author by compiling data on individual sites from the EPA's NPL database. See http://www.epa.gov/superfund/sites/query/queryhtm/nplfin.htm; Accessed November 16, 2013.

nervous system, endocrine system, and on fetal and child development (Hall et al. 1995, Hu et al. 2007, Currie et al. 2011). In addition to these public health effects, contamination can cause ecological impacts, including death, bioaccumulation of contaminants, growth impairment, reproductive impairment, and loss of critical habitat.

2.3. An overview of potential factors influencing program implementation for military Superfund sites

Given the scope and severity of military contamination, I analyze the key factors that influence program implementation for military Superfund sites. This includes how technical (i.e., extent of and complexity of contamination), political (i.e., cleanup budgets and community participation), and socioeconomic factors (i.e., population density, income, and race) contribute to how quickly a military Superfund site is remediated.

While other studies have analyzed how various factors influence Superfund remedial progression, these previous studies have either excluded federal sites from the analysis, due to their complexity or inherent institutional differences, or have run analyses on federal and private sites together (e.g., Viscusi and Hamilton 1999, Burda et al. 2014, Daley and Layton 2004, Hird 1993, Sigman 1998, Petrie 2006). By focusing on military sites, I address a critical omission in the literature, given that the DOD is a main actor in the Superfund Program (responsible for over 80% of federal sites and 10% of all federal and non-federal sites). Furthermore, Superfund is already notorious for its complexity, yet DOD sites encompass some of the most difficult sites to remediate given the magnitude and technical challenges of military contamination, its risks to human and ecological receptors, and the immense cost of cleanup (funds spent until the

end of fiscal year 2010 were over 18 billion dollars[22]). While non-federal Superfund sites often cover relatively smaller swaths of physical terrain, and have just a few key contaminants of concern, military sites typically have many different contaminants and contaminated media, and are spread out of vast stretches of land. The science and technology to address particularly complex and novel pollution problems, such as chemical weapons or unexploded ordnance, can be in their infancy.

Adding multiple other federal and state agencies into the cleanup process, versus just the EPA who has Lead Agency status for private sites, complicates implementation of the program (Daley and Layton 2004). The DOD is the Lead Agency during cleanup under the Superfund program, meaning the military determines the money it is willing to spend on cleanup, and can select its own schedules, cleanup methods, investigation strategies to determine the extent and nature of contamination, and post-remedial monitoring approach[23]. The EPA has oversight of the cleanup of military Superfund sites and enters into negotiations with the military; its jurisdiction, however, is more restricted than with the private sector.

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[22] Statistics are compiled by the author from FY2010 DOD reports to Congress.

[23] The Superfund Act gives the EPA oversight of investigations, cleanup, and plans for long-term operation and maintenance for sites on the National Priorities List, yet the EPA's jurisdiction with other federal agencies is more restricted than with the private sector or state and local government (Rahm 2005). While the EPA is the lead agency on private sites, for remedial actions on federal facilities, the EPA must negotiate an Interagency Agreement and has less direct authority. Other governmental agencies, such as the state-level EPA and the Department of Toxic Substances Control, can be members of cleanup teams and influence remedial activities. While local governmental entities have a limited role under the Superfund program, remediated land is often transferred to cities or counties and the military will enter into negotiations with these actors over acceptable cleanup standards.

Furthermore, the racial and socioeconomic composition of host neighborhoods may influence the pace of remediation. An increase in the awareness and investigation of environmental justice was precipitated in large part by the publication of the Commission for Racial Justice Study for the United Church of Christ in 1987. This study observed that hazardous waste facilities were disproportionately located in areas with large non-white populations. Environmental justice research and policy subsequently became institutionalized into agencies' programs and practices, in part a result of President Clinton's 1994 Executive Order 12898 to address environmental justice. In the past two decades the Department of Defense and other federal agencies have adopted mandates of identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income communities.

Substantial evidence indicates that lower socioeconomic status populations, defined by some combination of racial, ethnic, and poverty characteristics, are more likely to live near hazardous waste sites as compared to higher socioeconomic status populations (UCC 1987, Zimmerman 1993, Rinquist 1997, Szasz and Meuser 1997, Stretesky and Hogan 1998, Gayer 2000, Pastor and Hipp 2001, Saha and Mohai 2005, Mohai and Saha 2006, Bullard, Mohai, Saha, and Wright/UCC 2007, Smith 2009, Sigman and Stafford 2010, Eckerd and Keeler 2012). Environmental injustice is not restricted, however, to the disproportionate siting of and proximity to environmental hazards; there can also be inequities in environmental risk abatement. For the Superfund process, this could translate into environmental injustices in the designation, prioritization, and remediation of hazardous waste sites. Empirical research indicates that sites located in

poor and ethnically and racially disadvantaged communities are less likely to be placed on the Superfund's National Priorities List (Lavelle and Coyle 1992, Hird 1993, Anderton et al. 1997, Sigman 2000, O'Neil 2007), are slower to be remediated once on the NPL, and experience lower quality cleanups (Lavelle and Coyle 1992,). Eckerd and Keeler (2012) examined a larger set of hazardous sites, encompassing those not on Superfund's National Priorities List, and found sites are more likely to be cleaned up slower if located in areas with a higher proportion of non-white residents.

Other results, however, have been mixed in tying unjust cleanup results to race, ethnicity, or poverty indicators. Hird (1993), for example, found that, once a site is in the Superfund pipeline, how quickly a site is progresses through the phases of site investigation, cleanup decisions, and remediation does not depend on the socioeconomic characteristics of the host counties but rather contamination characteristics. Burda and Harding (2014) found that communities with higher rates of unemployment and a larger share of the population which is urban and black experienced slower cleanups at the onset of the Superfund program, but that degree of discrimination appeared to lessen over time; the authors attribute the passage of Executive Order 12898, which mandated federal agencies take environmental justice into account in their programs, of reprioritizing resources for faster cleanups in socioeconomically disadvantaged communities. In contrast, however, O'Neil (2007) found that Superfund site listings for several racially marginalized and poor populations were less likely for sites discovered since the 1994 Executive Order, indicating that the Executive Order had not increased the equitability of the Superfund program.

No one has looked at if there are patterns of inequities in the risk abatement of military bases; the links between military contamination and environmental justice has been the subject of little empirical analysis and is largely under theorized. To add to the extant literature of EJ indicators and the dynamics of site remediation, I analyze how socioeconomic indicators influence how quickly a site moves through the Superfund military cleanup process.

2.3.1. *A stage-based approach*

In addition to being the first study to look at Superfund implementation in the context of the military, this study contributes to the existing literature on Superfund remediation in that it considers multiple stages in the process. There are numerous indicators of a site's remedial progress prior to its removal from the National Priorities List. The CERCLA remedial action process, as defined in Title 42 USC Section 9601 and the following sections, clearly specifies the different stages that a site must go through to investigate the nature and extent of the contamination, to identify and evaluate cleanup alternatives, and then to proceed with actual remediation (see Fig. 2-1).

Following NPL listing, the Remedial Investigation/Feasibility Study (RI/FS) phase of the process determines the nature and extent of contamination and assesses the technologies that could be used to clean the site. A RI/FS outlines various alternatives for cleanup actions and requires a public comment period. After the RI/FS, the first cleanup action typically occurs. The construction completion phase signifies that all major physical or engineering tasks required for cleanup has been completed, even

though final cleanup levels might not have been attained. Even though all physical infrastructure is in place, the post-construction phase may still require maintenance and monitoring activities, restricting public access, or continued remedial activities (such as the pump and treatment of groundwater). To point to problems with bureaucratic implementation of the program, critics often highlight how very few sites have been delisted since the inception of the Superfund program (Rahm 2005). The low percentage of sites being delisted, however, is in part because remedial activities themselves can take a long time to reduce contamination to final cleanup levels. For example, pump and treat groundwater remediation will often need to be in place for many years before contaminants have attained cleanup goal levels. Not being delisted does not necessarily mean cleanup is not underway. Recognizing how policymakers' and public perception of Superfund progress may not reflect actual programmatic activity, in 1993 the EPA introduced the metric of Superfund Construction Completion List for assessing Superfund achievements. By this metric, a much higher percentage of sites qualify as a success story. For example, from 1993-2004 over 500 sites reached the construction complete phase as compared to only 156 sites that achieved construction completion in the first thirteen year period of the program (1980-1993; Daley and Layton 2004).

Other quantitative analyses of Superfund progress often focus solely on the time it takes from listing to reaching the construction complete event (the penultimate event before the site is delisted) rather than analyzing various different stages separately. My initial data exploration phase, however, indicates that the times taken for various Superfund stages are not correlated with each other. That is if a site has one stage that goes slowly (e.g., time of listing to finalization on the NPL list) this does not typically

mean that another stage (e.g., time of first cleanup to construction complete) will likewise progress slowly. Given this, it is likely that factors have different importance, with respect to inhibiting or increasing the speed of program progression, at various stages. For example, demographic and socioeconomic factors, such as the surrounding residential density and racial and economic makeup of adjacent neighborhoods, may be more important in early stages of the process, such as determining how fast a site goes from being listed to having its first Remedial Investigation and Feasibility Study. Technical factors might become more critical in later stages of the program, such as influencing how long it takes for a site to achieve construction complete for all remedies. It is thus important for investigations to have a multistage model.

I analyze why some military sites move faster through the Superfund remedial process than others. I first give an overview of the distribution of military sites through various stages, including investigating and analyzing cleanup alternatives and implementing and completing remedial responses. I then analyze the actual factors that might influence programmatic progression (i.e., lengthening or shortening time) through these different stages (see Table 2-8 to Table 2-11for a detailed description of factors). These factors can broadly be divided into three categories: **(1)** contamination variables (e.g., the extent and severity of contamination), **(2)** political variables (e.g., cost of cleanup), and **(3)** demographic variables (e.g., the race and class characteristics of nearby communities). While other literature tends to focus on a single stage, such as the time it takes to achieve construction complete, this might not accurately represent the progress of a site; this is true particularly for large and complex sites with multiple types of contaminant and multiple media being affected (e.g., water, air, and soil), as is the case with most military

sites. For example, Daley and Layton (2004) found that sites with more severe predicted contamination (i.e., how contaminated the site is thought to be when proposing it to the NPL) are less likely to reach the construction complete stage. The authors then conclude that less contaminated sites reach the construction complete stage more quickly because the EPA deals with the less complicated sites first despite their mission to tackle the "worst" contamination first. This conclusion, however, does not consider that "easier" sites might have reached the construction complete milestone earlier not because the EPA remediates "easier" sites first, but because there is less challenging contamination to address within these sites. As such, reaching a later stage first does not always signify more cleanup activity. I thus consider various stages of program implementation to give more holistic insights into how various factors influence the level of cleanup activity, insights which would be missing from an analysis of just the time from formal entry into the Superfund program until construction is complete.

2.3.2. Expectations for relationship between factors and the time to complete a stage

For contamination factors, if the military responds quicker to more contaminated sites, then I expect the duration of earlier stages such as Listing- Remedial Investigation/Feasibility Study and time to first cleanup action to be shorter when there is more contamination. Later stages, such as Listing-Construction Complete, might take longer as there is more contamination to address (see Table 2-1). These different stages include investigating contamination and debating cleanup alternatives, the actual site remediation, selecting the final remedy, and having all cleanup technology put into place.

I expect that sites with higher expenditures will reach early stages, such as the Listing-RI/FS, more quickly. While for private sites the majority of sites are cleaned up with money from responsible companies, and the rest are funded with tax revenues, cleanup for military sites is appropriated from within the DOD budget. Some have criticized this funding mechanism, stating that cleanup competes with other DOD priorities. Resource constraints could thus delay cleanup activities. It is difficult to predict how funding correlates with other stages, such as the time from listing to first remedial action, as remedial actions can vary; for example, remedial actions vary from less expensive capping approaches that contain pollution *in situ* to more expensive technologies that pump contaminated groundwater to the surface for treatment in an aboveground reactor. If a majority of cleanup activities in the military site utilizes less permanent cleanup technologies, or relies on natural attenuation, then the site might reach the Construction Complete stage quicker and relatively inexpensively (i.e., budgetary spending might actually be negatively correlated with how quickly a site

progresses through the program, particularly for later stages of program implementation) . Nevertheless, I thus expect that more funding allocated would reflect positively on program implementation (i.e., would cause military sites to progress through different stages of the process faster).

I would expect there to be an issue of environmental inequalities if sites in racial and socioeconomically disadvantaged communities experienced a different rate of cleanup. This could be particularly apparent during the early stages of program implementation, such as undertaking the first Remedial Investigation/Feasibility study. For the first Remedial Investigation/Feasibility Study, I expected statistically significant negative coefficients for the socioeconomic and demographic characteristics to indicate biases in remediation with respect to the pace of cleanup. A slower rate of cleanup in this case would likely signify that Superfund site cleanups are not being prioritized in these communities and this would be incompatible with environmental justice considerations. Conversely, however, I expect that a longer amount of time to reach construction complete could have two explanations: 1) sites are not being prioritized or 2) cleanup remedies take longer to complete because they are more comprehensive. In this case, without finer scale details on cleanup remedies selected, it would be difficult to tell if a longer time to complete cleanup activities is a result of environmental inequities. Nevertheless, if stages take longer to complete based on the socioeconomic makeup of adjacent neighborhoods this could signal that communities are being treated differently.

Specific questions I address are: (1) Contamination: *How does the extent and complexity of site contamination affect how quickly it progresses through the various stages of Superfund remediation? Are larger sites cleaned up more quickly (for example, due to the likelihood of political*

awareness) or more slowly (as contamination may be more expansive? **(2) Budgetary priorities:** *How do allocated funds influence how quickly a site progresses?* **(3) Environmental justice indicators:** *Do military sites where adjacent socioeconomic makeup are poorer communities and/or communities of color experience slower program implementation, as they are not prioritized politically, or faster program implementation, as cleanup methods are less comprehensive?*

While this study looks at factors that influence Superfund progression, it does not make the same assumption of some earlier studies that faster progression is equivalent to successful progress. Throughout time there has been a shift from cleaning up sites to residential standards to adopting more institutional controls (e.g., containing pollution though capping or fencing off) and deed restrictions. This shift has happened largely because of the high costs associated with permanent and complete cleanup remedies in federal facilities, but also because there may be technical barriers to providing a better solution. Thus faster progress does not imply that the final cleanup standards attained and remedies implemented will be acceptable to all social actors. Nevertheless, assessing the factors that influence site progression at different stages is critical for insights into the dynamics of the Superfund process.

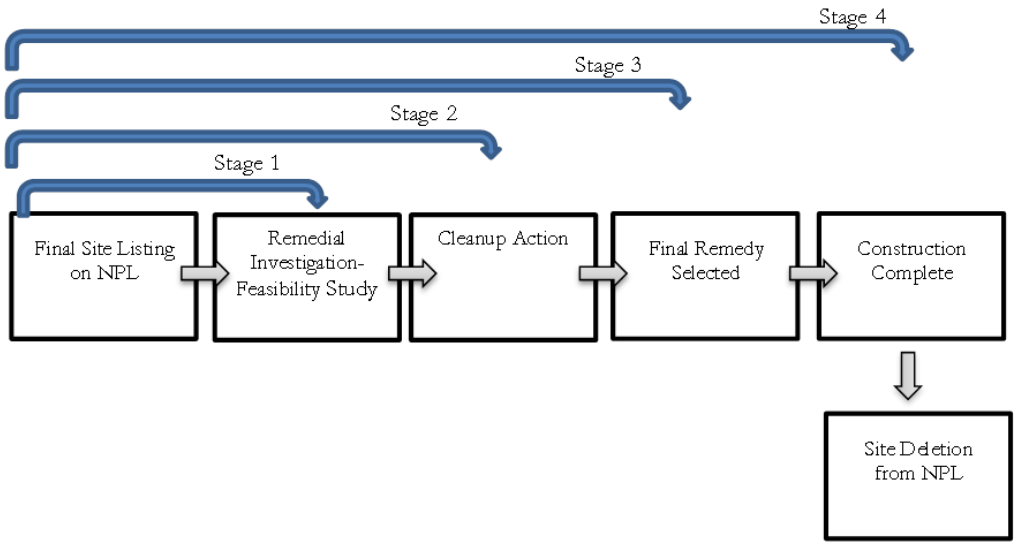

Fig. 2-1 The different stages of Superfund remediation used in our analysis

The schematic shows progression through different events in the Superfund program with arrows above indicating the stages of cleanup that I analyze. An event refers to a milestone in the Superfund process (e.g., the final listing on the NPL or the first cleanup action), whereas the stage is the difference in time between milestones. The stages are numbered in this figure and referred back to in Table 1.

Table 2-1 Description of stages analyzed and how factors are expected to influence their length

A down arrow (↓) means a factor or time decreases, an up arrow (↑) indicates that a factor or time increases. "EJ group" refers to environmental justice communities (i.e., communities that have higher proportions of low-income and non-white populations)

Dependent Variables	Description (Source: EPA CERCLIS database)	Expected Relationship to variables
Stage 1: Listing-RI/FS	Time in number of days between formal listing on the National Priorities List and the first Remedial Investigation/Feasibility Study.	Contamination ↑, time ↓ Funding ↑, time ↓ EJ group ↑, time ↑
Stage 2: Listing-First Cleanup	Time in number of days between formal listing and the first cleanup action.	Contamination ↑, time ↓ Funding ↑, time ↓ EJ group ↑, time ↑
Stage 3: Listing-Final Remedy Selection	Time in number of days between formal listing and final remedy selected.	Contamination ↑, time ↑ Funding ↑, time ↓ EJ group ↑, time ↑↓
Stage 4: Listing-Construction Complete	Time in number of days between formal listing and construction complete.	Contamination ↑, time ↑ Funding ↑, time ↓ EJ group ↑, time ↑↓

2.4. Study context and methods

2.4.1. Overview of remedial stages

I use survival analysis to analyze the pace of Superfund site remediation, specifically the Cox (1972) proportional hazards model. Proportional hazards models for duration data relate the time required to complete an event to a number of covariates. I employ survival analysis to predict the likelihood (or "hazard") of a site progressing to the next stage in its cleanup given the socioeconomic and demographic characteristics of surrounding communities, site-specific characteristics (i.e., contamination and site size), and the resources allocated to cleanup. Data is analyzed in R version 3.0.0. I included all Superfund sites where a branch of the military is the lead agency overseeing cleanup. Superfund sites where there are multiple responsible actors, including other government agencies or private potentially responsible parties, were excluded from analysis. Overall, 127 military Superfund sites were analyzed.

I look at the time differences between four different milestones of the remediation process, using the listing date on the Superfund's National Priorities List as the initial starting point for all cleanup stages. The different events in the process that I use to calculate time stages are final listing on the NPL, the start of the first Remedial Investigation and Feasibility Study (RI/FS), the first cleanup (either a remedial action or a time-critical removal action), the date of final remedy selection, and when the construction of remedies are complete (see Fig. 2-1). I created the dependent variables as the time it takes (in days) between different steps in the process (see Table 2-1). For example, the stage of Listing-RI/FS is the amount of days it takes from a site being

officially listed on the NPL until it has its first remedial investigation and feasibility study.

Stages were selected to be representative of different milestones in the process, collectively comprising site investigations and feasibility studies, actual remedial activities, and the overall duration of cleanup activities. For example, the Listing-RI/FS stage (Stage 1) gives insights into how long it takes for investigations and negotiations over cleanup alternatives to be initiated. The time it takes for the first cleanup action to begin after being included in the National Priorities List (Stage 2) gives insights into what factors influence actual remedial processes. Finally, the stages Listing-Final Remedy Selection (Stage 3) and Listing-Construction Complete (Stage 4) give insights into what factors influence the overall lifespan of the decision-making process and cleanup activities. I analyzed all stages with NPL listing as the start time, as intermediate stages often do not correspond directly; for example, depending on the length of time it takes to complete the investigation and feasibility studies, and how soon after the cleanup approach gets implemented, the first RI/FS might be developed for a different remedial action than what turns out to be the first remedial action. I did not analyze how long it takes for military sites to be delisted from the program as only 12 have achieved this end stage and statistical calculations would not be robust. The dates for steps in the Superfund progress were compiled from the EPA's inventory of hazardous waste sites, known as the Comprehensive Environmental Response, Compensation and Liability System (CERCLIS). All historic and current Superfund data is publicly available from this database.

Progress is slow for many sites and, for certain sites, they might not have reached a particular cleanup milestone. Excluding these observations from the analysis, however, would bias the results since they contribute important information regarding the time-to-completion of the various remediation phases; sites that have not reached a particular milestone might contain valuable information as to what factors might impede site progress (Eckerd and Keeler 2012). Survival analysis allows all data to be used in analyses by counting the number of days that they are in a particular stage and noting whether sites are "noncensored" (have completed that stage milestone) or "censored" (have not completed that stage milestone). Stages were right censored, as is typical in survival analysis. For stages which had not been completed by the EPA's Fiscal Year 2013 program progress reporting (the last time in which a complete and accurate dataset on Superfund program implementation was available to the public as of early 2015), December 31, 2013 was inputted into the database. Many of the observations were censored for later stages.

Sites that had stages that were negative were excluded from the analysis, as survival analysis requires stages to happen across sites in the same consecutive manner. Stages could be negative, for example, if a site initially is remediated under different cleanup legislation (for example, the Resource Conservation and Recovery Act) but later is inducted into the Superfund program or if an emergency cleanup response happens before being officially added to the Superfund program. In both these cases, the first cleanup action would happen before NPL listing and this inversion, relative to the typical process, would result in the stage of Listing-First Cleanup being negative. After removal of negative stages, 100 sites were analyzed for the Listing-RI-FS stage, 108 sites were

analyzed for the Listing-First Cleanup stage, and all sites were included in the analyses for both the Listing-Final Remedy Selection and the Listing-Construction Complete stages.

2.4.2. Variable selection

I look at a variety of independent variables including ones that signify technological and political complexity and the socioeconomic characteristics of surrounding populations (see Table 2-2 to Table 2-6). The data was collected from the EPA's CERCLIS database, National Institute of Health databases, and DOD congressional reports.

The principle mechanism for NPL listing is based upon acquiring a threshold score on the Hazardous Ranking System (HRS). The HRS is a numerically-based screening system that scores sites by considering the toxicity and quantity of the waste involved, the likelihood of a site release of hazardous substances, and the surrounding environments and number of people who are in danger. Sites are scored from 0 to 100; sites that meet a minimum threshold of risk (HRS scores of 28.50 out of 100 or above) are eligible for the NPL, although other factors are considered before listing on the NPL (e.g., the views of the states and politicians). While other studies have similarly employed HRS as a proxy for site contamination (e.g., Sigman 1998, Daley and Layton 2004), this ranking occurs early in the process and with limited inspections of the extent and nature of the contamination. It is not uncommon for site toxicity and exposure risks to be greatly underestimated early on in the Superfund process. Given that there is not enough information to sufficiently delineate the extent of contamination, HRS scores do not prioritize sites for cleanup nor determine the cleanup remedies or funding required

(more detailed studies during the Remedial Investigation/Feasibility Study event do), but rather are used for NPL listing decisions. I thus expect HRS to be weakly related to overall cleanup duration. Nevertheless, as it is the only summary score available for the intensity of contamination, I employ it as a proxy of how contaminated a site *may be*, in addition to how contaminated a site *is perceived to be* early in the process (which in turn can influence how federal agencies determine priorities, time-detailed studies, and remedial actions). Uncertainty about the nature and extent of contamination is often ubiquitous in Superfund cleanup (Zimmerman 1998) and can be critical in shaping cleanup outcomes, as it can either delay cleanup schedules or instigate action if the threat is perceived to be high.

As the HRS score is a crude composite measure of contamination severity and risks, I also analyze various other factors to estimate site toxicity and the complexity of cleanup. Many sites have varied contaminated media and numerous contaminants that need to be addressed. I thus include indicator variables for the presence of particular contaminants (e.g., dioxins, pesticides, radioactive waste, munitions), and the presence of the type of contaminated media (e.g., sediment, soil, surface water). Despite the EPA widely reporting on whether or not petroleum substances are present in a site for Superfund-related documentation, petroleum is typically remediated under non-CERLCA environmental regulation. I therefore exclude petroleum from the analysis. In addition, I analyze the total number of contaminants for each military installation as a function of the sum of contaminants (present=1, absent=0) and the total environmental media contaminated as a function of the sum of environmental media affected (affected=1, non-affected=0). The hazardousness of each site can only be roughly

estimated this way as I do not have data on the quantities of each contaminant for all sites. Nevertheless, I believe including the nature of contaminated media and types of contaminants is an accurate and comprehensive representation of the challenges encountered at the site and the degree of difficulty in addressing site cleanup.

In addition, I include indicator variables for how many individual areas within a single military installation are being remediated by including the number of areas in the Installation Response Program (IRP) and Military Munitions Response Program (MMRP). Superfund military cleanups are governed under the Defense Environmental Restoration Program, which in turn has two subcomponents; 1) the Installation Restoration Program, which focuses DOD resources on the cleanup of traditional industrial contaminants found on military ranges, and 2) the Military Munitions Response Program, established in 2001, to address health and safety hazards resulting from unexploded ordnance and munitions. I predicted that the Hazard Ranking System score would be important in the early stages of the process, such as time to a remedial investigation or first cleanup action, as it relates to how contaminated a site is perceived to be. In contrast, I expected that the number of areas in an installation being remediated under the MMRP and IRP would be more critical for determining how long an installation remains in the program (with an increasing number of MMRPs and IRPs lengthening the time to complete construction of all cleanup remedies).

The overall installation size at closure was included in analyses. While the size of the base at closure does not necessarily reflect the size of the contaminated area (the size of the contaminated area is not always known nor does it always have readily available data), it may be a rough indicator of how large the investigation area may extend. As the

size of site is a rough indicator of technological complexity, I consider site size to also be a political variable: larger sites may receive greater political attention.

I also include two measures for site cleanup costs. It is important to note that measures of cost reflect two distinct things: they reflect both the political prioritization of a site for remedial actions (with higher priority sites likely receiving more funding) and how contaminated a site may be (with more contaminated sites potentially receiving more funding). These two measures comprise 1) the total projected cost of site cleanup (which is a product of cleanup expenditures until the end of fiscal year 2010 and predicted future costs of completion) and 2) the costs of cleanup on a site per year (a function of money spent on cleanup until the end of fiscal year 2010 divided by how many years a site had been in the program). Often the DOD's cleanup progress reports to Congress note one of the following statements: "The cost of completing environmental restoration has changed significantly due to technical issues" or "The cost of completing environmental restoration has changed significantly due to changes in estimating criteria." As the complexity of contamination is often underestimated, the total projected cost may be only a crude approximation of the final scope of the project; nevertheless, it can reflect how toxic agencies perceive the site to be or how critical it is for agencies to have a thorough cleanup.

To empirically test if there is racial, ethnic, or class discrimination in the pace of Superfund progress, I analyze data for adjacent census tracts on human population density, percentage of non-white population nearby, and median household income. Using census tracts has advantages over more spatially aggregated or less defined units, such as the county data and zip code regions (Anderton et al. 1994, Anderton et al. 1997,

Stretesky and Hogan 1998); these latter units of analysis may mask differences of concern to environmental equity. Furthermore, census tracts may be more homogenous at the population level, giving better insights into community boundaries and dynamics. Many studies on environmental justice and hazardous waste select census tracts as the most appropriate unit of analysis (e.g., Anderton et al. 1994, Anderton et al. 1997, Been and Gupta 1997, Boer et al. 1997, Stretesky and Hogan 1998, Bowen 2002, O'Neil 2007).[24] Spatial analyses were conducted in ArcGIS ArcMap 10.2.2. Shape files for Superfund military installations were derived from DOD and EPA databases, spatially joined to all census tracts intersecting within a mile of the installation, and then relevant 2010 census data was summarized as the average value for all adjacent tracts. Other studies have merely used latitude and longitude data for site locations, but shape files more accurately correspond to the full boundaries of the site and the neighborhoods located adjacent.

In addition to seeing whether communities with larger proportions of non-white and poor residents face slower abatement of environmental risk than do their white, more affluent counterparts, I also analyze whether predominately poor communities are more likely to live adjacent to military Superfund sites. I do this by comparisons between the socioeconomic characteristics of all census tracts intersecting within a mile of an installation with all census tracts within the United States.

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[24] Anderton et al. (1997) do point out that census tracts tend to span larger areas in rural locations versus urban locations and thus may obscure rural differences more so than urban ones. See Mohai and Saha (2006) for an in-depth analysis on spatial approaches to assessing environmental disparities.

Although I do univariate analysis on all variables for all stages, many factors may not be particularly relevant for certain stages. For example, in the RI/FS stage, the investigations and feasibility studies may just be for one particular media; if the first RI/FS pertains to substantial sediment contamination of PCBs and pesticides, then whether or not there are radiological materials present is likely not related to the pace at which the RI-FS stage is implemented. Furthermore, while I calculate an average cost per year since program initialization (so as to be able to perform survival analysis across many sites for many stages), this average value might not reflect actual expenditures for early or late stages (e.g., there might be significant spending in early years of the cleanup and little spending later). Nevertheless, I include all univariates when doing survival analysis as factors that might not be directly related, may still be peripherally related (e.g., while an RI/FS might only pertain to one environmental media, substantial contamination across many different types of media may install a sense of urgency for site remediation).

Table 2-2 A description of the independent variables-technological and political difficulty

These are the covariates used in survival analysis. The source of data is also provided.

Independent Variable	Description	Source
Total Cost	Cost from start of project until end of fiscal year 2010 (FY2010) plus (+) estimated cost to complete projected. In U.S. dollars.	DOD Congress Report (FY2010)
Cost per year	Money spent until FY2010 divided by (/) total years in the program (from NPL listing to end of FY2010). In U.S. dollars.	DOD Congress Report (FY2010)
Site size	Size of site when listed in acres	EPA Site Overview page

Table 2-3 A description of the independent variables-aggregated measures of contamination

These are the covariates used in survival analysis. The source of data is also provided

Independent Variable	Description	Source
HRS	Hazardous Ranking Score for the site. The score ranges from 28.5 to 100 and represents the site's potential and human ecological health risk.	TOXMAP
IRPs	The number of contaminated individual areas/sites within a single installation in the Installation Response Program (IRP) at the end of FY2010 ; sites can be undergoing investigation, active remediation, or response can be complete.	DOD Congress Report (FY2010)
MMRPs	The number of individual areas/sites within a single installation in the Military Munitions Response Program (MMRPs) at the end of FY 2010; sites can be undergoing investigation, active remediation, or response can be complete.	DOD Congress Report (FY2010)

Table 2-4 A description of the independent variables-contaminant groups present

These are the covariates used in survival analysis. The source of data is also provided.

Independent Variable	Description	Source
PCBs	Binary variable indicating the presence or not of PCBs (Y=1, N=0)	EPA CERCLIS database
VOCs	Binary variable indicating the presence or not of volatile organic compounds (Y=1, N=0)	EPA CERCLIS database
Dioxins and dibenzofurans	Binary variable indicating the presence or not of dioxins and dibenzofurans (Y=1, N=0)	EPA CERCLIS database
Metals	Binary variable indicating the presence or not of metals (Y=1, N=0)	EPA CERCLIS database
Nitroaromatics	Binary variable indicating the presence or not of nitroaromatics (Y=1, N=0)	EPA CERCLIS database
Radioactive materials	Binary variable indicating the presence or not of radioactive materials (Y=1, N=0)	EPA CERCLIS database
Munitions	Binary variable indicating the presence or not of munitions (Y=1, N=0)	EPA CERCLIS database
Total Contaminants	A sum of the types of contaminants that are present.	EPA CERCLIS database

Table 2-5 A description of the independent variables-types of contaminanted media

These are the covariates used in survival analysis. The source of data is also provided.

Independent Variable	Description	Source
Groundwater	Binary variable indicating the presence or not of groundwater contamination (Y=1, N=0)	EPA CERCLIS database
Sediment	Binary variable indicating the presence or not of sediment contamination (Y=1, N=0)	EPA CERCLIS database
Soil	Binary variable indicating the presence or not of soil contamination (Y=1, N=0)	EPA CERCLIS database
Surface Water	Binary variable indicating the presence or not of surface water contamination (Y=1, N=0)	EPA CERCLIS database
Total media effected	A sum of the main types of media effected	EPA CERCLIS database

Table 2-6 A description of the independent variables-demographic and socioeconomic characteristics

These are the covariates used in survival analysis. The source of data is also provided.

Independent Variable	Description	Source
Population Density	The number of individuals per square mile at the census tract level for all adjacent towns and cities (averaged across adjacent census tracts).	US Census Bureau (data from 2010) and government-produced shape files for sites (stats derived in ArcMap)
Income	The median household income averaged for all adjacent towns to a military base at the census tract level.	US Census Bureau (data from 2010) and government-produced shape files for sites (stats derived in ArcMap)
Percentage non-white	Percentage of self-identified non-white populations at the census level averaged for all adjacent towns and cities.	US Census Bureau (data from 2010) and government-produced shape files for sites (stats derived in ArcMap)

Table 2-7 Summary Statistics for independent variables

*Absent=0, Present=1

Independent Variable	Mean	Standard Deviation	Min	Max
Technological and Political Difficulty				
Total cost (spent + estimated; in millions)	210.74	280.67	6.5	1944.2
Cost per year (in millions)	7.47	9.52	0.1	75.6
Site size (in acres)				
Hazard Ranking System	43.70	9.44	28.9	70.82
IRPs	71.21	63.87	2	342
MMPRs	5.10	7.59	0	32
PCBs*	0.63	0.48	0	1
VOCs*	0.87	0.33	0	1
PAHs*	0.80	0.41	0	1
Dioxins and dibenzofurans*	0.31	0.47	0	1
Pesticides *	0.64	0.48	0	1
Metals*	0.94	0.23	0	1
Nitroaromatics*	0.31	0.46	0	1
Radioactive materials*	0.09	0.29	0	1
Munitions*	0.66	0.48	0	1
Total contaminant types	5.57	2.03	1	10
	,			
Groundwater*	0.91	0.29	0	1
Sediment*	0.50	0.50	0	1
Soil*	0.93	0.26	0	1
Surface water*	0.38	0.49	0	1
Total media effected	2.71	1.09	0	4
Census Demographics				
Population Density	1915.64	2054.63	0.50	13, 025.07
Income	60, 863.30	19, 236.25	17, 355	13, 2074
Percentage non-white	30.04	21.35	2.00	94.30

2.5. Results

My analysis included 127 military sites (3 military Superfund sites were excluded due to the military not being the only lead agency on cleanup or due to problems with data reporting). There was a variation in the distribution of the duration of stages (see Fig. 2-2) and this article analyzes which factors influence these ranges in distributions. For earlier stages in the process, few of the observations were censored; there were no censored observations for the Listing-RI/FS stage and one censored observation for Listing-First Cleanup. The latter two stages are highly censored (71 censored observations and 85 censored observations for Listing-Final Remedy Selected and Listing-Construction Complete respectively) and this feature will need to be accounted for in the estimation. As mentioned above, sites that had a negative value for a stage were removed from analysis for that particular stage (i.e., sites that had a negative value for time to first cleanup action, perhaps because a first cleanup action happened before official listing, were removed from analysis). The mean values for the durations used in the analysis (censored and non-negative) are 1.6 years for Listing-RI/FS, 4.4 years for Listing-First Cleanup, 17.8 years for Listing-Final Remedy Selected and 19.3 years for Listing-Construction Complete. 75% of the sites which have achieved the Final Remedy Selected milestone have also reached the construction complete process, typically within a few years. This likely indicates that many of the sites that are labeled as "construction complete" relatively soon after the final remedy is selected have less intensive subsequent cleanup processes. Nevertheless, for a substantial number of sites, the Construction Complete milestone has not been reached, with even less sites being delisted (127 out of the total 139 military listed are still in the program), indicating that a large part of former

military land has not been returned to general use[25]. I analyze which factors influence this variance in the distributions of time for stages.

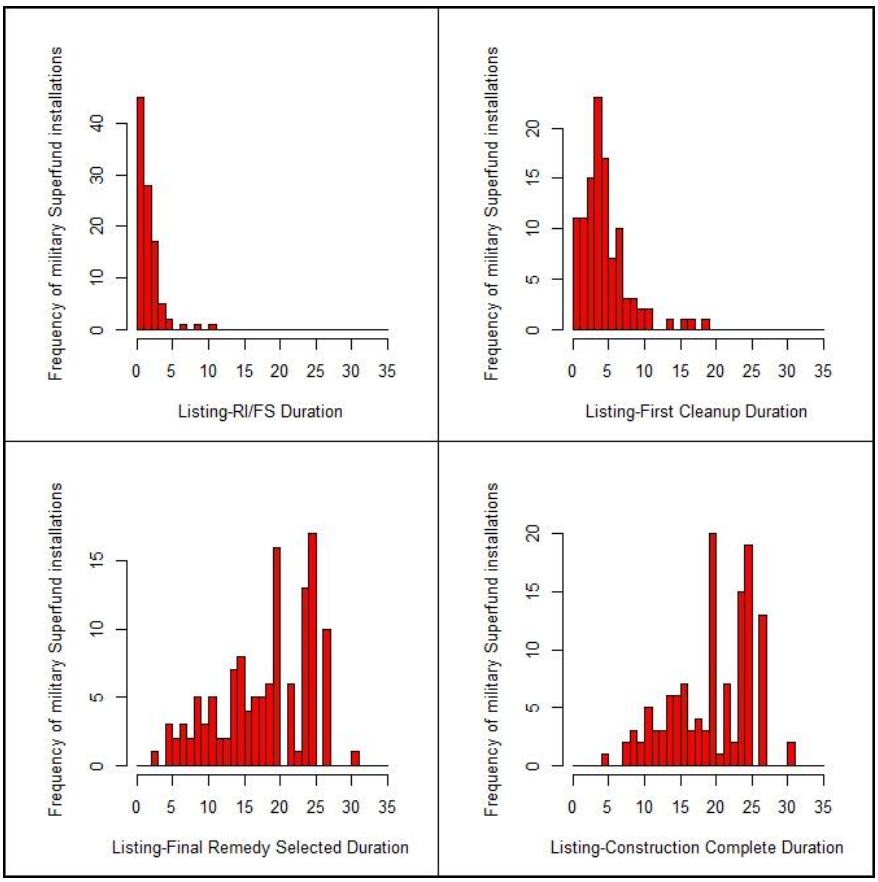

Fig. 2-2 Variation in how long four different Superfund stages take to complete

Time is in years. Sites for which a stage is negative (e.g., there was an RI/FS before the site was listed in the NPL) were deleted as data is unreliable and survival analysis cannot be run with negative values. For Listing-RI/FS (Stage 1), 100 sites are included in the histogram and subsequent analyses. There were no censored observations for Stage 1. For Listing-First Cleanup (Stage 2), 108 sites are included in the histogram and in subsequent analyses. There was one censored observation for Stage 2. For Listing-Final Remedy Selected (Stage 3), 127 sites were included in the analysis (there were no negative values) and there were seventy-one censored observations. For Listing-Construction Complete (Stage 4), 127 sites were included in the analysis (there were no negative values) and there were eighty-five censored observations.

[25] Most sites are, however, parcelized so parts of the site might be transferred for reuse even though the site itself is still listed.

2.5.1. For Listing-RI/FS Stage

If an estimated covariate is positive this reflects faster remedial progress and a shorter expected duration for that stage, whereas a negative covariate reflects slower progress and a longer expected duration for that stage. In the univariate analysis, few site characteristics were found to be statistically significant for the Listing-RI stage. The significant univariates at the $p<0.15$ level include the presence of dioxins and dibenzofurans and whether or not there was sediment contamination. Interestingly, site size and variables associated with cost (e.g., the total projected cost and cost per year) were not significant for this stage nor were most indicators of the extent of and complexity of contamination (e.g., HRS score, the number of areas in the IRP and MMRP programs, or most types of contaminants or contaminated media). Socioeconomic and demographic variables do not indicate any statistically significant influence on the amount of time it takes to progress from site listing to beginning of first RI/FS.

All univariates with $p<0.15$ were included in a step model (see Table 2-8) and AIC values were evaluated to select the most parsimonious model (see Table 2-12 and Table 2-13). The final model was

$$\textbf{Intercept}+\beta_1\textbf{(sediment)}+\beta_2\textbf{ (dioxins/dibenzofurans)}$$

For the final model, both sediment pollution and the presence of dioxins and dibenzofurans had a significant influence on the length of time to begin the first RI/FS.

The coefficient for sediment is negative meaning that, other things being equal, the presence of sediment pollution increases the probability that the first RI/FS will be initiated later (i.e., makes the stage take longer). The coefficient for the presence of dioxins and dibenzofurans is positive meaning that it, conversely, increases the probability that the first RI/FS will be initiated earlier (see Table 2-8).

Table 2-8 The variables that significantly affect the time it takes from listing to the first Remedial Investigation/Feasibility Study

Statistics were derived using Cox regression estimates on univariates. The date used for the RI/FS is the date that it was initiated. Analysis was run with 100 sites (27 negative stages deleted). Statistically significant results ($p<0.05$) are bolded.

Independent Variable	P-value	Coefficient estimate	Standard error	Hazard ratio
Technological and Political Difficulty				
Total cost (spent + estimated)	0.549	$2.306*10^{-4}$	$3.846*10^{-4}$	1.000
Cost per year	0.408	$1.228*10^{-2}$	$1.484*10^{-2}$	1.012
Site size	0.198	-0.004	$3.171*10^{-3}$	1.000
HRS	0.944	$8.259*10^{-4}$	$1.169*10^{-2}$	1.000
IRP	0.731	$5.593*10^{-4}$	$1.625*10^{-3}$	1.000
MMPRs	0.589	$7.638*10^{-3}$	$1.413*10^{-2}$	1.007
PCBs	0.700	0.081	0.211	1.085
VOCs	0.703	0.118	0.310	1.126
PAHs	0.174	-0.342	0.251	0.711
Dioxins and dibenzofurans	**0.034 ***	**0.455**	**0.215**	**1.576**
Petroleum Hydrocarbons	0.330	0.206	0.212	1.229
Metals	0.963	0.020	0.423	1.020
Nitroaromatics	0.974	-0.007	0.223	0.992
Radioactive materials	0.316	0.354	0.353	1.425
Munitions	0.815	0.050	0.214	1.051
Total contaminant types	0.477	0.035	0.050	1.036
Groundwater	0.445	0.268	0.351	1.308
Sediment	**0.019 ***	**-0.487**	**0.207**	**0.615**
Soil	0.390	0.319	0.371	1.375
Surface water	0.635	-0.102	0.214	0.903
Total media affected	0.428	-0.073	0.092	0.930
Census Demographics				
Population Density	0.353	$5.148*10^{-5}$	$5.537*10^{-5}$	1.000
Income	0.812	$1.103*10^{-6}$	$4.642*10^{-7}$	1.000
Percentage non-white	0.807	0.001	$4.790*10^{-3}$	1.001

2.5.2. Listing-First Cleanup stage

In the univariate analysis for Listing-First Cleanup stage, the coefficients for the site size and variables associated with cost were not significant. Likewise, coefficients for demographics (race, class, and population density characteristics of nearby communities) were not significant. In this stage, however, indicators of the extent of and complexity of contamination were significant at the $p<0.15$ level; this includes the total number of contaminants present, the total number of media affected, HRS score, the presence of PCBs, VOCs, PAHs, metals, pesticides, dioxins and/or dibenzofurans, and all variable indicators for the presence of environmental media contamination (i.e., groundwater, sediment, soil, and surface water). The coefficients are all positive, meaning that increases in the hazard ratio will be associated with an increase in the "hazard" or "risk" of being categorized as reaching the first cleanup stage after NPL listing (i.e., increases in the values for these variables will correspond to an earlier first cleanup). While positive and statistically significant, the coefficient for HRS is small meaning the effects are marginal.

The full model, using all significant univariates ($p<0.15$; see Table 2-9) was

$$\text{Intercept}+\beta_1(\text{surface water})+\beta_2(\text{HRS})+\beta_3(\text{total number of contaminants})+\beta_4(\text{PAH})+\beta_5(\text{VOC})+\beta_6(\text{PCBs})+\beta_7(\text{Metal})+\beta_8(\text{Pesticides})+\beta_9(\text{dioxins/dibenzofurans})+\beta_{10}(\text{soil})+\beta_{11}(\text{sediment})+B_{12}(\text{groundwater})+\beta_{13}(\text{total number of media})$$

After a stepwise function was performed in R and AIC values were obtained, the final reduced model (see Table 2-12 and Table 2-14), was

Intercept+β_1(surface water)+ β_2(HRS) + β_3(total number of contaminants)

For the final multivariate model, the total number of contaminants, the HRS score, and the presence of contaminated surface water had the most significant influence on the length of time to begin the first cleanup. The coefficients were all positive, meaning an increase in their value (i.e., for total number of contaminants and HRS) or their presence (i.e., for contaminated surface water) signifies a higher probability of reaching the first cleanup milestone and a faster first cleanup.

Table 2-9 The variables that significantly affect the time it takes from listing to the first cleanup action

Statistics were derived using Cox regression estimates on univariates. 108 sites were analyzed with 19 sites deleted because stages were negative. Statistically significant results (p<0.05) are bolded.

Independent Variable	P-value	Coefficient estimate	Standard error	Hazard ratio
Technological and Political Difficulty				
Total cost (spent + estimated)	0.872	$-5.914*10^{-05}$	$3.674*10^{-04}$	.9999
Cost per year	0.304	0.01609	0.01563	1.01622
Site size	0.408	0.002548	0.003078	1.002551
HRS	**0.025 ***	**0.02550**	**0.01133**	**1.02583**
IRPs	0.579	0.0008261	0.0014905	1.0008264
MMPRs	0.313	0.01389	0.01377	1.01399
PCBs	**0.025 ***	**0.4660**	**0.2083**	**1.5935**
VOCs	**0.024 ***	**0.7157**	**0.3180**	**2.0457**
PAHs	0.054	0.4942	0.2569	1.6393
Dioxins and dibenzofurans	0.133	0.3134	0.2087	1.368
Pesticides	**$6.86*10^{-3}$ ****	**0.5746**	**0.2125**	**1.7765**
Metals	**0.034 ***	**1.1046**	**0.5212**	**3.0180**
Nitroaromatics	0.567	0.1213	0.2117	1.1289
Radioactive materials	0.317	0.3211	0.3211	1.3787
Munitions	0.705	0.07866	0.20788	1.08184
Total contaminant types	**1.22**$*10^{-3}$ ****	**0.16102**	**0.04978**	**1.17470**
Groundwater	**0.039 ***	**0.7173**	**0.3478**	**2.0488**
Sediment	**$2.660*10^{-3}$ ****	**0.6205**	**0.2065**	**1.8599**
Soil	**0.0272 ***	**1.0322**	**0.4673**	**2.8072**
Surface water	**0.000431 *****	**0.7340**	**0.2085**	**2.0834**
Total media affected	**0.0000359 *****	**0.40936**	**0.09905**	**1.50586**
Census Demographics				
Population Density	0.377	$4.99*10^{-05}$	$5.65*10^{-05}$	1.000
Income	0.144	$-7.52*10^{-6}$	$5.15*10^{-6}$	1.00
Percentage non-white	0.77	-0.001273	0.004355	0.998728

2.5.3. Listing-Final Remedy Selected stage

For the Listing-Final Remedy Selected Stage, univariates that are significant at the $p<0.15$ level include site size, the number of areas in the Installation Response Program (IRPs), the number of areas in the Military Munitions Response Program (MMRP), the number of total media affected by contamination, income of adjacent communities, and the presence of dioxins and/or dibenzofurans, radioactive materials, groundwater contamination, and surface water contamination. These are all included in the full model with the exception of the number of MMRPs. The number of MMRPs is excluded to avoid the issue of overlapping information and tightly correlated variables as the presence or absence of munitions was included in the full model. The full model, using all significant univariates ($p<0.15$; see Table 2-10) was a function of

$$\text{Intercept}+\beta_1(\text{Groundwater})+ \beta_2(\text{Dioxins and dibenzofurans}) + \beta_3(\text{Site Size})+\beta_4(\text{Munitions})+\beta_5(\text{IRP}) + \beta_6(\text{Surface Water})+\beta_7(\text{Radioactive})+ \beta_8(\text{Nitroaromatics})+ \beta_9(\text{Total Media})$$

Multivariate models were derived by running a stepwise function on the full model (all parameters that were significant, $p<0.15$, in the univariate analysis) and comparing AIC values. After a stepwise function was performed in R and AIC values were obtained, the final reduced model (see Table 2-12 and Table 2-15) is

Intercept+β_1 (groundwater)+ β_2(dioxins and dibenzofurans) +

β_3(site size)+β_4(munitions)+β_5(IRP) + β_6(surface water)

These six variables had the most significant influence on the length of time to final remedy selected. The coefficients were positive for contaminated site size and the presence of contaminated groundwater and surface water, meaning that the presence or increase in these variables makes a site more likely to reach the final remedy selected stage sooner. The coefficient for site size, however, was quite small signifying the effects are marginal. Conversely, the presence of dioxins and/or dibenzofurans, munitions, and an increase in the number of IRPs, increases the amount of time it takes to reach the final remedy selected stage (the coefficients are negative). The coefficient for IRPs is quite low meaning it has little effect on the length of time to reach this stage.

Table 2-10 The variables that significantly affect the time it takes from listing to final remedy selected

Statistics were derived using Cox regression estimates on univariates. 127 were sites analyzed, with no sites deleted. Statistically significant results ($p<0.05$) are bolded.

Independent Variable	P-value	Coefficient estimate	Standard error	Hazard ratio
Technological and Political Difficulty				
Total cost (spent + estimated)	0.167	$-8.985*10^{-4}$	0.001	0.999
Cost per year	0.334	-0.019	0.019	0.982
Site size	0.052	0.008	0.004	1.008
HRS	0.616	-0.007	0.014	0.993
IRPs	0.117	-0.004	0.003	0.996
MMPRs	**0.015 ***	**-0.065**	**0.027**	**0.937**
PCBs	0.774	0.081	0.282	1.084
VOCs	0.856	-0.073	0.405	0.929
PAHs	0.648	-0.149	0.326	0.862
Dioxins and dibenzofurans	0.102	-0.496	0.304	0.609
Pesticides	0.267	0.323	0.292	1.382
Metals	0.677	0.300	0.721	1.350
Nitroaromatics	**0.024 ***	**-0.741**	**0.327**	**0.476**
Radioactive materials	0.148	-0.860	0.594	0.423
Munitions	**0.042 ***	**-0.549**	**0.269**	**0.578**
Total contaminant types	0.388	-0.057	0.066	0.944
Groundwater	0.108	1.158	0.720	3.183
Sediment	0.751	0.085	0.268	1.089
Soil	0.792	0.157	0.595	1.170
Surface water	0.092	0.454	0.269	1.575
Total media affected	0.143	0.192	0.131	1.211
Census Demographics				
Population Density	0.866	$1.163*10^{-5}$	$6.909*10^{-5}$	1.000
Income	0.954	$-4.29x10^{-7}$	$7.46\ x10^{-6}$	1.000
Percentage non-white	0.417	$-5.697*10^{-3}$	0.007	0.994

2.5.4. Listing to Construction Complete Stage

For the listing to construction complete stage, the coefficients that are significant at $p<0.15$ are primarily related to contamination indicators and include the presence of surface water contamination, the presence of radioactive materials, the total number of areas in the Military Munitions Response Program, and the total media affected (see Table 2-11). Site size is also significant at the $p<0.05$ level for the univariate analysis. None of the variables representing the cost of cleanup or the demographic and socioeconomic characteristics of adjacent communities were significant at the univariate level. The full model, using all significant univariates ($p<0.15$) was a function of

$$\text{Intercept} + \beta_1(\text{MMRP}) + \beta_2(\text{Radioactive Materials}) + \beta_3(\text{Site Size}) + \beta_4(\text{Surface Water}) + \beta_5(\text{Total Media})$$

After a stepwise function was performed in R and AIC values obtained, the final reduced model (see Table 2-12 and Table 2-16) is

$$\textbf{Intercept} + \beta_1(\textbf{MMRPs}) + \beta_2(\textbf{Radioactive Materials}) + \beta_3(\textbf{Site Size}) + \beta_4(\textbf{Surface Water})$$

An increase in the number of areas in the Military Munitions Response Program and the presence of radioactive materials increase the amount of time it takes to reach the construction complete stage (the coefficients are negative). The coefficient was positive

for site size meaning an increase in site size decreases the time to reach the construction complete stage. The coefficient for site size, however, was quite low meaning that it does not have much of an effect on how fast sites progress to this stage. Somewhat surprisingly, the presence of surface water contamination is also associated with a decrease in the time it takes to reach the construction complete stage (the coefficient is positive).

Table 2-11 The variables that significantly affect the time it takes from listing to construction complete

Statistics were derived using Cox regression estimates on univariates. 127 sites analyzed, no sites were deleted. Statistically significant results ($p<0.05$) are bolded.

Independent Variable	P-value	Coefficient estimate	Standard error	Hazard ratio
Technological and Political Difficulty				
Total cost (spent + estimated)	0.123	-0.0014699	0.0009521	0.9985312
Cost per year	0.212	-0.03452	0.02765	0.96607
Site size	**0.0424 ***	**0.009345**	**0.004605**	**1.009389**
HRS	0.685	-0.006853	0.016911	0.993170
IRPs	0.219	-0.003545	0.002881	0.996462
MMPRs	0.0958	-0.04661	0.02798	0.95446
PCBs	0.531	0.2091	0.3339	1.2325
VOCs	0.986	-0.008562	0.476961	0.991474
PAHs	0.893	0.05308	0.39307	1.05452
Dioxins and dibenzofurans	0.194	-0.4571	0.3522	0.6331
Pesticides	0.257	0.3872	0.3417	1.4729
Metals	0.53	0.6363	1.0133	1.8894
Nitroaromatics	0.114	-0.5743	0.3635	0.5631
Radioactive materials	0.0984	-1.6737	1.0129	0.1875
Munitions	0.337	-0.3022	0.3145	0.7392
Total contaminant types	0.836	-0.0163	0.0786	0.9838
Groundwater	0.148	1.464	1.013	4.321
Sediment	0.549	0.1853	0.3092	1.2036
Soil	0.353	0.9412	1.0129	2.5630
Surface water	**0.0243 ***	**0.6963**	**0.3091**	**2.0063**
Total media effected	**0.0483 ***	**0.3073**	**0.1556**	**1.3597**
Census Demographics				
Population Density	0.828	0.00001769	0.0000812 0	1.000
Income	0.225	-1.15×10^{-5}	9.46×10^{-6}	1.00
Percentage non-white	0.822	-0.001786	0.007947	0.998216

Table 2-12 The variables that are significant in the multivariate model for four stages of the Superfund program

Coefficients and p-value (in brackets) for variables that are significant in the reduced multivariate are provided for stages 1 through 4. The multivariate model was calculated by running a stepwise function on the full model (all parameters that were significant, $p<0.15$, in the univariate analysis) and comparing AIC values.

	Stage 1: Listing-RI/FS	Stage 2: Listing-First Cleanup	Stage 3: Listing-Final Remedy	Stage 4: Listing-Construction Complete
Sediment	-0.548 (0.009)			
Dioxins and dibenzofurans	0.527 (0.016)		-0.669(0.030)	
Surface Water		0.659 (0.003)	0.422(0.140)	0.724 (0.022)
HRS		0.037 (0.001)		
#Contaminants		0.165 (0.002)		
IRPs			-0.004(0.170)	
Groundwater			1.190(0.106)	
#Media				
Munitions			-0.466(0.092)	
Site Size			0.007 (0.082)	0.009 (0.048)
MMRPs				-0.062 (0.024)
Radioactive Materials				-1.87 (0.066)

2.5.5. Relationships between variables

To understand the relationship between variables, we performed pairwise-correlation analyses on quantitative variables using Spearman rank correlation. The relationships between categorical variables were analyzed in 2x2 contingency tables using Pearson's chi-squared tests (degrees of freedom=1; total comparisons=78). For quantitative-categorical combinations, the means of the quantitative variables were compared with and without the binary variable (e.g., the total projected cost of cleanup was compared with and without groundwater contamination being present) using Student's t-test (see Table 2-17 to Table 2-19).

The cost of cleanup (both spent funding per year and total projected cost) is correlated with the extent and complexity of contamination. The cost of cleanup increases with the number of areas being remediated under both the Installation Restoration Program and the Military Munitions Response Program, as well as the total number of contaminants present at a site and the total number of affected types of environmental media. Many contaminants tend to be co-located with other contaminants or with a type of contaminated media. For example, dioxins are typically present with PCBs and dioxins often co-occur with pesticides as well. Metals tend to co-occur with PAHs and with VOCs. This is reflective of sites often having complex contamination with many types of contaminants within a single site. Furthermore, for many contaminants (e.g., dioxins, metals, PCBs, pesticides, and VOCs), when the contaminant is present the mean number of total contaminants is significantly higher. This further indicates that many contaminants tend to be co-located with many others

(i.e., contamination can be quite complex for many sites). Likewise, when a particular environmental media is contaminated (e.g., groundwater, sediment, soil, and surface water), the total number of contaminated media is significantly higher.

As discussed, demographic and socioeconomic characteristics, such as race and income, were not demonstrated to significantly affect the pace of remediation. I compared the income data for census tracts intersecting within a mile of military sites to all census tracts in the United States to see whether military sites are more likely to be located in comparatively lower socioeconomic status neighborhoods. I did not find that military sites are more heavily located in areas with lower incomes but rather military sites are spatially distributed across communities with diverse economic profiles. Other studies have found that certain disadvantaged communities are more likely to live adjacent to hazardous waste sites (Reisch and Bearden 1997, Ringquist 2005, Bullard, Mohai, Saha, and Wright/UCC 2007). Unlike other Superfund sites and brownfields, military Superfund sites do not appear to be concentrated in poor communities, but rather census tracts adjacent to military Superfund sites have a similar distribution to all census tracts (Fig. 2-3). Furthermore, unlike the findings of other analyses, there is not a strong relationship between race and class for the census tracts adjacent to military Superfund sites (Fig. 2-4).

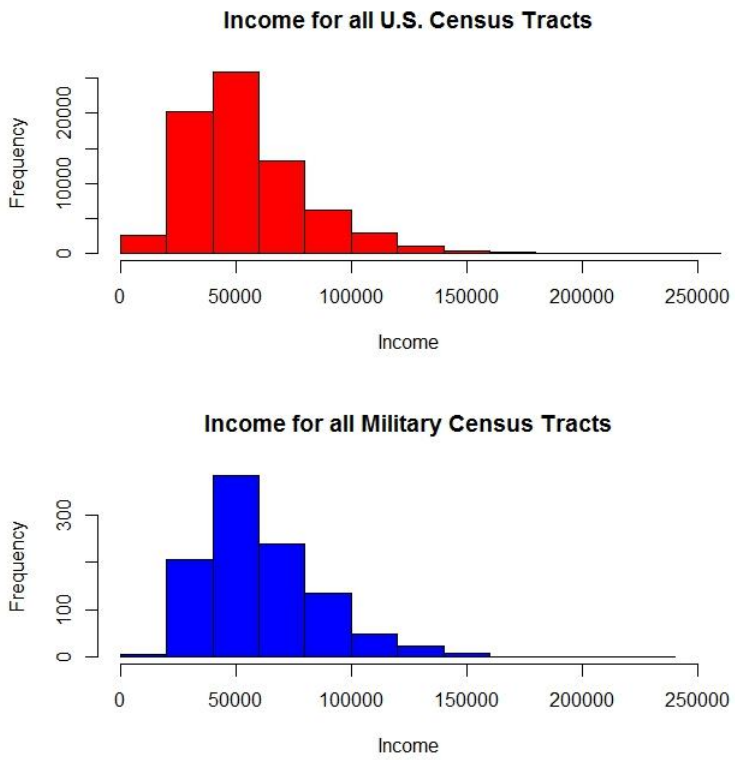

Fig. 2-3 Income for communities next to military sites compared to the rest of the U.S.

The median household income for all U.S. census tracts is compared to the median income for census tracts adjacent to (intersecting within 1-mile) military Superfund sites.

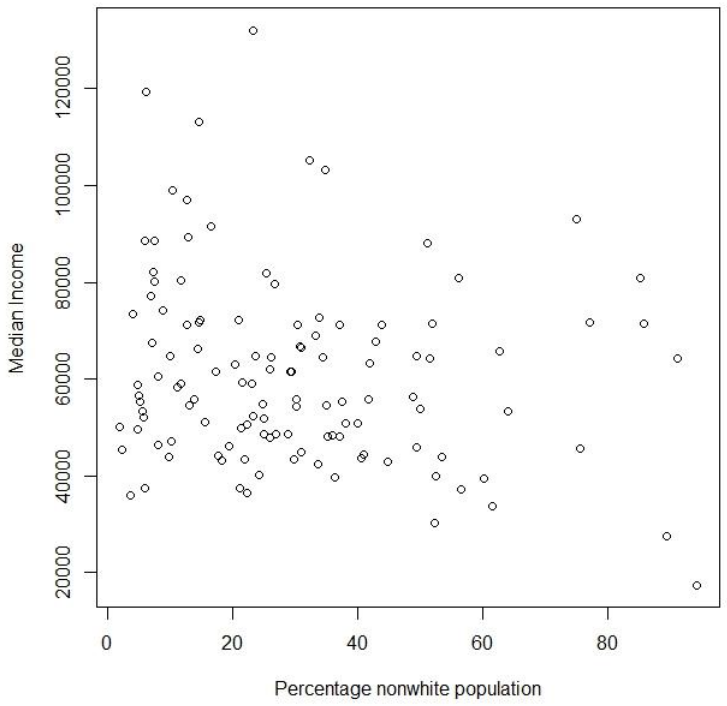

Fig. 2-4 The relationship between race and income for communities next to military sites

All census tracts adjacent (intersecting within 1-mile) to military Superfund sites are used in the analysis. Spearman rank correlation is -0.16 and is not significant at $p<0.05$

2.6. Discussion

I found that cleanup durations are influenced primarily by the nature and extent of contamination at a site. The number and types of contaminants cause the time for the first cleanup response to happen more quickly, while certain types of contamination will delay the finalization of most cleanup activities at the site. Higher hazard scores also increase the odds of a site having a first cleanup action earlier, albeit slightly. This appears to indicate a prioritization of more environmentally risky sites by Superfund regulators and the military. Site attributes, namely the nature and severity of contamination, thus appear to be more important determinants of cleanup durations than site funding and neighborhood characteristics.

For later stages, some types of contamination may slow down the completion of these stages as agencies have to deal with the technical complexity and constraints that they pose. While the severity and types of contamination shorten the time to first cleanup, the presence of munitions or radioactive materials lengthen the time for the construction of remedies to be completed. It makes sense that certain types of contamination pose additional challenges for site remediation and delay the time to reach final cleanup milestones. The techniques for cleaning up munitions are still novel in many respects. Furthermore, the DOD's munitions cleanup programs have been criticized as making limited progress on identifying, assessing, and cleaning up sites that are potentially contaminated with military munitions (GAO 2003). For example, while the DOD identified 2,307 sites potentially contaminated by munitions as of 2002, for well over half of those sites (1,387), the DOD had not begun or completed its initial evaluations or determined if further study was required. To reduce cleanup timelines for

munitions, the DOD may appropriate funds currently designated for the cleanup of chemical hazardous waste. Hazardous substance cleanups, however, often take longer than anticipated and delays in this availability of funding can impede the DOD's ability to make progress in cleaning up Military Munitions Reponse sites (GAO 2003). If DOD's munitions cleanup programs are slow in making progress, this would impede reaching the construction complete stage faster for sites that have munitions contamination but would not have a similar effect on the earlier stages of cleanup.

As with any statistical analysis of this nature, these findings are of association and not causality. Despite this, the types of variables that are significant, and the direction of their effect, lends itself to explaining trends in military Superfund remediation. From the perspective of addressing the worst contamination more quickly, or responding to sites with the greatest risk, it makes sense that indicators of the extent of and complexity of contamination are important in instigating a cleanup action (either a removal or a remedial cleanup action). Daley and Layton (2004), in contrast, found for private Superfund sites that an increase in HRS score is associated with a decrease in the hazard of a site being categorized as construction complete (i.e., the more contaminated a site is, the slower progress is towards reaching the construction complete milestone). She states that this is indicative of the EPA tackling the "easiest" sites first or a tendency to "pick the low hanging fruit". The inverse relationship between HRS and duration to construction complete, however, might not be due to tackling the "easiest" sites first but rather more contaminated sites take longer to remediate. In my study, I show that the response time is shorter for more complex contamination; agencies thus do not tackle the "easiest" sites first, but rather riskier sites are a priority for the first cleanup. The

remediation process for these riskier sites does appear to bog down during later stages (i.e., finalizing the selection of all cleanup remedies and completing all construction activities are slower), likely because cleanup is more complicated. This finding demonstrates the importance of considering multiple stages in the analysis.

Cost, contrary to expectations, does not significantly predict either an increase or decrease in the pace of remediation for any of the stages analyzed. This could be partially related to projected total cost being imprecise estimates by the Department of Defense; often total costs will turn out to be much higher than originally expected. However, even average cost per year was not significant for any of the stages examined. From these findings, it is not possible to conclude that there is a pattern of environmental remediation progress being determined by resource constraints; higher funding does not seem to substantively decrease the time required to complete a stage. It could be that the time required to complete a stage is more dependent on the comprehensiveness of cleanup efforts. From this perspective, if site remedies are less comprehensive then the pace of remediation may be quick despite little funding being allocated to cleanup efforts. While cost might not be that important during the early stages of the process (for example, when the focus is on remedial investigations or feasibility studies rather than expensive remedial activities), I predicted that it would be critical in influencing site remediation progress for later stages of the process (e.g., time from listing to construction complete). It could be that most sites have not reached this later milestone (i.e., two-thirds of data is censored for this stage) and estimations of effects have less power. Also, projected costs are likely less accurate the earlier a site is in the process.

Perhaps, as more sites progress through the Superfund program, the relative importance, or non-importance, of cost will become more apparent.

Agencies do not seem to prioritize environmental remediation in an ultimately inequitable fashion. Contrary to expectations, I did not find statistical evidence that the pace of military Superfund remediation is related to the racial and socioeconomic profile of the community bearing those risks. Communities with depressed socioeconomic status or a higher percentage of non-white populations do not have delayed investigations and first cleanup actions nor are decision-making and construction activities finalized later than more affluent, predominantly white communities. The results for later stages must be read somewhat carefully as fewer of the sites in the analysis have progressed all the way through the remediation process.

Furthermore the duration of cleanup stages are independent of the population density of surrounding neighborhoods. This contradicts statements and official policy that indicate that the most highly densely populated areas will be dealt with first (for example, the Hazard Ranking System ranks contaminated sites as riskier if they have the potential to expose more people to harm[26]). My findings are similar to Sigman (2000) who finds that sites in densely populated area do not progress faster. Military sites tend to be large and are adjacent to multiple census tracts that are diverse in socioeconomic backgrounds. Thus in addition to analyzing the average median household income,

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[26] There are ethical arguments, however, that risk should not just be based on the number of people who are potentially exposed to harm (the utilitarian argument). Arguments, based on egalitarian ethics, can be made to protect small groups of vulnerable populations (see Shrader-Frechette 1991).

percentage non-white population, and population density for each military tract, I also analyzed the minimum and maximum values for each site. Like the average value, the minimum and maximum values of these factors were not statistically significant either for any of the stages analyzed.

Both earlier stages and later stages do not vary in pace based on the socioeconomics of surrounding towns; certain communities are thus not privy to a quicker response. While there does not appear to be an environmental justice problem with the rapidity with which risks are alleviated, it is important to note that the speed of the process can be a vague indicator of the justice of remediation. A site reaching a final stage of remediation quicker may indicate that either the site is being prioritized for cleanup due to public concern or environmental justice directives or, conversely, that the cleanup relies on less detailed, permanent, and comprehensive approaches, such as natural attenuation, fencing, and institutional controls (as compared to more costly and permanent engineering approaches). Cleanup alternatives that include containing the contamination in place through a remedy such as a concrete cap or natural attenuation are generally less accepted by communities. In contrast, a slow cleanup may mean that the DOD does not prioritize the site or that the DOD is trying to do a more thorough job and/or accommodate input from the community. There is evidence that sites in areas with socioeconomically disadvantaged communities experience less comprehensive and permanent cleanups than in areas with majority-white communities (Lavelle and Coyle 1992). Hamilton and Viscusi (1999) found that environmental remediation is completed at similar speeds across neighborhoods of different socioeconomic backgrounds, but remediation methods appear to diverge dependent on the

socioeconomic profile of the community; this study signals that socioeconomic differences may be more apparent in analyses of site remedies versus the speed of site progress. Lavelle and Coyle (1992) found that the EPA selects containment of contamination over permanent treatment more frequently at sites located in majority non-white communities. In contrast, Gupta et al. (1996) did not find evidence that agencies varied the permanence of site remedies based on the median household income or racial compositions of surrounding populations. While my analysis mostly considers the pace of remediation, future studies can provide in-depth analyses of the target risk levels and remediation methods selected for military Superfund sites to investigate whether socioeconomically disadvantaged communities receive lower quality cleanups.

Furthermore, proximity to a Superfund site, and its pace of remediation, does not translate into information on actual health exposures (Morello-Frosch et al. 2001). The extent of exposure to hazardous substances among communities living near Superfund sites is unknown, although there is certainly evidence of health exposures that are inimical to health and wellbeing (Evans and Kantrowitz 2002). Currie e al. (2011) find that living near a Superfund site can increase congenital anomalies in newborns between 20 to 25%, underscoring the importance of remediation. Exposure assessment studies conducted by the ATSDR found that certain compounds, such as heavy metals and polychlorinated biphenyls, are at levels posing a health concern in people living close to some hazardous waste sites. Other studies have demonstrated increased exposure to hazardous compounds by consuming contaminated vegetables, livestock, milk, and fish raised or caught near hazardous waste sites (ASTDR 1997). One study did not find a relationship between HRS and the race and ethnicity of area residents (Greenberg 1994)

and thus did not demonstrate that certain communities live next to more toxic Superfund sites (albeit HRS is an initial and crude estimate of the severity of contamination). Environmental justice-oriented research can examine whether proximity to military sites corresponds with higher rates of exposures to contamination and poorer health status for socioeconomically disadvantaged communities.

Other studies have found that majority non-white and/or poor communities are less likely to be added to the Superfund's National Priorities List or take significantly longer to be listed (Anderton et al. 1997, O'Neil 2007). Studies have also provided substantial evidence that NPL placement is more related to concentrated private interests, such as Potentially Responsible Parties, media attention, and local community influence than to the contamination risks of the site (Hamilton and Viscusi 1999; Sigman 2000). Similar to this study, Hird (1993) found that the pace of EPA's Superfund cleanup durations depend mostly on the sites' potential hazard, rather than local socioeconomic characteristics or political representation. He did, however, find that beneficiaries of Superfund listing tend to be on average wealthier and have higher educational attainment. As listing itself is a political process[27], future work should look at whether there are racial or class biases in the listing process of federal Superfund sites. Are

[27] During the Bush Administration, from 2001-2009 only one military site was added to the Superfund's NPL: The Navy's training range in Vieques, Puerto Rico was added after the Puerto Rican governor exercised a federal statute, known as the "Silver Bullet" provision, to force its placement on the list. The state of Maryland pressured the EPA to add Fort Detrick to the Superfund list as well, a move resisted by Army (the groundwater portion of the site did end up being listed for cleanup under the Superfund program). The decrease in site listing, however, is also likely a product of the bulk of military closures happening prior to the Bush administration and many of the most challenging and hazardous miltiary sites being listed earlier.

military sites located in predominantly white communities or are more affluent communities likelier to have a military installation selected for closure and listed as a Superfund site? It does appear that military sites have shifted much of their operations from urban, densely populated coastal areas to more remote locations in the Southwest; these locations are not necessarily unpopulated and might disproportionately impact Native American populations (Hooks and Smith 2004).

Similar to this study, other empirical work has demonstrated the importance of contamination factors in influencing cleanup durations (Hird 1993, Burda and Harding 2004). Burda and Harding (2014) similarly found that cleanup duration is largely driven by the nature of contamination as opposed to demographic characteristics. The authors, however, also found that sites listed early in the program that were located in largely black, urban neighborhoods experienced slower cleanup times. These racial and class biases appear to have lessened over time, a finding they attribute to environmental justice action and policy.

Sigman (2000) finds that cleanup durations are influenced primarily by the nature of liable parties rather than contamination threats. Liable parties that are expected to bear a large share of remediation costs will use their political and economic influence to encourage the selection of less extensive cleanup remedies (Sigman 1998). In many private sites, several parties will be liable and it can be a difficult and litigious process to make Potentially Responsible Parties pay for cleanup; while some military sites have had several responsible parties, and an adversarial climate over responsibility, finding the liable party, and holding them responsible, is not a similar issue for military sites.

My study included many variables, yet it is still not possible in this study to account for all the site-specific features that may influence the pace of cleanup. Political action can also affect environmental outcomes (Arora and Cason 1999, Pastor et al. 2001, Campbell et al. 2010). Some military cleanup sites generate little in the way of political conflict, while others precipitate protracted battles carried out in administrative programs, courts, and media outlets. Future studies should employ this observable variation to explore how the levels of public participation and regulatory scrutiny affect cleanup pace. Although the EPA and the military are required by law to allow public participation, communities take advantage of this to a greater or lesser degree, such that community participation is more pronounced at certain sites. I did not include the presence of a citizen advisory board as a proxy for public interest, as almost all Superfund military sites have or at one time had an advisory board (>90%); to distinguish amongst sites would require a more detailed study of the extent of citizen advisory board involvement in the cleanup process. Public participation may slow down the process, by challenging cleanup programs, or quicken the pace by pressuring agency action). As this analysis does not tackle the important question of the relationship between collective action and site remediation, future studies can look at this phenomenon.

2.7. Acknowledgements - Chapter 2

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2.9. Appendices for Chapter 2

Table 2-13 Most parsimonious model explaining the length of time required to reach the first Remedial Investigation/Feasibility Study

Step model AIC comparisons for reduced parameter models compared to the full two-parameter model for the Listing-RI/FS stage. The full model included all significant univariates ($p<0.15$) that influence the time from listing to the beginning of the first RI/FS for Superfund implementation. All military Superfund sites for which the stage is positive are included (100 sites in total). The final selected model is in bold.

Model	Sediment	**Dioxin/Dibenzofurans**	AIC
1	✓	✓	**720.37**
2	✓		723.95
3		✓	725.20

Table 2-14 Most parsimonious model explaining the length of time required to reach the first site cleanup

Step model AIC comparisons for reduced parameter models compared to the full thirteen-parameter model for the Listing-First Cleanup stage. The full model included all significant univariates ($p<0.15$) that influence the time from listing to the beginning of the first cleanup. All military Superfund sites for which the stage is positive and data is complete are included. Two sites were excluded as there is no assigned HRS (106 sites in total). The final selected model is in bold. AIC was computed in both directions.

Model	Surface Water	HRS	# Cont.	PAH	VOC	PCBs	Metal	Pesticide	Dioxins/ Dibenzo.	Soil	Sediment	Ground-water	Media #	AIC
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	768.6
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		768.6
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			766.6
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				764.7
5	✓	✓	✓	✓	✓	✓	✓	✓	✓					762.8
6	✓	✓	✓	✓	✓	✓	✓	✓						761.2
7	✓	✓	✓	✓	✓	✓	✓							759.6
8	✓	✓	✓	✓	✓	✓								757.9
9	✓	✓	✓	✓	✓									756.3
10	✓	✓	✓	✓										754.9
11	✓	✓	✓											**754.2**
12	✓	✓	✓	✓										754.9
13	✓	✓	✓										✓	755.0
14	✓	✓	✓									✓		755.6
15	✓	✓	✓							✓				755.7
16	✓	✓	✓								✓			755.9
17	✓	✓	✓		✓									755.9
18	✓	✓	✓				✓							756.0
19	✓	✓	✓						✓					756.1
20	✓	✓	✓			✓								756.2
21	✓	✓	✓					✓						756.2
22		✓	✓											761.0
23	✓	✓												761.8
24	✓		✓											762.4

Table 2-15 Most parsimonious model explaining the length of time required to decide on the final cleanup remedies

Step model AIC comparisons (direction=both) for reduced parameter models compared to the full nine-parameter model for the Listing-Final Remedy Selected stage. The full model included all significant univariates ($p<0.15$) that influence the time from listing to the beginning of the first cleanup, with the exception of the number of sites in the Military Munitions Response Program (MMRP). MMRP was excluded due to repetition with the variable indicating whether or not munitions are present. One military Superfund site was excluded as there was incomplete information for the number of sites in the Installation Response Program (IRP; there were 126 sites in total analyzed). The final selected model is in bold.

Model	Ground-water	Dioxins/ Dibenzo.	Site Size	Munition	IRP	Surface Water	Radioactive	Nitro-aromatics	Total Media	AIC
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	490.26
2	✓	✓	✓	✓	✓	✓	✓	✓		488.49
3	✓	✓	✓	✓	✓	✓	✓			487.45
4	**✓**	**✓**	**✓**	**✓**	**✓**	**✓**				**487.39**
5	✓	✓	✓	✓	✓		✓			487.55
6	✓	✓	✓	✓		✓	✓			487.79
7	✓	✓	✓		✓	✓	✓			488.00
8	✓	✓		✓	✓	✓	✓			488.62
9	✓		✓	✓	✓	✓	✓			488.88
10	✓	✓	✓	✓	✓	✓	✓		✓	489.28
11		✓	✓	✓	✓	✓	✓			489.36
12	✓	✓	✓	✓	✓					487.53
13	✓	✓	✓	✓		✓				487.54
14	✓	✓	✓	✓	✓	✓		✓		488.13
15	✓	✓	✓		✓	✓				488.17
16	✓	✓		✓	✓	✓				488.47
17		✓	✓	✓	✓	✓				489.05
18	✓	✓	✓	✓	✓	✓			✓	489.23
19	✓		✓	✓	✓	✓			✓	490.50

Table 2-16 Most parsimonious model explaining the length of time required to finalize all remedial construction activities

Step model AIC comparisons (direction=both) for reduced parameter models compared to the full five-parameter model for the Listing-Construction Complete stage. The full model included all significant univariates ($p<0.15$) that influence the time from listing to the beginning of the first cleanup. One military Superfund site was excluded as data was missing for the MMRP field (126 sites in total). The final selected model is in bold.

Model	MMRP	Radioactive	Site Size	Surface Water	Total Media	AIC
1	✓	✓	✓	✓	✓	369.40
2	**✓**	**✓**	**✓**	**✓**		**367.60**
3	✓	✓	✓		✓	367.94
4	✓	✓		✓	✓	371.62
5	✓		✓	✓	✓	373.91
6		✓	✓	✓	✓	374.03
7	✓	✓		✓		369.65
8	✓	✓	✓			370.77
9	✓		✓	✓		372.02
10		✓	✓	✓		372.37

Table 2-17 Relationships between quantitiative variables

Derived using pair-wise correlation analysis for quantitative variables with Spearman rank correlation. * and bolded text indicates whether significant at the p<0.05 level.

	Total Cost	Cost Year	Site Size	HRS	IRP	MMRP	#Contam.	#Media	Pop.Density	Income	%Nonwhite
Total Cost	1										
Cost Year	**0.90***	1									
Site Size	0.04	0.05	1								
HRS	0.06	0.08	0.11	1							
IRP	**0.58***	**0.54***	-0.02	0.00	1						
MMRP	**0.32***	**0.28***	-0.03	-0.06	**0.40***	1					
#Contaminant	**0.40***	**0.41***	0.12	-0.10	**0.31***	**0.35***	1				
#Media	**0.26***	**0.21***	0.08	-0.04	**0.21***	0.12	**0.45***	1			
Pop. Density	0.14	**0.21***	0.08	0.10	-0.11	-0.13	0.01	0.03	1		
Income	-0.01	0.03	0.03	0.04	-0.13	-0.15	0.01	-0.04	0.03	1	
%Nonwhite	0.08	0.13	0.14	0.09	0.02	-0.05	-0.03	-0.03	**0.13***	-0.16	1

Table 2-18 Relationships between categorical variables

The relationships between categorical variables were analyzed using Pearson's chi-squared tests (degrees of freedom=1; total comparisons=78). Variables are binary (present or not) and each row in the table has the four possible combinations of two variables (i.e., with both, without both, and having only one present). * and bolded indicates whether significant at the p<0.05 level.

A-B	With A With B	With A No B	No A With B	No A No B	Chi-squared
Dioxin/dibenzo-Metals	40	0	80	7	2.04
Dioxin/dibenzo-Nitroaromatics	15	25	24	63	0.84
Dioxin/dibenzo-PCBs	33	7	47	40	**8.35***
Dioxin/dibenzo-Pesticides	36	4	45	42	**15.76***
Dioxin/dibenzo-Radioactive	8	32	4	83	**5.90***
Dioxin/dibenzo-Munitions	26	14	58	29	0.00
Dioxin/dibenzo-PAH	38	2	63	24	**7.25***
Dioxin/dibenzo-VOC	40	0	71	16	**6.82***
Dioxin/dibenzo-Groundwater	40	0	75	12	**4.59***
Dioxin/dibenzo-Sediment	22	18	41	46	0.40
Dioxin/dibenzo-Soil	40	0	78	9	3.02
Dioxin/dibenzo-Surface Water	19	21	29	58	1.78
Metals-Nitroaromatics	37	83	2	5	0.00
Metals-PCBs	80	40	7	0	**9.91***
Metals-Pesticides	81	39	0	7	**10.29***
Metals-Radioactive	12	108	0	7	0.05
Metals-Munitions	78	42	6	1	0.51
Metals-PAH	101	19	1	6	**23.84***
Metals-Groundwater	114	6	1	6	**41.37***
Metals-Sediment	62	58	1	6	2.35
Metals-Soil	116	4	2	5	**36.81***
Metals-Surface Water	48	72	0	7	2.96
Nitroaromatics-PCBs	26	13	54	34	0.14
Nitroarom.–Pesticides	23	16	58	30	0.30
Nitroarom.-Radioactive	6	33	6	82	1.42
Nitroaro.-Munitions	32	7	52	36	**5.38***
Nitroaromatics-PAH	31	8	70	18	0.00
Nitroaromatics –VOC	30	9	81	7	**4.32***
Nitroaro.-Groundwater	35	4	80	8	0.00
Nitroaro.-Sediment	19	20	44	44	0.00
Nitroaromatics-Soil	38	1	80	8	0.90
Nitroar.-Surface Water	15	24	33	55	0.00
PCBs –Pesticides	64	16	17	30	**22.75***
PCBs-Radioactive	10	70	2	45	1.48
PCBs-Munitions	52	28	32	15	0.03
PCBs-PAH	72	8	29	18	**12.88***
PCBs-VOC	73	7	38	9	**2.04**

Table 2-18 Relationships between categorical variables (Continued)

A-B	With A With B	With A No B	No A With B	No A No B	Chi-squared
PCBs-Groundwater	74	6	41	6	0.44
PCBs-Sediment	50	30	13	34	13.02*
PCBs-Soil	79	1	39	8	8.92*
PCBs-Surface Water	38	42	10	37	7.58*
Pesticides-Radioactive	8	73	4	42	0.00
Pesticides-Munitions	56	25	28	18	0.56
Pesticides-PAH	75	6	26	20	21.28*
Pesticides-VOC	78	3	33	3	13.91*
Pesticides-Groundwater	77	4	38	8	**3.96***
Pesticides–Sediment	52	29	11	35	**17.47***
Pesticides–Soil	80	1	38	8	**9.31***
Pesticides-Surface Water	41	40	7	39	**14.16***
Radioactive-Munitions	8	4	76	39	0.00
Radioactive-PAH	11	1	90	25	0.52
Radioactive-VOC	11	1	100	15	0.00
Radioactive-Groundwater	12	0	103	12	0.43
Radioactive–Sediment	6	6	57	58	0.00
Radioactive-Soil	12	0	106	9	0.17
Radioactive-Surface Water	5	7	43	72	0.00
Munitions-PAH	65	19	36	7	0.37
Munitions-VOC	70	14	41	2	2.72
Munitions-Groundwater	75	9	40	3	0.13
Munitions –Sediment	43	41	20	23	0.10
Munitions-Soil	79	5	39	4	0.11
Munitions-Surface Water	32	52	16	27	0.00
PAH-VOC	95	6	16	10	**17.02***
PAH-Groundwater	96	5	19	7	**9.24***
PAH-Sediment	55	46	8	18	**3.74***
PAH-Soil	97	4	21	5	**5.18***
PAH-Surface Water	45	56	3	23	**8.23***
VOC-Groundwater	107	4	8	8	**29.96***
VOC-Sediment	59	52	4	12	3.38
VOC-Soil	106	5	12	4	**6.08***
VOC-Surface Water	47	64	1	15	**6.29***
Groundwater-Sediment	60	55	3	9	2.21
Groundwater-Soil	110	5	8	4	**9.81***
Groundwater-Surface Water	48	67	0	12	**6.37***
Sediment-Soil	62	1	56	8	**4.20***
Sediment-Surface Water	41	22	7	57	**37.31***
Soil-Surface Water	48	70	0	9	**4.28***

Table 2-19 Relationships between categorical and quantitative variables

The difference in means for a quantitative variable, without and without a binary variable, is compared using Student's t-test statistic. B refers to quantitative variable, A refers to a categorical (binary) variable. The t-test statistic, degrees of freedom (df), and p-values are included in the table. * and bolded indicates whether significant at the p<0.05 level.

A-B	Mean of B with A	Mean of B without A	T	df	p-value
Dioxin/dibenzo-Total Cost	266.34	185.17	-1.55	78.80	0.13
Dioxin/dibenzo - Year Cost	9.17	6.69	-1.45	87.12	0.15
Dioxin/dibenzo-Pop. Density	2222.08	1769.89	-1.08	67.20	0.28
Dioxin/dibenzo -MMRP	5.55	4.88	-0.46	77.04	0.65
Dioxin/dibenzo-% Nonwhite	29.57	30.27	0.17	78.43	0.86
Dioxin/dibenzo-Income	62663.27	60007.22	-0.74	84.75	0.46
Dioxin/dibenzo -Site Size	66.13	58.71	-1.12	76.95	0.27
Dioxin/dibenzo -HRS	42.59	44.22	0.86	68.97	0.39
Dioxin/dibenzo –IRP	88.30	63.27	-1.92	63.42	0.06
Dioxin/dibenzo -# Media	3.03	2.56	-2.47	95.92	**0.02**
Dioxin/dibenzo-# Contaminants	7.40	4.72	-9.74	100.55	**3.45×10^{-16}**
Metals- Total Cost	214.63	144.00	-1.10	8.58	0.30
Metals- Year Cost	7.32	9.87	0.62	6.56	0.56
Metals- Population Density	1845.59	3056.39	0.68	6.11	0.52
Metals- MMRP	5.19	3.17	-1.09	6.81	0.31
Metals-% Nonwhite	29.84	33.35	0.35	6.49	0.74
Metals- Income	60603.1	65100.9	0.45	6.39	0.67
Metals- Site Size	61.43	54.57	-0.49	6.68	0.64
Metals- HRS	46.32	43.54	1.01	7.43	0.35
Metals- IRP	71.68	61.83	-0.79	8.39	0.45
Metals- Total Media	2.83	0.571	-7.29	7.12	**1.52×10^{-4}**
Metals- Total Contaminants	5.82	1.29	-18.38	18.57	**2.28×10^{-13}**
Nitroaromatics- Total Cost	305.33	168.81	-2.36	60.14	**0.02**
Nitroaromatics- Year Cost	10.253	6.23	-2.20	70.88	**0.03**
Nitroaromatics-Population Density	1261.54	2181.84	2.54	81.98	**0.01**
Nitroaromatics—MMRP	7.60	4.011	-2.27	57.94	**0.03**
Nitroaromatics- % Non-White	27.58	31.04	0.78	59.16	0.44
Nitroaromatics- Income	58601.59	61783.77	0.83	64.53	0.41
Nitroaromatics- Site Size	53.97	64.18	1.48	67.56	0.14
Nitroaromatics- HRS	42.71	44.11	0.77	71.32	0.44
Nitroaromatics- - IRP	92.58	61.99	-2.15	51.64	**0.04**
Nitroaromatics- # Media	2.74	2.69	-0.24	80.18	**0.80**
Nitroarom#Contaminants	6.44	5.18	-3.25	68.43	**1.80x10-3**

Table 2-19 Relationships between categorical and quantitative variables (Continued 2/4)

A-B	Mean of B with A	Mean of B without A	T	df	p-value
PCBs- Total Cost	242.07	157.41	-1.96	119.87	**0.05**
PCBs -Year Cost	8.02	6.53	-0.92	119.72	0.36
PCBs -Site Size	64.66	54.89	-1.51	92.59	0.13
PCBs –HRS	43.75	43.58	-0.09	100.38	0.92
PCBs –IRP	78.59	58.39	-1.88	118.20	0.06
PCBs –MMRP	5.54	4.33	-0.88	99.75	0.38
PCBs - #Contaminants	6.53	3.94	-8.66	92.06	**1.49×10^{-13}**
PCBs- Total Media	3.01	2.19	-4.24	87.61	**5.45×10^{-5}**
PCBs-Pop. Density	1842.85	2034.32	0.45	70.33	0.65
PCBs –Income	62807.37	57693.63	-1.42	95.17	0.16
PCBs- % Nonwhite	29.86	30.33	0.12	110.72	0.90
Pesticides- Total Cost	259.64	124.62	-3.40	99.73	**9.67×10^{-4}**
Pesticides -Year Cost	8.86	5.01	-2.67	121	**8.65×10^{-3}**
Pesticides -Site Size	64.16	55.57	-1.35	97.14	0.18
Pesticides –HRS	43.85	43.43	-0.24	93.29	0.81
Pesticides –IRP	82.14	51.56	-2.96	120.72	**3.69×10^{-3}**
Pesticides –MMRP	5.67	4.07	-1.17	98.66	0.25
Pesticides - #Contaminants	6.62	3.72	-10.52	90.45	**2.20×10^{-16}**
Pesticides -Total Media	3.09	2.04	-5.77	91.77	**1.07×10^{-7}**
Pesticides -Pop. Density	2051.27	1669.60	-0.93	74.66	0.36
Pesticides –Income	60555.96	61420.80	0.23	78.58	0.82
Pesticides - % Nonwhite	30.61	29.00	-0.39	85.30	0.70
Radioactive- Total Cost	393.58	191.66	-1.74	12.03	0.11
Radioactive -Year Cost	13.89	6.80	-1.88	12.15	0.08
Radioactive -Site Size	61.00	61.05	0.01	14.02	0.99
Radioactive –HRS	41.31	43.93	0.76	11.44	0.46
Radioactive –IRP	72.17	71.11	-0.04	12.40	0.97
Radioactive –MMRP	4.25	5.18	0.52	15.66	0.61
Radioactive-#Contaminants	7.58	5.36	-4.43	14.56	**5.18×10^{-4}**
Radioactive -Total Media	2.92	2.69	-0.91	15.98	0.37
Radioactive -Pop. Density	2682.76	1831.18	-0.99	12.09	0.34
Radioactive –Income	54684.74	61543.51	1.23	13.90	0.24
Radioactive - % Nonwhite	40.02	28.94	-1.21	12.02	0.23
Munitions- Total Cost	212.51	207.27	-0.09	63.42	0.93
Munitions -Year Cost	6.94	8.49	0.70	50.82	0.49
Munitions -Site Size	59.37	64.33	0.75	84.13	0.45

Table 2-19 Relationships between categorical and quantitative variables (Continued 3/4)

A-B	Mean of B with A	Mean of B without A	T	df	p-value
Munitions –HRS	43.54	43.99	0.26	96.40	0.79
Munitions –IRP	80.61	53.06	-2.60	112.2	**0.01**
Munitions –MMRP	7.72	0	-8.55	82.11	**5.57×10^{-13}**
Munitions- #Contaminants	5.94	4.84	-3.18	100.37	**2.00×10^{-3}**
Munitions -Total Media	2.73	2.67	-0.26	88.27	0.80
Munitions -Pop. Density	1756.20	2215.53	1.15	79.76	0.25
Munitions –Income	57750.49	66718.35	2.26	63.80	**0.03**
Munitions - % Nonwhite	28.41	33.11	1.09	71.72	0.28
PAH- Total Cost	213.78	198.93	-0.19	31.49	0.85
PAH -Year Cost	7.17	8.59	0.47	28.43	0.64
PAH -Site Size	62.23	56.46	-0.71	36.47	0.48
PAH –HRS	44.06	42.30	-0.83	38.24	0.41
PAH –IRP	73.82	60.72	-1.21	59.02	0.23
PAH –MMRP	5.23	4.56	0.41	39.70	0.68
PAH -#Contaminants	6.18	3.19	-8.53	40.34	**1.42×10^{-10}**
PAH -Total Media	2.90	1.96	-3.82	35.27	**5.20×10^{-4}**
PAH -Pop. Density	1816.03	2318.20	0.81	27.46	0.43
PAH –Income	61230.92	59377.52	-0.43	36.10	0.67
PAH - % Nonwhite	29.48	32.32	0.66	42.43	0.51
VOC- Total Cost	224.11	117.98	-2.70	54.33	**9.14×10^{-3}**
VOC -Year Cost	7.89	4.51	-2.29	40.21	**0.03**
VOC -Site Size	63.32	45.31	-2.22	21.65	**0.04**
VOC –HRS	43.76	43.26	-0.17	16.89	0.87
VOC –IRP	73.94	51.07	-2.19	33.59	**0.03**
VOC –MMRP	5.37	3.07	-1.96	38.40	**0.06**
VOC -#Contaminants	5.91	3.19	-5.65	19.74	**1.64×10^{-5}**
VOC -Total Media	2.87	1.56	-4.33	18.28	**3.91×10^{-4}**
VOC -Pop. Density	1940.13	1742.56	-0.22	15.25	0.82
VOC –Income	60728.76	61814.05	0.19	17.50	0.85
VOC - % Nonwhite	30.50	26.77	-0.50	16.21	0.62
Groundwater- Total Cost	220.79	114.38	-2.36	26.06	**0.03**
Groundwater-Year Cost	7.74	4.85	-1.67	20.98	0.11
Groundwater -Site Size	60.82	63.25	0.25	14.08	0.80
Groundwater-HRS	43.33	47.12	1.80	16.55	0.09
Groundwater-IRP	73.09	51.54	-2.25	27.93	**0.03**
Groundwater-MMRP	5.27	3.27	-1.42	18.45	**0.17**
Groundwater-#Contaminants	2.90	0.92	-8.07	14.43	**1.00 x10-6**

Table 2-19 Relationships between categorical and quantitative variables (Continued 4/4)

A-B	Mean of B with A	Mean of B without A	T	df	p-value
Groundwater-Total Media	5.81	3.25	-3.79	12.59	**2.34×10^{-3}**
Groundwater-Pop. Density	1886.52	2180.14	0.26	11.58	0.79
Groundwater- Income	61233.85	57497.48	-0.59	13.04	0.57
Groundwater- % Nonwhite	29.43	35.58	0.74	12.33	0.47
Sediment-Total Cost	247.79	174.27	-1.48	106.98	0.14
Sediment -Year Cost	8.59	6.36	-1.31	98.92	0.19
Sediment-Site Size	62.41	59.70	-0.44	124.37	0.66
Sediment –HRS	44.51	42.92	-0.94	122.98	0.35
Sediment –IRP	78.27	64.38	-1.22	118.76	0.22
Sediment –MMRP	6.15	4.08	-1.53	105.33	0.13
Sediment-#Contaminants	6.24	4.91	-3.90	122.27	**1.55×10^{-4}**
Sediment-Total Media	3.59	1.84	-15.00	123.51	**2.2×10^{-16}**
Sediment -Pop. Density	1827.83	2004.91	0.47	106.97	0.63
Sediment –Income	60055.56	61684.50	0.46	118.99	0.64
Sediment - % Nonwhite	29.82	30.26	0.11	118.95	0.91
Soil-Total Cost	222.70	53.84	-6.18	124.98	**8.338×10^{-9}**
Soil -Year Cost	7.63	5.23	0.75	9.37	0.47
Soil -Site Size	61.39	56.56	-0.35	8.92	0.73
Soil –HRS	43.43	47.13	1.64	11.22	0.13
Soil –IRP	73.49	41.67	-2.82	15.57	**0.01**
Soil –MMRP	5.32	2.11	-2.26	14.27	**0.04**
Soil -#Contaminants	5.81	2.33	-5.79	9.42	**2.22×10^{-4}**
Soil -Total Media	2.86	0.67	-8.74	10.35	**4.26×10^{-6}**
Soil -Pop. Density	1860.57	2600.80	0.53	8.24	0.61
Soil –Income	59717.36	75123.90	1.94	8.83	0.09
Soil - % Nonwhite	30.32	26.63	-0.42	8.90	0.68
Surface Water-Total Cost	262.93	179.03	-1.53	78.63	0.13
Surface Water -Year Cost	9.87	6.00	-1.94	60.41	0.06
Surface Water -Site Size	66.57	57.69	-1.38	95.65	0.17
Surface Water –HRS	43.45	43.84	0.22	95.94	0.82
Surface Water –IRP	87.19	61.38	-2.13	85.72	**0.04**
Surface Water -MMRP	6.48	4.24	-1.51	79.31	**0.13**
Surface Water -#Contaminants	6.46	5.03	-4.32	115.58	**3.37 x10-5**
Surface Water -Total Media	3.85	2.01	-18.77	119.82	**2.2×10^{-16}**
Surface Water -Pop. Density	1724.92	2032.61	0.84	110.10	0.40
Surface Water-Income	60235.50	61248.35	0.27	86.74	0.79
Surface Water - % Nonwhite	28.43	31.03	0.66	102.62	0.51

Chapter 3: Island Under Fire: Implications for Integrating Environmental Justice Principles into Superfund Policy in Vieques, Puerto Rico.

3.1. Chapter 3 - Abstract

Over the last two decades, environmental justice principles have grown in prominence within agency programs and practices. I employ a case study of Vieques, Puerto Rico to examine how federal environmental justice policy is translated into Superfund legislation, public participation programs, and government health assessments. From 1941-2003, the U.S. military used the small, populated island of Vieques, Puerto Rico for training purposes, including intensive bombing from land, sea, and air. While parts of the island are declared a Superfund site, as a result of a legacy of contamination, key impediments to implementing federal environmental justice policies into actual cleanup programs include: (1) Residual health effects from past and persistent exposures to military activities are outside the jurisdiction of the Superfund Act. (2) Public participation in Superfund cleanup programs is low in part because there are few formal mechanisms to ensure agencies are responsive to public input. Furthermore, health concerns and the impact of past military activities on social welfare cannot be addressed within existing public participation programs. (3) A lack of historical data on military activities and environmental conditions, coupled with small and mobile populations, make it difficult to reconstruct past health exposures to military toxins. Taken together, these restrictions confound the ability of the military to respond to its own adopted environmental justice strategies, as well as the broader health, ecological, social, and political conditions upon

which the movement is based. I extend current environmental justice scholarship through an emphasis on the temporal aspects of justice; specifically, I demonstrate the myriad of ways in which regulatory, participatory, and scientific institutions make it difficult to attend to the historical legacies of long-term and persistent past exposures to environmental burdens.

3.2. Introduction

How to implement environmental justice into policy has gained significant attention over the last several decades. The environmental justice movement has long pushed for the U.S. Environmental Protection Agency (EPA) and other federal and state agencies to incorporate environmental justice principles into agency practice (Cole and Foster 2000, Bullard et al. 2007). Currently, government agencies have integrated environmental justice into public policy in the federal, state, regional, and local levels, a process that was in part initiated by President Clinton's Executive Order of 1994 (#12898). The Executive Order instructs federal agencies to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities." A year later, the DOD published their 1995 Strategy on Environmental Justice policy report to meet the intent of the Executive Order. The outlined goals in the DOD's Strategy largely align with the directives in the Executive Order and include supporting data collection and research on the health effects of its actions on minority and low-income populations, evaluating current risk methodologies as they relate to affected

populations, considering cumulative exposures in risk assessments, and ensuring diversity in public participation initiatives.

Despite federal efforts, social scientists have critiqued the ability of government agencies to meaningfully address the principles and expectations of the environmental justice movement in public policy initiatives (e.g., Benford 2005, Faber 2008; Harvey 1996). The environmental justice movement adopts a pluralist notion of justice that extends beyond addressing disproportionate exposures to environmental hazards to embrace a myriad of environmental and social justice concerns (Pellow 2000, Taylor 2000, Cole and Foster 2001, Harrison, 2014, Schlosberg 2004). By analyzing environmental justice narratives and practices, Schlosberg (2004) develops a comprehensive taxonomy of the environmental justice movement, demonstrating that, in addition to arguing for substantive reductions in exposures to environmental hazards, the movement encompasses issues of participation parity in decision-making processes and scientific research, recognition of group-based oppression and self-determination over political, economic, and cultural futures, and enhancing the basic capabilities (e.g., adequate public transit, food, education, and safe and affordable housing) needed for full participation in social and civil life. Empirical studies of environmental justice policy implementation acknowledge that environmental justice legislation and programs have resulted in some noteworthy changes to agency conduct, but criticize these initiatives for failing to address key elements of the movement's organizing tenets and activism (e.g., Fan 2006, Bullard et al. 2007, Carruthers 2007, London et al. 2008, Sze et al., 2009, Harrison 2011, Holifield 2004, 2012, 2014, Lievanos et al. 2010, Lievanos 2012, Walker 2007, 2010). Holifield (2004), for example, states the environmental justice efforts of

agencies are largely restricted to increasing economic opportunities, through making community residents aware of federal grants, and providing a vehicle for managed public participation. In this context, federal initiatives may blunt the more radical edges of environmental justice frames that call for wider structural changes (Harrison 2011, McCarthy 2009). Since its original institutionalization over twenty years ago, environmental justice policies, programs, and practices have continued to grow with constant tension among activist, academic, and agency definitions of environmental justice. This raises important questions as to what federal and state environmental justice initiatives should encompass, and the capacity of agencies for fostering them.

Given these two decades of policy evolution and grassroots organizing around environmental justice, I analyze how environmental justice policy is applied within the military Superfund context[28]. The 1980 passage of the Superfund Act, more formally known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), gave the EPA authority and limited funding to identify and compel responsible parties to remediate land with hazardous substances that may endanger

[28] The DOD's Strategy on Environmental Justice is both similar to and more comprehensive than the Superfund's guidelines. Superfund calls for non-traditional community interaction techniques to ensure community participation (e.g., translation of key documents and special outreach to community groups and leaders) for environmental justice populations. The DOD's Strategy states that expanded public participation can be addressed through their Restoration Advisory Boards (RABs), a type of citizen advisory board meant to provide for more sustained and meaningful interactions between community members and the base cleanup team. The DOD's Strategy also calls for developing data collecting systems to identify minority and low-income populations, and evaluate the impacts of their programs on these populations, as well as develop health research for marginalized populations exposed to substantial environmental hazards.

public health and ecosystems.[29] To analyze the DOD's environmental justice practices, I employ a case study of Vieques, Puerto Rico. Due to Puerto Rico's status as a territory of the United States, Superfund policy applies to the island[30]. From the early 1940s until 2003, the small Puerto Rican island of Vieques was used for U.S. military support training and weapons storage. Mock military campaigns were staged, often with the participation of the Air Force, Marines, and Army, and other NATO nations. Artillery shells, missiles and rockets were fired from offshore locations, mines were buried underwater and on beaches, and terrestrial targets were strafed and bombed from air and sea. As a result, thousands of acres of the island were contaminated by a broad range of munitions, including bombs, rockets, missiles, projectiles, mortars, and sub-munitions. The EPA added portions of Vieques to the Superfund's National Priorities List (NPL) on February 11, 2005; a Restoration Advisory Board was created around that time to allow for public input into cleanup programs. The island's residents, and their supporters, allege the military's ownership of land and activities caused ecological damage and elevated illnesses on the island, in addition to contributing to high poverty and unemployment rates as they hampered the development of fishing, agricultural, and tourism industries.

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[29] CERCLA did not originally cover federal properties, and the military was at first exempt from environmental regulation. Congress passed the Superfund Amendments and Reauthorization Act (SARA) in 1986, which requires the Department of Defense to comply with CERCLA and with other state and federal environmental statutes and regulations.

Given the length and intensity of military activities in Vieques, and ethnic and class political marginalization of the population, it provides an important case study of how environmental justice policy is applied in situations of pervasive ecological and social impacts and potentially chronic (i.e., multi-decadal) health exposures. I, similar to other academic critiques, found critical distinctions between institutionalized and grassroots representations of justice, with the former often being more limited. I engage and extend the environmental justice scholarship through emphasis on the temporal aspects of justice; specifically, I demonstrate that regulatory, participatory, and scientific institutions make it difficult to attend to the historical legacies of long-term and persistent past exposures to environmental burdens.

The importance of scale for understanding and responding to environmental (in)justice has been the target of considerable debate and analytical study. Numerous studies have underscored the relevance of spatial scale as both an analytical category, as well as a circumscriber of environmental justice activism and political response. For example, studies have drawn attention to the modifiable areal unit problem[31], or the importance of the scale of resolution in debates over the existence, extent, and severity of environmental injustices (Openshaw 1983, Anderton et al. 1994, Bowen et al. 1995, Cutter et al. 1996, McMaster et al. 1997, Tiefenbacher et al. 1999, Bowen 2002) and the disjuncture between the geographic scale(s) at which a problem is experienced and the

[31] The modifiable areal unit problem refers to the issue in which different spatial units of analysis can reveal different relationships among spatially aggregated data. For example, racial or class disparities in the siting of hazardous facilities may be apparent at a census level but not at a county level analysis.

scale at which it is perpetuated or politically addressed (Williams 1999, Towers 2000). While most of the attention has been directed to the spatial dimensions of scale, less attention has been paid to the multiple temporal dimensions of environmental justice[32].

I argue the following with respect to how environmental justice intersects with Superfund legislation, public participation programs, and government health assessments and the resulting impediments to redressing past harms (1) **Legislative:** The Superfund legislation limits cleanup programs to reducing current and future risks of exposure to contaminants for site-related releases, with past health effects of exposures being outside regulatory purview. This prevents federal agencies involved in Superfund cleanups from expanding health research on at-risk populations or assessing the cumulative impacts of exposure to multiple contaminants. It also restricts the ability of agencies to attend to the broader (both temporally and topically) notions of justice engendered by grassroots social movements. (2) **Public participation:** Despite efforts to address environmental justice mandates by diversifying Restoration Advisory Boards, public participation is low in large part because of a lack of authority for boards. This, combined with an absence of trust in agencies and the significant resources (both time and technical) required by the boards, presents barriers to diverse public participation. Restoration Advisory Boards are restricted to commenting on the technical aspects of cleanup remedies and are thus also not an avenue to address the residual effects of military tenure. (3) **Scientific response:** Insufficient knowledge of past health exposures further confounds the

[32] An exception to this is the importance of considering intergenerational justice, or effects across multiple generations, of activities with adverse environmental consequences.

tensions that result from legislation and public participation being restricted in redressing residual health and social impacts. It is difficult to reconstruct past exposures to military contaminants because of a lack of historical data on military activities, environmental conditions, and potential exposure pathways, in addition to the potential outmigration of exposed populations over the last several decades. The federal Agency for Toxic Substances and Disease Control (ATSDR) is tasked with investigating health-related claims for Superfund sites, but only in a non-regulatory capacity (i.e., the agency can make recommendations, but not enforce them). Moreover, recommendations from the agency often conflict with what is authorized by the Superfund Act.

The difficulties with accounting for and addressing the past effects of military tenure in regulatory, participatory, and scientific institutions has implications for environmental justice; namely, the timescales of environmental justice are constrained by a policy focus on managing the *current* and *future* health and ecological risks of exposure to military waste, and communities are limited in their ability to redress *past* harms by appeals to formal hazardous waste policy or public participation programs. What types of issues stemming from historical exposures should parties be liable for in hazardous waste statutes and programs and public participation venues? How far back should parties be responsible? How can public participation initiatives be structured to incorporate diverse individuals and groups given strained relationships created by historical activities? Given sparse extant environmental and health exposure data for the multiple decades of military operations, what environmental justice responses are possible? I will explore how not having answers for these questions affects the implementation of environmental justice concerns into environmental policy.

To date, the Department of Defense is responsible for 130 of the 1320 Superfund's National Priorities List, the list of the most hazardous waste sites in the United States. As such, the DOD is liable for about 10% of overall Superfund sites and over 80% of sites in which the responsible party is a federal agency.[33] Nevertheless, despite being responsible for the majority of contaminated federal lands in the U.S., there is little published scholarship on environmental justice in the military context. Some work has explored how the military has systematically exposed Native Americans and indigenous lands to military toxins (e.g., see, Ishiyama 2003, Hooks and Smith 2004, LaDuke 2004). Other work has looked at the effects of militarism on the Marshall Islands and the integration of environmental justice principles into social movements challenging militarism (Johnston 2008; Baver 2006). To the author's knowledge, this is the first work that critically assesses how the military translates federal environmental justice directives and strategies into actual cleanup practices and environmental restoration. Given the centrality of the military in Superfund cleanups, and the development of their environmental justice strategy, this is an important omission. As a low-income, ethnically marginalized community with evidence of poor public health status, Vieques provides an important case study for analyzing environmental justice implementation.

3.3. Island under fire: the military in Vieques

[33] Statistics compiled by author from data on individual sites from the EPA's National Priorities List database. See http://www.epa.gov/superfund/sites/query/queryhtm/nplfin.htm; Accessed November 16, 2013.

The 21-mile long, four-mile wide island of Vieques, located 6 miles off the southeastern coast of Puerto Rico, has a population of over nine-thousand residents. From 1941-2003, the U.S. military used Vieques for training purposes, including intensive bombing from land, sea, and air. By the end of the 1940s, over 76% of the island (25,360 of 33,119 acres) had been expropriated by the Navy. Residents who did not resettle elsewhere, such as the neighboring island of St. Croix in the U.S. Virgin islands, were relocated without property titles to small tracts of land in the central zone of Vieques, between a training area in the east and a weapons storage depot and small operational base in the western part of the island.

The Navy purchased more than 80% of the land it acquired from just two landowners. This purchase of almost three-quarters of the island was facilitated due to the heritage of Spanish colonization that, by the end of the 19th century, had concentrated the island's land in the hands of just a few sugar plantation owners (Ayala 2001, McCaffrey 2002). While the majority of those relocated were technically "landless", there was not the contemporary urban geographic separation between workplace and residents. Instead, many rural workers lived on the plantations, building houses and having small subsistence agricultural plots that provided security beyond just monetary wages. The workers, having no land titles, were evicted from their homes without legal obstacles when the large landowners sold their properties. With the displacement of the *agrego* lifestyle by the Navy, with its traditional usufruct rights over parcels of land, workers lost both their jobs and their homes, contributing to a sense of rural dispossession.

While the original land acquisitions supplanted the sugar cane industry, the island's main source of employment, there was an initial boom in well-paying jobs in construction and cleaning for the Navy. Little subsequent work, however, was created by the base as Vieques did not host a permanent group of soldiers; rather most trained there temporarily (Ayala 2001, McCaffrey 2002). The navy's purchase of almost three-quarters of the island thus dislocated the island's main source of income and restricted public access to land for subsistence activities. After appropriation of the land, the Navy also took control of water and air routes and aquifers.

Vieques was unique compared to other U.S. bombing ranges because of the intensity of training and the small buffer between civilian and military areas (Baver 2006). For over six decades, U.S. troops used Vieques, known as the Atlantic Fleet Weapons Training Area, to prepare for every military engagement since 1941. This includes Guatemala in 1954, Cuba in 1961, Vietnam between 1965 and 1972, Santo Domingo in 1965, Chile in 1973, Grenada in 1983, Panama in 1989, and Iraq in 2002. The site was also rented out to NATO allies around the world for target practice and testing new weapons; virtually every type of ammunition and ordnance available to the Navy since World War II was used for training purposes. In the eastern part of the island, the Navy established the Vieques Naval Training Range, which comprised 1) the Live Impact Area and a Secondary Impact Area for ship-to-shore and aerial bombing exercises, and 2) The Eastern Maneuver Area, primarily used for ground-based training with smaller munitions. In the western part of the Island, the Navy established the Naval Ammunition Support Detachment to store and dispose of munitions (see Fig. 3-1). Until 2001, munitions such as missiles, rockets, and bombs, in addition to chemical, biological

and nuclear weapons, were stored in 117 ammunition shelters on 8,000 acres, making the island one of the biggest munitions containment facilities in the Atlantic basin. Cleaning solvents for engine parts were dumped into pits, contaminating soils and groundwater (Wargo 2009).

In the early 1980s, there was an average of 3,400 bombs dropped, 158 days of naval bombardment, and 200 days of air-to ground combat exercises per year (Davis et al. 2007). While records are not comprehensive, Vice Admiral John Shanahan estimated that between 1980 and 2000 nearly 3 million pounds of ordnance were dropped on Vieques every year (Wargo 2009).The estimate for the total weight of ordnance dropped is over 80 million pounds. Hazardous waste products resulting from military weapons and industrial use in Vieques, may comprise, but is not limited to, napalm, white phosphorous, polychlorinated biphenyls, arsenic, copper, lithium, mercury, lead, aluminum, cadmium, antimony, magnesium, 2,4,6-trinitrotoluene (TNT), perchlorate, barium, cyanide, solvents, petroleum products, and pesticides. Due to past secrecy around the nature and intensity of its training on Vieques, there are concerns that the Navy has to this day not been forthright about its chemical usage on the island. Military and EPA representatives state, rather than being non-transparent about past training activities, records are incomplete and little investigations and monitoring were present during the time the Navy was active[34].

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[34] Community members have initiated lawsuits, human rights petitions, and FOIA requests in Vieques to reveal more information. In response to a FOIA request, the Navy disclosed that it had mistakenly fired 267 rounds tipped with depleted uranium, only 57 of them were

The ecology of Vieques includes beaches, coral reef formations, mangroves, rare bioluminescent bays, and tropical dry forests, and rich flora and fauna, including listed endangered species such as the hawksbill and leatherback sea turtles. The Live Impact Area, used for target practice, was adjacent to fertile fishing grounds, as well as important ecological habitats including beaches with turtle nesting grounds, seagrass beds, mangroves, and coral reef formations. Military activities were alleged of damaging marine habitats on the northern and southern coasts of Vieques by direct bombing and artillery practice and causing the re-suspension of sediment that reduced solar light and decreased productivity (DNER 1978, 1999). Numerous sizes of bombs, pieces of artillery, bullets, rockets, parachutes, flares, and metal fragments of different types are still present in underwater habitats and pose a dilemma for current cleanup efforts, as the technology to detect and remove underwater ordnance is in its infancy. Furthermore, the military was accused of destroying vegetation and altering island topography by bombing practices, cutting down coconut plantations that served as subsistence agriculture for islanders, and leaving behind chemical residue of explosives in fresh and saltwater lagoons and on lands in the Impact Area. Few ecological studies exist from this time period, with anecdotal evidence and independent research pointing to most of these effects.

In the 1970s, an intensification of Naval target practice and bombing, and the successful precedent of the neighboring island Culebra in removing military practices

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subsequently recovered. For depleted uranium ammunition, a significant percentage of the uranium vaporizes upon impact, with estimates as high as 60% (Special Commission for Vieques 1999). Officials from the Marine Corps admitted in 1999 that napalm was dropped on Vieques in 1992 (Barreto 2002). Also there are resident suspicions and legal testimony from a Marine stationed in Vieques that Agent Orange was used in Vieques as a defoliant.

from their island, sparked anti-Navy organizing on Vieques. Fishermen in particular became the symbol of resistance in the 1970s, alleging the bombing, fire exercises, and other military activities caused long-term ecological damage to coral reefs and other marine breeding grounds and reduced offshore fishing productivity. Furthermore, military maneuvers barred fishermen access to prime fishing waters on the eastern end of the island and military ships' propellers severed the buoys that indicated the locations of their traps.[35] In 1978 and 1979, Vieques fishermen and their supporters obstructed maneuvers by military battleships with their fishing boats, forcing cancellations or suspensions of ship-to-shore or air-to-ground bombardment exercises. Dozens of arrests resulted from these fishermen protests.[36]

In 1978, Viequenses fishermen filed a class action suit against the Navy for violating a number of federal laws and called for an immediate halt to maneuvers. Then-Governor Carlos Romero Barcelo also filed a petition in 1978 in a federal court seeking an injunction against the Navy and Marine Corps in Vieques until the military complied with environmental protection statutes. This included a demand that that Navy file an

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[35] According to a study by the U.S. Department of Agriculture these lost traps could continue to collect 4500 to 5000 of pounds of marine species over a ten-month period.

[36] In response to anti-Navy organizing and strained military-civilian relations, the military undertook an extensive public relations campaign to improve community-Navy relations. A bizarre turn of events for this campaign came when the military's hired Community Liaison Officer, Lt. Alex de Zerda, was arrested in Vieques by the FBI in 1980 for a bombing on the Puerto Rican Bar Association's offices on the mainland, an organization lending support to the Vieques' protests. The bombing was said to be in retaliation for an earlier attack on a Navy bus on the main island by Independence Party members, who in turn were said to retaliating for an earlier killing of party members and the death in a jail cell of a protestor arrested for civil disobedience in Vieques. This relations officer was also accused of singling out particular community leaders for arrest during the fishermen protests.

environmental impact statement as to how its exercises affected the ecological, cultural, and socioeconomic attributes of the island. The fishermen and Governor's suits were combined, although the fishermen later attempted to withdraw their case citing biases by the judge (this request was denied). In 1983, after five years of costly litigation, the Navy signed a Memorandum of Understanding (MOU) with the Puerto Rican government, agreeing to mitigate environmental impacts and assist local economic development. In return, the government of Puerto Rico dropped its federal suit against the Navy.[37]

Despite this, Viequenses and their supporters alleged that the Navy on multiple occasions violated the MOU.[38] Special commissions, multiple administrative regimes, and movement organizers all argued that the Navy's training activities, altering of transportation routes,[39] and ownership of the majority of land in Vieques negatively impacted the island's ecology and hindered its cultural, educational, and socioeconomic development.

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[37] In response to environmental mitigation mandates, the Navy committed itself to a leading a program of reforestation in coordination with the Department of Natural and Environmental Resources, established seven ecological protection zones, instituted a program for the management of sea turtles and sea mammals, and agreed to reduce adverse impacts on lagoons and mangroves near the impact zone.

[38] Some efforts failed simply because they were not appropriately scaled to the island. For example, to address socioeconomic effects, the Navy agreed to increase employment on the island. The island, however, lacked the infrastructure to sustain large manufacturing and most companies that located to Vieques had closed within five years, while others failed to materialize from the planning stage (Grusky-Fajardo 1989).

[39] The old transportation route and main commerce conduit between the main island of Puerto Rico and Vieques was 9 miles. With the establishment of the military complex of Roosevelt Roads Naval Base on the main island and the Navy on Vieques, however, this route was closed and civilian traffic and commerce was rerouted to a longer eighteen-mile route between the two islands.

Civil disobedience once again erupted on the island in 1999 after Viequense civilian security guard David Sanes was killed by two errant five-hundred-pound live bombs dropped near the guard post. For over a year, demonstrators set up camps directly on the bombing range, strewn with rusting tanks and unspent explosives, halting military maneuvers. Supporters of this movement included the local community and Puerto Rican citizenry at large, human rights activists, church groups, environmentalists, lawyers, national and international celebrities, the mayors of San Juan and Vieques, and government representatives affiliated with the three major Puerto Rican parties.[40] Included amongst the subsequent arrests were 21 Puerto Rican doctors who entered the Live Impact Area, declaring that it was part of the Hippocratic Oath to be concerned with public health. In 1999 and 2000 Robert Kennedy Jr. challenged the Navy in court on behalf of a mix of environmental and human rights groups (i.e., Vieques Pro-Rescue and Development Committee, the Vieques Women's Alliance, the Natural Resources Defense Council, the Water Keeper Alliance, Horsemen for Peace, the Vieques Water Keeper, the Professional Technical Support, and the Vieques Sustainable Development Group) seeking an end to the bombing in Vieques (Barreto 2002). The protests cut across party lines and managed to unite a large sector of society because they were

[40] For example, On May 11, 1999, soon after the death of Sanes, the Governor of Puerto Rico Pedro Rossello issued Executive Order 1999-21 appointing a Special Commission on Vieques to study the impacts of Navy activities on the island. The Special Commission was headed by Norma Burgos, Secretary of State, with the participation of elected officials from the three major Puerto Rican political parties, the mayors of Vieques and San Juan, and a representative from Vieques' Fisherman's Association, and demanded immediate cessation of military operations and a comprehensive epidemiological study. Party members from the three main parties also participated in setting up protest camps on the bombing range.

framed around issues of health, the environment, and human rights, rather than as an anti-colonial struggle (which would have appealed to a smaller subset of supporters).

Political pressure contributed to the end of the Navy's use of Vieques (McCaffrey 2008). In 2001, Congress directed the Navy to relinquish control of its facilities in the western part of Vieques. The land was apportioned and transferred to the Department of the Interior's U.S. Fish and Wildlife Service to be managed as a National Wildlife Refuge (approximately 3,158 acres), the Municipality of Vieques (around 4000 acres), and the Puerto Rico Conservation Trust (around 800 acres). In 2002, Congress authorized the Navy to close its training facilities on the east part of Vieques. In 2003, the Navy ceased all military operations and, upon closure, transferred approximately 15,000 acres of property on the eastern side to the U.S. Fish and Wildlife Service to be managed as a National Wildlife Refuge and Wilderness Area. While environmental investigations were initially performed under the Resource Conservation and Recovery Act, the Governor of Puerto Rico used his silver bullet to get Vieques listed in Superfund's National Priority List (NPL), the nation's most hazardous sites, in 2005. The NPL site also includes offshore areas where munitions may have settled underwater during past training exercises. While the EPA has oversight over cleanup activities, the DOD is designated the Lead Agency under the Superfund program, meaning the military determines the resources it is willing to spend on cleanup, and can select its own cleanup strategies and post-remedial maintenance and monitoring approach. Other governmental agencies can be members of base cleanup teams and influence remedial activities; in the case of Vieques this includes the Puerto Rico Environmental Quality Board and U.S. Fish and Wildlife Service.

The transference of land to the Fish and Wildlife Service, and the resulting refuge designation, has been controversial among some members of the public, who see the transfer as a means to permit a less stringent cleanup program. With the wildlife designation, risk assessments assume that public access and use of the site will be restricted; thus human exposures to munitions and chemical hazards are more limited on land intended for conservation purposes. This approach allows for a cleanup program that might save hundreds of millions of dollars as compared to a program that assumes more intensive human use of the site (Wargo 2009). Vieques has long been one of the poorest Puerto Rican municipalities. Estimates placed the unemployment rate at 19.1% (Special Commission Report 1999) The 2000 Census indicates that 65% of residents of Vieques live in poverty as compared to 48% for all of Puerto Rico. While poverty in Vieques has many historical reasons that predate the Navy, the Navy's ownership of land and its naval activities hampered the development of the fishing, agricultural, and tourism industries and perpetuated and exacerbated land insecurity.

There have been few comprehensive studies on the health of people living in Vieques. Available studies indicate that cancer rates, infant mortality, birth defects, cardiac illness, diabetes, strokes, hypertension, and liver diseases are high compared to the Puerto Rico mainland (ATSDR 2013). The ATSDR is the principal federal agency, established in 1985, that investigates whether harmful public health effects resulted from exposure to hazardous substances. Health assessments released by the ATSDR state that while there is evidence of elevated rates of illnesses in Vieques, the origins of this poorer health status is inconclusive. Furthermore, Vieques has a poor state of health services, with no hospital equipped for medical emergencies or labor and no cancer treatment

available on the island. Access to oncology and other specialty services (e.g., neurology, cardiology) requires travel by ferry to the main island of Puerto Rico.

Concern about the cleanup manifest in varied legal, legislative, and administrative recourses. In 2007, over 7000 residents in Vieques (of an approximately 9000 total population) brought a class action lawsuit against the U.S. under the Federal Torts Claims Act, seeking monetary compensation for health issues they claimed resulted from long-term exposures to military contamination. The tort claims are based on EPA-documented past violations by the Navy of environmental statutes (such as the Clean Water Act discharge permit requirements), independent studies finding elevated levels of contamination and higher incidences of certain diseases (e.g., such as cancer, cirrhosis, diabetes, and hypertension) on Vieques, as well as insufficient public notification of contaminant releases into the environment. This lawsuit was dismissed in court, without hearing the plaintiffs' substantive claims, due to a claim of "sovereign immunity", a legal doctrine that bestows the federal government with broad "discretion" to carry out its activities without being sued[41]; an appeal of the decision to dismiss is currently pending. All three judges in the original suit agreed that the lawsuit raised legitimate concerns about health and suggested Congress as the appropriate venue for redress. Supporters of Vieques have already turned to Congress, introducing multiple bills to address public

[41] The case was not unanimous as the dissenting appellate judge wrote "Nowhere does the medieval concept of 'the King can do no wrong' underlying the doctrine of sovereign immunity sound more hollow and abusive than when an imperial power applies it to a group of helpless subjects."

health issues and improve detection and health services[42]. While community members and their supporters have focused on legal suits and congressional bills for addressing potential past harms resulting from military operations, this paper deals only with the federal policy response (i.e., the structure of Superfund legislation, public participation programs, and agency health assessments).

[42] For example, the Vieques Recovery and Development Act of 2011 was introduced by the New Jersey representative and Puerto Rico's non-voting representative to provide funding for a hospital and toxins research center on the island.

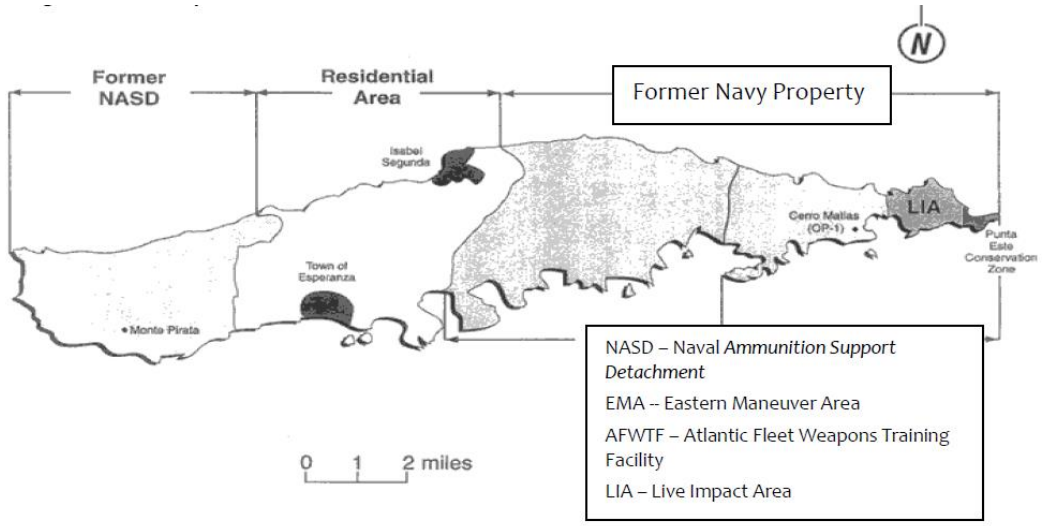

Fig. 3-1 Map of the former Navy property in Vieques

In the eastern part of the island, the Navy established the Vieques Naval Training Range, which included 1) the Atlantic Fleet Weapons Training Facility (AFWTF), which comprised the Live Impact Area and a Secondary Impact Area. These sites were used for ship-to-shore and aerial bombing exercises, and 2) The Eastern Maneuver Area, which was primarily used for ground-based training with smaller munitions. In the western part of the island, the Navy established the Naval Ammunition Support Detachment (NASD) to store munitions and dispose of obsolete or damaged munitions Source: ATSDR, 2013

3.4. A note on methodology

Vieques was selected as a case study of how Superfund military sites address environmental justice due to the length of time and intensity of military training, the narrow buffer zones between civilian and military areas, and the ecological, social, and economic impacts of the naval appropriation of approximately three-quarters of the island. Furthermore, Vieques is one of the poorest municipalities in Puerto Rico and remains ethnically distinct and politically marginal relative to the rest of the U.S., with no voting authority in Congress (Baver 2006). Furthermore, while social movements that emerged in Vieques during the last five decades typically did not organize under an explicit environmental justice frame, their framing relied on key tenants of the general environmental justice movement. This includes articulations around redressing health and contamination, human rights, and threats to cultural and traditional ways of life (e.g., fishing).

I draw on 33 in-depth interviews that primarily took place from January to March 2014 and June to August 2014. A few follow-up interviews were conducted during Spring 2015. Interviews were in English, Spanish, or a mixture of both. Interviewees encompassed agency representatives, including from the Navy, U.S. EPA, and U.S. Fish and Wildlife, as well as individuals involved in formal participation programs, community organizers, or affiliated with the University of Puerto Rico's School of Public Health. Community organizers include leaders in Vieques working on issues relating to illness and health care, decontamination of the military base, human rights, fishermen rights, community development, and those involved in municipal politics. Interviews were semi-structured to allow for qualitative investigation and

organized around the following four themes: the environmental remediation of the military Superfund site, the formal public participation initiatives, the ATSDR health assessments, and environmental justice and its applicability to military cleanup programs. Interviews and archival work were conducted primarily in Vieques, with additional interviews with agency representatives conducted in San Juan, Puerto Rico and New York City, New York. Archival research includes environmental and health assessment documents, technical reports, Restoration Advisory Board meetings, and video recordings and transcripts from ATSDR meetings. I also went on several site tours and attended public meetings, community outreach events, symposiums, and a February 2014 RAB meeting. Technical documents and health assessments were retrieved from online EPA, military, and ATSDR information repositories. I also conducted historical archival research out of El Fortin Conde de Mirasol, a public-run museum and archive center; this gave me daily interaction with community groups and residents in Vieques. All data gathered from interviews and observations are anonymized in accordance with Institutional Review Board approval from the University of California, Santa Cruz.

3.5. Addressing Environmental Justice under Superfund Policy

3.5.1. Environmental justice as equated with technological progress

The Superfund policy does not address health effects resulting from past exposures and also limits risk assessments to contamination occurring within official site boundaries. These aspects of the law pose a barrier to environmental justice directives and strategies that aim to evaluate the health impacts of federal programs on vulnerable communities, as well as assess cumulative exposure risks. Given the jurisdiction of the Superfund Act, and its interpretation by agency representatives overseeing cleanup, it is difficult to address the residual harms and broader community concerns that relate to long-term military programs. This limits the temporal dimensions of environmental justice, as historical legacies of military activities are outside the scope of response.

Environmental remediation in Vieques is currently quite contentious. During interviews with community members concerned about the cleanup, it was often claimed that the cleanup is superficial or absent. This public perception of little to no environmental remediation occurring is not reflective of a multi-million dollar program of Navy investigations and actions in the site. On the eastern side of the island, which housed the navy's training range and Live Impact Area, there is an extensive munitions removal program. As of April 2013, over 2,604 acres had been surface cleared of munitions; approximately 38,386 munitions items have been collected and destroyed by blowing these up onsite. While the remediation of underwater munitions is still in its infancy, three pilot studies had been conducted by the National Oceanic and Atmospheric Administration and the Navy to evaluate technologies for safely detecting underwater munitions around the island (EPA 2013). The cleanup of munitions and

munitions constituents is estimated to be completed by Fiscal Year 2022, with the overall cleanup estimated to be completed in Fiscal Year 2045.

When I asked interviewees representing the Navy whether environmental justice is addressed in their remedial programs, they often highlighted the high expenditures associated with cleanup. As stated by an interview with two representatives,

> Interviewee 1- "I've attended environmental justice seminars where people complain that 'they put a landfill here because it's a poor area' but I think the resources allocated to this project are higher than any other site in the main United States. So in terms of environmental justice you would say, this site is treated differently because less funding would be allocated for here. But that is not the case of Vieques".
>
> Interviewee 2- "It's already by far the top priority in the Navy munitions response program and it's been getting probably 30-45% of the funding. It's already the top priority so there is not really any shift that could occur that would make it more of a priority. It gets a high level of attention and concern and a lot of funding"
>
> JO (interviewer)- "Why do you think it gets so much funding compared to other sites?"
>
> Interviewee 2- "That kind of grows out of the history of the site. For the Navy, Vieques is the most heavily impacted site, so that funding is appropriate. And I think it's also in response to public concern. If there is a site on a base somewhere that no one is talking about then that can afford to wait. But in the case of Vieques, there is an urgency about let's get on this and that's been done"

An EPA representative relayed to me that their agency is not responsible for invoking any particular environment justice policy as they are not the lead agency in federal cleanups (in contrast to their role for private sites).[43]

Through the end of Fiscal Year 2010, the Navy spent a total of $142.4 million on the cleanup of its former facilities in Vieques and estimated that an additional $380.6 million is needed to complete the planned cleanup. The spending through to the end of FY2010 represents 2.6% of the $5.56 billion total spending on cleanup for all navy bases. While this represents a much smaller proportion than referenced by the Navy representative, Vieques is a top priority, being the third highest funded base in the Navy's cleanup programs (see Fig. 3-2).

One of the issues highlighted by environmental justice activism and scholarship is inequities in the enforcement of environmental and public health laws (Bullard et al. 2000). By citing that Vieques is a priority in the Navy's munitions response program, confirmed by the high expenditures for cleanup, the Navy representative makes the case that Vieques does not have an unequal enforcement of environmental laws relative to other bases undergoing cleanups; rather the site receives greater attention than other

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[43] In the last few years, there has been the creation and development, by the EPA, of a Vieques' Sustainability Task Force. The objectives of the Task Force are to ensure a comprehensive remediation of the closed military site, and expand other projects to support sustainability, including waste reduction and recycling programs, and to protect Vieques' bioluminescent bay. The President's Task Force from 2011 also directs relevant federal agencies, including the Navy and Department of Health Services, to support the Sustainability Task Force. As it is too early to tell how effective this Task Force will be in making improvements to health care, infrastructure, and the environment, and as this Task Force is not mandated by Superfund (but rather is specific to Vieques and came about due to the high visibility of the case), this paper omits an analysis of its promise in addressing environmental justice.

sites. Albeit, the high spending is in part a result of the heavy impact on the site rather than simply because of environmental justice concerns. As such, increased expenditures do not guarantee that residents do not bear a disproportionate burden of pollution (i.e., contamination will still remain present at the site, alongside restrictions on land use, despite the high cleanup expenditures).

3.5.2. Addressing past health exposures

In this iteration of environmental justice, the concept is equated to a technological feat, and the expenditures associated with it, to degrade, remove, or contain over a half century of military waste production. Under this interpretation of environmental justice, as well as the legislative framework, which orients Superfund towards the reduction of *current* and *future* human and ecological risk, the base cleanup team members do not consider the residual health effects or other historical legacies of long-term military operations. The military representatives and regulators, in charge of identifying and addressing pollution are not technically, epistemologically, or legislatively equipped to address public health concerns; public health assessments and epidemiological studies are not encompassed in the jurisdiction of base cleanup teams nor do they have the training to address these concerns. The personnel in charge of cleanup do not have toxicologic, epidemiologic, or other specialized health expertise. As one interviewee from the military stated, "There is a lot of concern about public health on Vieques and there continues to be that concern, but our CERCLA [Superfund] cleanup program is focused on cleaning up environmental contaminants and the munitions. We just aren't qualified to speak about public health and it's certainly not our

mission to address it." An EPA interviewee emphasized, "Our whole motto is protecting future generations and the health effects of what may or may not have happened is not in Superfund at all." The passage of the Superfund Act by Congress was a landmark public victory, a response to the crisis of Love Canal and mounting, unaddressed industrial waste. It is, however, limited in its ability to redress past health exposures to environmental contaminants despite contentious attempts during the legislation's early development history to provide compensation to victims of pollution and reform toxic tort laws (Szasz 1994).

3.5.3. Addressing cumulative risk exposures

It is also outside of the jurisdiction of Superfund to address health threats that extend beyond official Superfund boundaries and this makes it difficult to address the risks of cumulative exposures to multiple contaminants. Environmental risks are often considered on a *per site* basis or single contaminant framework (i.e., chemical-by-chemical analyses) and do not incorporate exposure to multiple and cumulative environmental burdens across a landscape. Populations, however, are often exposed to multiple environmental burdens, that can act additively or synergistically, and increase susceptibility to environmental pollution, particularly for populations with overall poorer health status (Morello-Frosch et al. 2000). Furthermore, social stressors, such as racial discrimination, social inequality, and economic discrimination, increase susceptibility to the negative health effects of exposure to environmental hazards (Morello-Frosch et al.

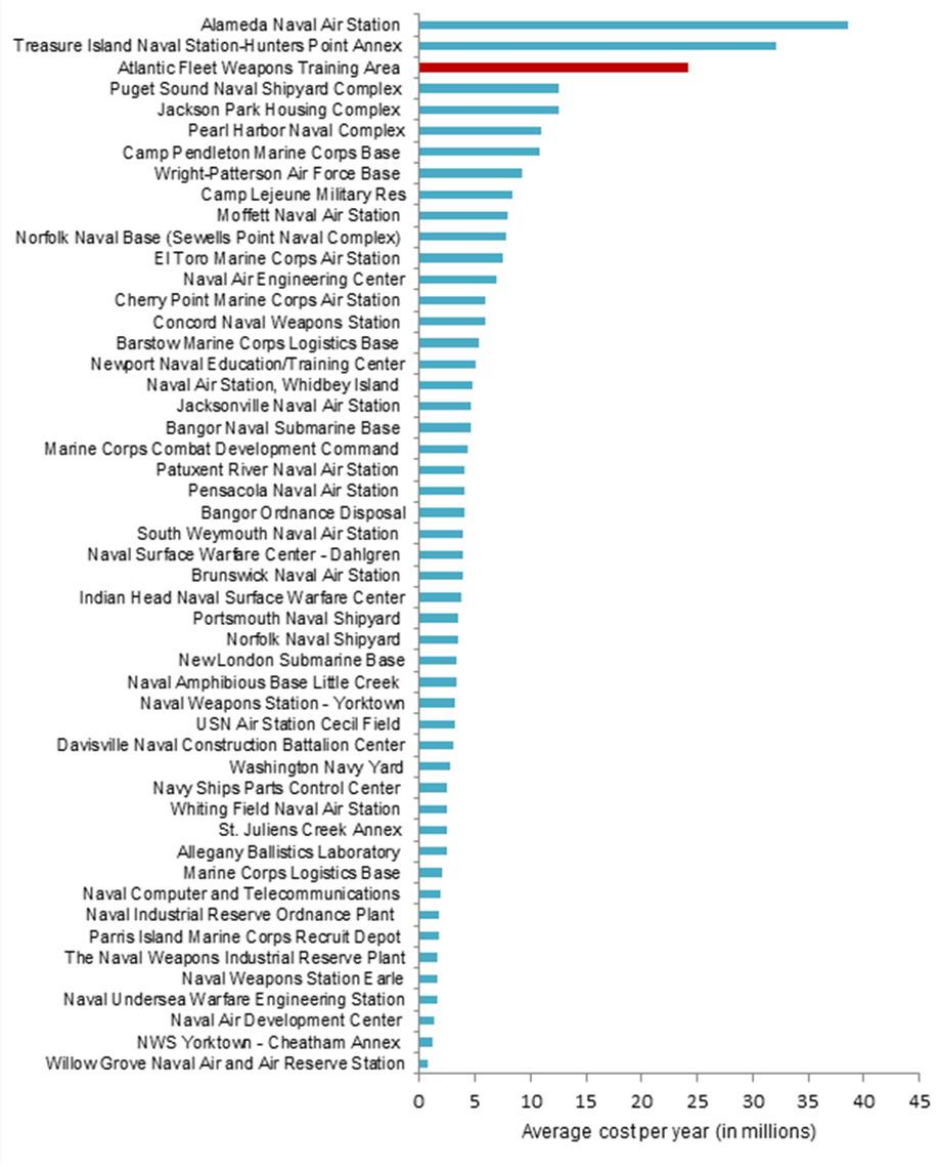

Fig. 3-2 Average annual spending on cleanup programs for Superfund military sites where the Navy is the lead agency

Vieques, known as the Atlantic Fleet Weapons Training Area, is highlighted in red.

2011). While researchers and policymakers have increasingly grappled with how best to characterize the impacts of multiple exposures to chemical and non-chemical stressors [44], in addition to disparate social vulnerabilities, (e.g., see Morello-Frosch et al. 2001, Su et al. 2009, Chakraborty et al. 2011, Couch and Coles 2011, McEwen et al. 2011, Morello-Frosch et al. 2011, Nweke et al. 2011, Schwartz et al. 2011, Sexton et al. 2011), Superfund cleanup programs focus narrowly on the pollutants found within site boundaries.

Environmental justice activists have intensified pressure on public agencies to shift away from impoverished notions of causality to better account for the multiple and concentrated burdens that poor, non-white, and linguistically or educationally disadvantaged communities may face. Agencies have recognized this call and formalized official policy to reflect so. Both the Executive Order and the DOD Strategy on Environmental Justice discuss, when "practicable and appropriate", analyzing the health effects of cumulative, and/or synergistic exposures rather than assessing contaminants or pathways of exposure in isolation of each other. When asked, however, about the feasibility of implementing environmental justice policies within the Superfund context, one EPA representative states,

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[44] For example, in 2010, the EPA held a symposium on the science of disproportionate health impacts. The symposium was meant to produce knowledge on science and environmental justice that can be considered in governmental decision-making processes. Much of the research and discussions focused on environmental disparities and differential vulnerabilities, cumulative risk assessment, the combined effects of chemical and non-chemical stressors, and increasing community capacity. Many of the published pieces are cited in the text immediately following the footnote.

> "The Superfund process is very prescriptive in what it allows us to do. CERCLA only lets us evaluate site-related releases. From the standpoint of looking at environmental justice, or how I interpret it, environmental justice approaches will focus on a variety of stressors on a community or take a holistic look at what that community might have been exposed to. Many of the factors that identify an environmental justice community, such as exposures to multiple sources of contaminants, go beyond the purview of what the Superfund Act lets us consider or address."

As a result, for example, despite scenarios in which a resident might be exposed to heavy metals within official Superfund boundaries, in addition to heavy metals from subsistence fishing, Superfund risk assessments would not assess those exposures cumulatively.

Despite the Navy's presence in Vieques since the federal institutionalization of environmental justice in the mid-1990s, there has not been widespread study of the health impacts of the military's programs.[45] Others scholars have demonstrated that despite adopting protocols on mitigating adverse health and environmental impacts on low income and minority communities, there is an absence of the systematic appraisal of demographic characteristics and patterns of "disproportionate impact" in the U.S. and U.K (Holifield 2004. Office of the Inspector General 2004, Walker 2010); thus formal policies do not always translate easily into on-the-ground agency practices.

[45] An exception to this is the ATSDR health assessments, described below, that were conducted in response to community petitioning.

3.6. Federal versus grassroots interpretations of environmental justice

The broad environmental, socioeconomic, and political conditions upon which environmental justice movements are based do not get addressed within the Superfund program, which is mainly predicated on a technical program to reduce exposures to hazardous waste. During regulatory hearings, media releases, and interviews, activists in Vieques, in contrast, reveal a pluralist vision of justice that is consistent with the discourses and framing of the environmental justice movement and addresses a breadth of ecological, health, social, and political costs from a history of militarism. While not being labeled as an environmental justice movement by participants, residents and movement organizers in Vieques articulate concerns with elevated rates of acute and chronic health problems, in addition to insufficient public participation, issues with self-determination and sovereignty, access to environmental resources, and substandard and inadequate health care, education, housing, and transportation services. This resonates with the broader environmental justice movement's emphasis on equitable distributions, participation parity, recognition of group-based oppression and social inequalities, and enhancing community capabilities (Pellow 2000, Cole et al. 2001, Schlosberg 2004, 2007, Walker 2010, Harrison 2014).

Whereas public health concerns are outside the regulatory purview of Superfund cleanup, residents tend to foreground a concern for inequitable historical exposures to environmental hazards and the potential impacts on the island's health status. Ethnically and economically marginalized communities might experience environmental hazards differently than middle-class communities as a result of patchy access to health care,

nutrition, and other social stressors. Residents thus call for enhancing the island's capabilities and addressing disparities in issues of access. Compensating victims of toxic contamination has been embraced by the environmental justice movement as a critical response to environmental injustices (Capek 1993, Taylor 2000, Walker 2010), yet for some it is also incomplete. While over 7000 Viequenses joined the civil action suit seeking compensation, some also prioritize more overarching regulatory reform. Certain residents are wary of an emphasis on a civil action suit, seeing it as a one-time monetary compensation for individuals that could subvert pressure away from larger structural change. As one community member states "We have a good quality of life when we have good health services: hospitals, pharmacies, clinics. But to get these we need to pressure our government so that they can pressure the U.S. government. Compensation [by legal means] can only be for [individual] families, we need compensation for the community for all the environmental degradation." Accordingly, justice is not seen in monetary terms alone (either as compensation resulting from a civil suit or cleanup expenditures), but rather an enhancement of the basic capabilities (i.e., institutional structures, resources, and opportunities) needed to participate in social and civil life (Schlosberg 2004, Harvey 1996).

In addition to issues surrounding health, naval activities had broad socioeconomic and ecological impacts on the island, from causing harm to sensitive ecological habitats, altering transportation routes, and influencing the development of agricultural, fishing, and tourism industries. As such, grassroots organizations and politicians have emphasized the need for provisions in the cultural, educational, and social development of the island, including improvements of transportation networks,

agricultural systems, education, and affordable housing, and the delivery of social services to address poverty and unemployment. The extent of the Navy's responsibility for providing social and environmental amenities does not have an unambiguous resolution given that poverty and a system of inequitable land distribution and services predates the Navy's arrival. Nevertheless, for much of the twentieth century and onwards, military activities dominated the ecological, political, social, and economic landscapes of Vieques, raising questions concerning the jurisdictional (what range of issues?) and temporal (i.e., how far back?) extent of a justice-oriented response.

Moreover, community groups have argued that Vieques' position as an inhabited bombing range in the first place was an expression of their lack of political power, representation, and self-determination and sovereignty as a result both of Puerto Rico's status in U.S. politics and Vieques' marginalization from the rest of Puerto Rico. Environmental injustice is not a single event, but is embedded within a history of political, social, and economic relations that contribute to the perceived injustice (Sze and London 2008). The prevalent policy focus on disparity in the distribution of environmental burdens is incomplete, as it does not shed light on the institutional configurations and cultural processes that underlie poor distributions in the first place (i.e., the "why" of distributive injustice; Schlosberg 2004, Young 2011). The environmental justice movement goes beyond the distributional paradigm and calls for recognizing, accounting for, and remedying the group-based oppression and lack of recognition that perpetuates maldistributions and lack of political access. Since the 17th century, the ways in which ethnically and racially marginalized people live and interact with the land, and what jobs they can do, has been heavily influenced by racism and

colonialism. This has resulted in key struggles over self-determination and sovereignty, including the right to acquire and reclaim appropriated territories, fishing and water rights, and express agency over traditional skills and cultural practices (Taylor 2000). In Vieques, military activities and contamination were frequently framed as an outright attack on diverse local cultures, identities, and practices. This took root during the fishermen protests, when fishermen relied on a rhetoric that portrayed military activities as responsible for culturally undermining fishing as a way of life and endangering communities and livelihoods. The destruction of coconut groves and subsistence agricultural plots were similarly portrayed as encapsulating a disregard for particular cultural ways of life and relating to nature (McCaffrey 2002).

What manifested strongly with the fishermen protests has been a recurring theme for the movement, with activists in Vieques frequently evoking images of territorial appropriation, inequitable access to natural resources, and environmental racism. While cleanup expenditures for Vieques are high relative to other sites, this does not necessarily equate to public perception of a satisfactory level of cleanup. The transfer of land to the U.S. Fish and Wildlife Service to be run as a wildlife refuge was controversial for community members who called for the complete "decontamination" and "devolution" of the land to Viequenses. The wildlife refuge designation, and the restricted land use and access terms that result, do reduce cleanup costs; this provided a rationale for converting dozens of other former military sites into wildlife refuges (Havlick 2007). The sign that guards the entrance to the wildlife refuge entreats the lands to be returned to Vieques in the same ecological condition as when they were first appropriated by the Navy (see Fig. 3-3). The feasibility of this is in question, as over

sixty years of military use of the island had certain irreversible ecological effects and complete "decontamination" of the island would entail stripping some impacted zones of all vegetation and removing a significant depth of soil. Given this, a just response must reckon with harm that is not easily undone.

The residual health, ecological, social, and political costs of militarism remain unaccounted for within cleanup programs and environmental justice is primarily defined as a program of expenditures to remove or contain contaminants and reduce exposures. The other main way, however, as cited in policy documents and interviews, for addressing environmental justice is to incorporate publics into discussions about cleanup programs. Public participation programs have promise in meeting the procedural elements of justice, and influencing the distributive ones. In the following section, however, I show though how these are also restrained in attending to pluralist notions of environmental justice as a result of low participation by diverse stakeholders and restrictions in addressing past harms, or temporal matters of justice.

Fig. 3-3 Sign in the entrance to the wildlife refuge in Vieques, Puerto Rico calling for land devolution

Translation of "Devolución: Que nos entreguen nuestras tierras tal como las encontraron!" is "Devolution: Return our lands to us like you found them!).

3.7. Transferring Environmental Justice into Public Participation Efforts

Studies have also demonstrated how people of color and impoverished communities have a lack of influence over shaping environmental policy (Bullard 1990; Faber 1998; Harvey 1999). Environmental justice has emphasized procedural justice, insisting upon representational space in the political sphere (Cole and Foster 2001; Sze and London 2008). In addition to expenditures on cleanup, formal public participation programs are the central way for meeting environmental justice mandates, as cited in interviews and the Department of Defense's environmental justice strategy. The DOD's environmental justice strategy discusses the importance of expanding and diversifying public participation in the Restoration Advisory Boards (RABs), a type of citizen advisory board established through a 1994 DOD/EPA partnership at most closing bases. RABs are meant to be the primary way for the public to have two-way meaningful dialogues with the military and regulatory agencies during hazardous waste cleanups. RABs go beyond traditional methods of public participation and the participatory requirements of Superfund legislation, which focuses on public comment periods and information repositories. Despite agency investments into the RAB process, ongoing public participation in these participatory bodies is low in Vieques. This is in part due to a lack of authority of the boards, a lack of resources that enable community members to participate, and restrictions on topics that can be addressed. As such, the RAB is similarly limited in addressing the residual effects of militarism, or the broader timescales of environmental justice.

3.7.1. RAB Attendance

The RAB was created in 2004 in Vieques, growing out of a Technical Review Committee, another venue for community-Navy relations. The RABs have made inroads in addressing some of the environmental justice demands of publics and policy initiatives. For example, procedural justice gains have been made with respect to holding meetings at evening times that accommodate most working-class residents, translation of key public documents and notices, simultaneous English-Spanish translation during meetings, and improved relations between current RAB community-agency members. The Navy also advertises meetings in ways that are appropriate for communities with limited access to the internet or print newspapers (e.g., events are announced by a van with a loudspeaker).

Despite these procedural justice gains, attendance is low. While RAB attendance of agency representatives has increased since the board's formation in 2004, community RAB membership has decreased (Fig. 3-4). Since the RAB's formation, a total of 25 community members have, at different times, joined the boards. Most of that participation occurred prior to 2009. The four current RAB members who have been long-term participants are either from the continental United States or the main island of Puerto Rico. Rather than mobilizing large segments of the population to participate, the RABs focus on in-depth discussions with a small group of community members, appealing to the deliberative aspects of democracy. Nonetheless, there has been a continual evolution in public participation theory as to who is a stakeholder. The public is not a homogenous group and any participatory process is unlikely to give equal access to the diversity of public opinions. With little participation from Viequenses, including

those whom have been active on environmental and social rights issues, RABs may be limited in including representative segments of the population and fulfilling environmental justice objectives.

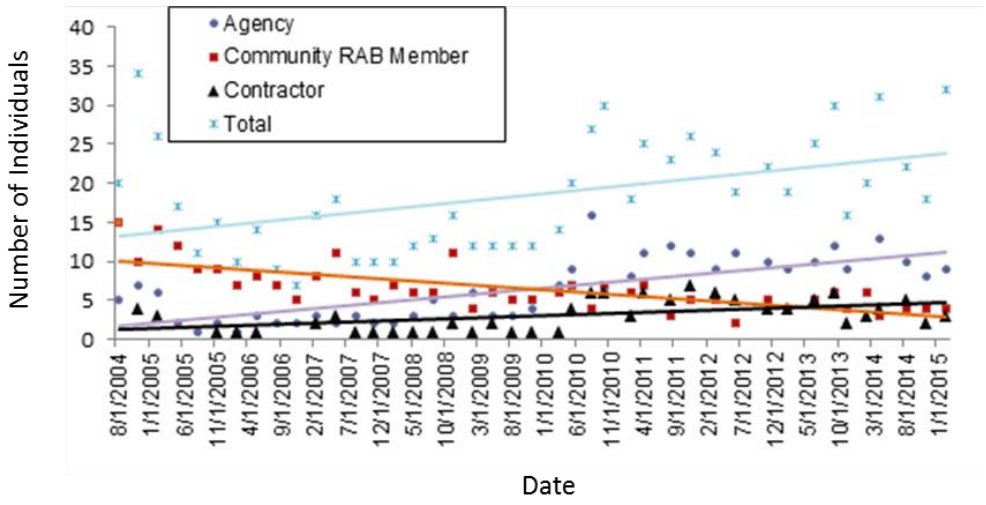

Fig. 3-4 Attendance at RAB meeting in Vieques

Dates are from its creation to December 2014. Linear regression lines (coordinated in color to data points) demonstrate the slope of the attendance trend over time for each group of attendees.

3.7.2. Reasons for not participating

During interviews, former RAB community members, as well as key organizers around the issues of health, military contamination, and the cleanup, were asked why they do not currently participate in the boards.[46] From interviews I identified several issues that inhibit diverse participation in these boards: these include the lack of authority of the boards (i.e., community members do not think participation meaningfully changes cleanup programs), lack of trust in the military and other federal agencies, and a lack of time and technical support for interpreting immense amounts of complex, technical documents.

While the RABs hold promise for meeting particular aspects of procedural justice, they are consultative, rather than authoritative, bodies, with no mechanisms to ensure that agencies are responsive to community concerns. Interviewees almost cited unanimously that they do not participate in the formal public participation programs, because they do not believe they have any influence on cleanup programs. The environmental justice paradigm has embraced the importance of public participation in environmental decision-making, but what constitutes meaningful participation is

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[46] Of the overall 33 interviews conducted for this study, 17 were with former RAB community members and activists who have never been affiliated with the RAB. I was interested in why those who have been key organizers around the issues of health, military contamination, and the cleanup do not participate in the boards or no longer participate. Interviews with non-RAB affiliated community members were not meant to be a comprehensive survey of the general population, but rather targeted key individuals who have been active in Vieques on environmental, health, and social justice issues; these collectively comprise key organizers on issues of public health and access to health care (including organizers of health clinics for cancer diagnostics and treatments), human rights, employment, sustainable community development, and fishermen rights and livelihoods.

contested. The structure of RABs, as purely advisory, contrasts with the environmental justice movement's envisioning of direct and substantial influence on scientific research and material outcomes or participation parity for affected communities (Taylor 2000; Holifield 2004; Bullard 2007; Schlosberg 2004, 2007; Walker 2010; Harrison 2014). In practice, most institutionalized methods of public participation allow for a more managed form than that envisioned by scholars, activists, and social movements.

Furthermore, community members participate in a volunteer capacity and participation can be time-consuming. Public participation methods can be a drain on activists' time, drawing them away from other organizing strategies and reducing time for family or other community obligations (Reardon 2009, Liévanos 2012).[47] Particularly if public participation methods are used to gain public trust and subvert confrontational methods, it can come to resemble cooptation more than cooperation (Szasz et al. 1997). Several former RAB participants stated in interviews that they no longer participated because they did not want to "legitimize" a process that they felt was implemented primarily as a result of regulatory specification rather than to allow community influence over the process.

Issues of authority are intimately linked with issues of accountability. With the issue of any systematic and transparent process that accounts for which community recommendations are incorporated into the cleanup response, and which are not

[47] Work in other case studies by the author has revealed, however, that rather than draw activists away from other methods of strategizing, RABs can be used as sites to gain information that is then used in more confrontational venues such as courts (see Ohayon 2015)

adopted, it is difficult to evaluate the substantive outcomes of public participation and its success in influencing policy. Public participation has been constructive from some standpoints, with both agency representatives and long-term community RAB members citing similar changes made to cleanup programs as a result of public participation; these include changes to cleanup investigations, ensuring that remedial responses are more protective of native vegetation, and reevaluating the preferred cleanup method for a site.[48] The influence of public participants, however, is not always knowable or transparent and there are no mechanisms to ensure that significant time investments into the process will translate into influence over decision-making.

Another significant obstacle to participation is marshaling the scientific literacy required to evaluate the immense number of technical documents produced during the complex and long cleanup process. Interpreting documents requires substantial human and technical resources, including being keenly aware of how to acquire and use these resources. Community interviewees, both current RAB and non-RAB members, stated that soliciting technical support in Vieques is difficult. While the EPA and DOD both offer grants for technical assistance, through the Technical Assistance Grant and Technical Assistance for Public Participation programs respectively, funds are limited

[48] With respect to changing investigations, different sampling locations were used, as a result of public input, to characterize reference background of "natural levels" of contamination. Heavy metals commonly occur in nature and a background investigation of inorganic constituents in soil was conducted to assess if metals detected in site-specific soils are consistent with background conditions or elevated as a result of military activities. Community RAB members argued that initial sites selected to serve as background were not reflective of "naturally occurring" levels of metals but rather were affected by military, industrial, or residential pollution. This community input led to the selection of alternative sites to characterize reference background.

and qualifying is a highly administrative and time-consuming process. While Vieques has received technical and legal support from academics and lawyers from the main island of Puerto Rico and the continental United States, it is generally expensive to bring technical support to the small, geographically isolated island; as such, agency-provided funds might not sufficiently subsidize ongoing outside technical support. Moreover, even if technical support is acquired, similar to community input, there are no mechanisms to ensure technical advisors themselves influence cleanup programs.

Additionally, interviewees frequently stated that they do not trust the scientific findings and recommendations relating to cleanup. The RABs are advisory bodies meant to comment on data, rather than be involved in active data collection or monitoring. Interviewees typically brought up that no one on the cleanup team has been selected by the community and, with the exception of the Puerto Rico Environmental Quality Board, few Puerto Rican scientists were involved in the process. While one interviewee distinguished between uniformed (i.e., those involved in training activities in Vieques) and civilian (i.e., those involved in cleanup programs) Navy representatives, community relations are strained due to secrecy concerning training activities and historical targeted suppression, arrests, and jailing of community activists. Volatile community-agency relations pose special challenges for public participation efforts as compared to initiatives that exist in a less historically checkered context. Several sociologists of science have discussed the importance of social and historical relationships for how publics judge the trustworthiness of major institutions and the credibility of scientific data (Wynne 1992, Jasanoff 1998). A representative from the Navy states community outreach programs and the hiring and training of local residents to work on cleanup crews are methods for

"overcoming lingering distrust." The Navy attempted to improve community relationships through the use of consulting firms, primarily Fulton Communications, a firm that works with the chemical industry to create community communication plans (such as for the Exxon Pipeline); consulting firms such as these are more experienced with building trust through public relations activities than with altering programs to be responsive to community input.

Distrust, however, can be a productive response to past state violations and current environmental and political conditions. According to this view, rather than a barrier to overcome, distrust is treated as a rational response to living within a stratified society (Benjamin 2013). In this sense, it might be more critical to increase community capacity to engage in the process, for example by focusing on influence over decision-making, accountability, and the ability to interpret technical documents, rather than on diverting distrust.

3.7.3. Restriction of RABs to technical issues

The RABs give an opportunity for community comment on cleanup programs, albeit in an advisory capacity and with difficulty channeling sufficient external technical support. The Restoration Advisory Boards are restricted to dealing with the technical aspects of the cleanup, rather than more inclusive agendas that address public and ecological health or the social impacts of militarism. This may strategically position public participation as a conflict around particular remedial methods and deflect attention away from broader issues surrounding restoration programs.

While environmental remediation is framed primarily as a technical endeavor in documents and public participation forums, cleanup decisions are made in a climate of conflicting accounts of environmental, ecological, and social risks, mutable environmental standards, competing political priorities, budgets, and resources, differing opinions over planned future land uses, and varying degrees of private and public investments into land reuse and redevelopment projects. Meeting remediation goals necessitates not only a technical cleanup program to remove or contain ordnance and chemicals, but also requires managing how island residents inhabit post-remedial spaces. While the refuge has ecological value, the decision to convert it into a national wildlife refuge made sense economically; cleanup costs are lower than if the land was earmarked for uses that require stricter standards (Havlick 2007, Wargo 2009). The decision to convert it into a refuge was not made with strong participation from the RAB or the public in general. As Reardon (2013) emphasizes, a commitment to justice requires interrogating the ways in which it is envisioned and how justice attaches itself to science; this requires figuring out which possible worlds are enacted by engineering and scientific responses, and which ones are never pursued.

Framing of environmental problems as technical ones delimits the universe of possible scientific inquiry, policy options, and political debate. While public participants can debate the technical details of sampling, cleanup, and monitoring, they cannot have input into the justness or desirability of the hybrid political-scientific standards upon which those actions are based. This implicitly empowers certain people to participate (i.e., individuals and institutions who can master technical discourses), while systematically excluding legitimate, but "non-expert" viewpoints (Jasanoff 1998, O'Brien

2000, Winner 2010). Community members might be able to give all types of insights into, for example, the desirability of a particular land use plan, yet might be more constrained in discussing a particular remedial technique due to a lack of background in the field. While community members do comment on intricate technical details, as displayed in RAB meeting minutes, Superfund and public participation frameworks center on the technical task of environmental remediation and are ill-equipped to address the social and political domains of justice, particularly as they relate to the historical legacies of militarism. RABs have been controversial in other military sites with disenfranchised communities as concerns around health, employment, and social inclusion have bubbled up within the venues (Ohayon 2015). Indeed, in the case of Vieques, as one Navy representative stated, "In the beginning we had people come to our [public participation meetings] and voice health concerns and we always refer them to the Agency for Toxic Substances and Disease Registry as the federal agency for health or the Health Department of Puerto Rico." RABs are designed to address the technical aspects of cleanup rather than to redress the historical legacies of militarism and broader social, ecological, and environmental agendas. The advisory bodies are thus limited in the types, and temporal extent, of justice for which they can account.

3.8. Addressing Temporality and Justice in Science: Insufficient Knowledge on Past Health Exposures

3.8.1. The Agency for Toxic Substances and Disease Registry and Data Poverty on Usage and Exposures

While cleanup team members and public participation policy can only address the technical aspects of cleanup, communities with concerns over public health at Superfund sites can petition for the Agency of Toxic Substances and Disease Registry (ATSDR) to review health data and estimate health risks. The ATSDR is the branch of government that addresses the health-related aspects of Superfund cleanup, albeit in an advisory capacity (i.e., it can make recommendations to federal and state agencies, and community members, but does not have regulatory authority to enforce them).[49] The ATSDR investigation, however, underscored the difficulty of reconstructing past health exposures and attributing responsibility for current health claims when data on past military activities, possible exposure pathways, and population health status is lacking. There is thus a contentious political climate over the extent to which historical military waste and weaponry testing can be implicated in illnesses and ecological degradation in Vieques. On one hand, island residents, and the scientists and lawyers representing them, are insistent that elevated mortality and disease rates are because of longstanding military

[49] The ATSDR itself was part of the trend in policy to institutionalize environmental justice. In 1990, the ATSDR held a historic conference in Atlanta on the health of "minority" populations. In 1994, the ATSDR and CDC, and EPA, with five other federal agencies, sponsored a significant health symposium that brought together federal agencies, grassroots organizations, and residents of affected communities to formulate recommendations for environmental justice.

tenure on the island. Military and regulatory representatives, however, argue that there is little conclusive evidence of this and have challenged the interpretation of "independent" studies. Policy responses to any health legacies, or past effects, are thus confounded not just by restrictions to the jurisdiction of Superfund and public participation programs, but also by an absence of data.

Despite it being outside the purview of the Superfund Act and public participation programs, community interviewees often demonstrated a preoccupation with the potential health impacts of past exposures to contaminants. As one community interviewee and former RAB member expressed,

> "There wasn't science, or monitoring, or really anything until the Navy stopped bombing. So whatever testing they do now is of little use. What was the navy doing in the 70s, how was the water quality, the air quality? That's around when I developed my cancer and when the Navy was doing the peak bombing and there was no government monitoring. So they come now and don't find things, no correlation, well I would like to know what happened here in the 70s… You cannot test now, 40 years later, and say we didn't find anything. You can only say we didn't find anything *now*."

This interviewee also expressed fear about the food she used to eat: "When I was eating all those crabs that my father was catching, in an area that was later off limits [due to contamination]. That is where we used to go crabbing."

Due to petitioning by community members in Vieques, the ATSDR conducted several public health assessments. From 2001-2003, the ATSDR released four public health assessments evaluating four different pathways of exposures: seafood, drinking water, air, and soil. They concluded that with one exception, water from one local well, that no pathway had an associated current health risk. Many Viequenses, Puerto Ricans,

government representatives, and some scientists, including from the University of Puerto Rico, the University of Georgia, and Yale University, disagreed, believing that the decades of military activity affected public health. [50]

In addition, a March 2009 hearing by the House Committee on Science and Technology's Subcommittee on Investigations and Oversight challenged the ATSDR's conclusions about Vieques, accusing the agency of producing "deeply flawed" scientific reports. Soon after, the ATSDR revised its findings in another highly publicized military case; in April 2009, the agency rescinded its previous conclusion that contaminated drinking water at Camp Lejeune, N.C. did not pose a cancer risk to adults.

A reexamination of the ATSDR's Vieques health assessments came on the heels of this controversy. In response to criticisms, the ATSDR was sent to reevaluate the conclusions from their original 2001-2003 public health assessments, namely that they could not make any links between public health issues and military activities on the island. In addition to reviewing and updating environmental data in the original report, they included analyses of human biomonitoring data and health outcome data. The ATSDR did not conduct any additional studies, but rather reviewed existing data from the Department of Health, independent researchers, and any agency monitoring data relevant to public health.

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[50] For example, independent advisers to the community critiqued conclusions of "no apparent health hazards from fish consumption", as they stressed there was a small number of overall samples and no or limited sampling for the most commonly consumed fish or shellfish from the contaminated eastside of the island.

On August 12, 2009, the ATSDR met with a group of community members in the Vieques lighthouse. Then-ATSDR Director Dr. Frumpkin addressed the group,

> "[We] visited the eastern part of the island today. It is a beautiful place, this is a beautiful island. But it's contradictory, words cannot describe the look of a terrain that has been bombed for so many years. If I lived downwind from that history I too would be as concerned as you are… I can tell you we are a small agency and only have so many tools in our toolbox… Very rarely do we collect environmental data, because our budget does not allow us. Most of the data is collected by other agencies and we analyze that data through the lens of health…"

Most residents present at the ATSDR community meeting expressed a concern with the magnitude of military practices and the lack of information about the extent and nature of chemical releases at the site, and a certainty that their personal illness or sick relative could be connected to this history. One Viequense stated,

> "I was born and raised in Vieques, in *barrio* Destino, directly downwind from the bombing range. And I am one of many who are victims of cancer. In 1986, after many years of excruciating headaches and earaches, at the age of 23, I was diagnosed with cancer of the neck and nasal passages. I went through three months of radiation therapy and a couple of surgeries that luckily took care of my cancer. The weird thing is that same summer my cousin, and next door neighbor, was also diagnosed with cancer and she was also 23. She died three years later after several sessions of chemotherapy. There was no prior history of cancer in my family, we were not smokers… What was the Navy experimenting with in Vieques, particularly at the end of the 1970s and in the first half of the 1980s when the bombing range from the nearby island of Culebra was moved over to Vieques and the bombing in Vieques doubled? … Was the air over my *barrio* Destino and *barrio* Lujan clean of contaminants? Why weren't there air monitors placed at those *barrios* when everyone knows that they make up the areas for cancer patients on the island?... If we cannot know what the Navy was working with, how can we conclude that people are healthy?"

In their released 2013 report, the ATSDR states there is evidence that cancer incidence and mortality, and other chronic health conditions, in Vieques are elevated in

relation to the main island. ATSDR's review of both new and previous data, however, did not find conclusive evidence of a relationship between military activities and the health of the island's residents. While studies had contradictory findings, the ATSDR found little convincing evidence that current levels of contaminants in air, water, soil, and food pathways are enough to trigger health concern. While many critiques of the ATSDR reports centered on the adequateness of the current data, throughout the report the ATSDR highlights the limitations in the ability to reconstruct possible past exposure pathways as a result of a lack of historical data (see Table 3-1 to Table 3-4).

Much of the information regarding military activities over six decades is lacking as site investigations, environmental assessments, and biomonitoring was largely absent through much of the military's tenure on the island. Few recorded soil, water, and air sampling data exist from active navy years. For example, during the time the Navy still conducted explosive-ordnance exercises on Vieques only three air-sampling studies occurred (1972, 1978, and 1979). There was no surface soil sampling prior to the 1990s and any current soil sampling data might not represent all potential past exposures. Levels of certain contaminants (e.g., volatile organic compounds, explosives) could, through volatilization or chemical or biological degradation, reduce considerably in concentrations over time in soil, water, or biological media. For this reason, the ATSDR report states that "background soil data were not useful for conclusions about past exposures to explosives or present and past exposures for nonanalyzed potential contaminants."(ATSDR 2010, p.142)

In addition, to measure contaminants present in fish and shellfish, the report used data from a 2000 study by Dr. Caro from the Universidad Metropolitana and a

2001 study by the ATSDR and EPA. There is evidence that explosive compounds, HMX and RDX, used exclusively in military applications, contaminated some fish and shellfish. As in surface soils, explosive chemicals rapidly decay in marine environments into other chemicals that might not be detected and current sampling efforts give little insights into, for example, conditions during the 1970s or 1980s when military activities were intensified. Pesticides, speculated to be associated with historical uses to control mosquitos during military training activities, were also detected in crab tissues, but were found at levels unlikely to cause human health effects. Pesticide concentrations, while not at a significant level of risk currently, could have previously been present at higher levels and posed a health threat historically.

As it is difficult to reconstruct past levels of environmental contaminants, why not conduct studies on residents in Vieques to see if they have been disproportionately exposed to pollutants (i.e., study people not just places)? Just as past levels of toxic chemical compounds in the environment cannot be straightforwardly reconstructed by recent sampling efforts, current measurements of chemical body burdens cannot easily establish levels of past exposures. The ATSDR acknowledges that current biomonitoring efforts likely indicate more about current or recent exposures than past exposures to military contaminants. Many contaminants and their metabolites are undetectable or underestimated by common biomonitoring tests, such as those using blood or urine markers, as they are excreted, metabolized, or partitioned to be stored in target organs, such as the liver and bone marrow, soon after exposure has ended. As the ATSDR (2013) states, "Many chemicals are short-lived in the human body and thus cannot be measured through a biomonitoring program if the exposure occurred some time ago;

only in certain situations where a chemical may persist in the body (e.g., lead in bone) does biomonitoring provide information about exposures long past." (p. xiii).

To address some of the issues with scarce empirical data, the ATSDR built an air dispersion model based on particulate ambient air monitoring data and meteorological data to predict how contaminants move in live bombing exercises. While there is no way to confirm model predictions, the ATSDR believes it is unlikely that these exercises resulted in adverse health effects as the modeling analysis predicted contaminants would have dispersed to essentially non-detectable levels over the 7.9 miles between the Live Impact Area and residential areas. The ATSDR also extrapolated the air model's findings of no significant transport of airborne contaminants into the residential zones of Vieques to likewise predict no significant deposition to soils or public or private water sources in residential areas.

A critique of the model was that larger particulate matter (PM_{10}) was employed, while the current emphasis is on the health effects of smaller particulate matter ($PM_{2.5}$). Smaller particles, $PM_{2.5}$, can stay suspended in the air for longer periods of times (i.e., days or weeks), disperse further distances (as many as hundreds of miles), have more toxic constituents, and embed themselves deeper into the lungs than larger diameter particles. Past health–based standards used PM_{10}, however, and historical measurements are not available for $PM_{2.5}$. Other critiques include that the data inputted into the model originate from three air sampling events that occurred in the 1970s and have no documentation describing appropriate quality assurance measures taken or sampling methods used. Furthermore, analyses in the air model might not have included all potential contaminants and chemical byproducts of concern. As limited historical

samples were collected to characterize soil, water, and air quality data, little is known about the spatial release, and consequent exposures, of certain contaminants that were intentionally or unintentionally released sporadically into the environment (i.e., through improper storage, disposal, or during transport). For example, the Navy never measured ground-level concentrations of the constituents of military chaff, a radar countermeasure, and thus peoples' exposure profiles are difficult to estimate; constituents of chaff include lead, aluminum, silicon, and fiberglass. Concern has been raised as to people's exposure through inhalation events or consumption of livestock that grazed near the bombing range (Wargo 2009). Thus while the air model aims to address the problem of the lack of past data through simulating potential exposures, concerns were raised as to the quality and limited quantity of the available data employed in the model, and the exclusion of smaller diameter particulates and potential contaminants of concern.

Notwithstanding critiques, the ATSDR concludes that given model findings and available data, it is unlikely that residents' health was affected by military activities. The ATSDR's findings and analytical methods have been subject to widespread criticism, with various non-federal researchers who have studied Vieques highlighting the report's multiple uncertainties and arguing that there is a more likely link between the Navy's past activities and residents' various health ailments than the report concludes. Federal researchers have found evidence of elevated contaminants in the hair samples of Viequeneses, in addition to the island's soil, food supply, and water. From their end, the ATSDR has critiqued many of these studies based on limitations to study designs and questions over the validity of data.

Studies on popular epidemiology indicate that there are often differences in how publics and professional groups' define data quality, methods of analysis, and the applications of scientific findings to policymaking (Brown and Mikkelsen 1997, Brown 2013). Scientists and officials are hindered from establishing a causality of harm based on inadequate histories of environmental conditions, unknowns about the existence and extent of toxins, and a lack of knowledge of the environmental transport of contaminants and potential exposure scenarios. In addition to a lack of site-specific historical data, there are also considerable uncertainties in quantifying the risks posed by substances on biological functions and disease incidence; this includes a lack of characterization of the various endpoint effects (e.g., developmental, reproductive, respiratory, neurotoxic, and physiological effects) of many chemicals, both alone and in concert, and unknown latency periods for carcinogens and other contaminants (Thornton 2001; O'Brien 2000). Furthermore, there are differences in accepted levels of measurement, sampling techniques, the adequacy of coverage, and statistical significance. Sociologists of risk have emphasized how assessments of risk incorporate simplifying assumptions, contingencies, and uncertainties, and artificially reduce variability; nature and society behave in more complex and unpredictable ways than that necessarily captured by model assumptions of contaminant plumes moving across exact pathways (Jasanoff 1993, Shrader-Frechette 2005). This leaves a great scope for disagreement about what constitutes a sufficiently robust analysis of harm.

Those working on health policy in Vieques demand considerable evidence of causality and clear etiology models in connecting military contaminants to diseases, whereas residents and their supporters have highlighted the tangible, experiential nature

of disease, brought attention to the lack of information surrounding the nature and extent of military practices, challenged the quality of extant data and simplifying assumptions used in assessing risk (e.g., does existing data represent the range of possible outcomes or "worst case scenarios"?), and called for shifting the burden of proof concerning the association between military contaminants and the island's poor health status. Direct causation is notoriously elusive in toxicological research and public health studies, with very few environmental cases having clearly established industrial or military origins. As one interviewee in Vieques states, "To prove that cancer is due to contamination caused by Naval activities, you have to prove that there was contamination, that the person with cancer was there, that they were exposed to the contamination, and that the contaminate is connected to that particular cancer." Residents often adopt science as a way to bolster their health claims, yet "expert" and "professional" scientific discourses become suspect when experts are seen to deny, challenge, or undermine what is strongly felt to be serious effects resulting from disproportionate exposures (Brown 1992, Brown 2013). While the ATSDR report acknowledges the multiple uncertainties in knowledge about historical environmental conditions and military use of the site, they are inclined to reject a relationship between illness and contamination given what the extant data and modeling indicates. Furthermore, like many other public health controversies, the ATSDR and Department of Public Health stated that the health issues in Vieques may be attributed to behavioral factors, such as smoking and hair dye. For their part, Viequenses are angered over these explanations, arguing that no comprehensive and reliable study substantiates that social or lifestyles behaviors are significantly different from the main island.

The issues in Vieques are ubiquitous in other environmental health challenges, including contestation over burdens of proof, evidence requirements, the quality of extant data, and how to address data poverty. In Vieques, however, these issues are particularly pronounced as little environmental and health data was collected for the more than sixty years of active military training. There needs to more critical reflection on how to adjudicate health claims in circumstances of significant knowledge gaps, particularly when environmental justice policy has been enacted to address such claims. Environmental justice activists and scholars have argued that given the overall poorer health status of certain populations, and due to the difficulties of establishing cause and effect, that with uncertain but suggestive evidence of negative environmental health effects, regulatory action should be taken before scientific certainty is established (Morello-Frosch et al. 2000). Erring on the side of precaution and shifting the burden of proof onto the polluters in events of high uncertainty and significant data gaps, yet have credible evidence of health effects, are main tenets within an environmental justice framework (Bullard et al. 2000). Shifting the burden of proof is also a critical component of the precautionary principle, which calls for environmental decision-making to also consider a broad range of alternatives to potentially harmful actions and take preventative action in the event of uncertainty (Kriebel et al. 2001).

The sociological notion of "undone science" emphasizes that society's understandings of environmental and public health threats are dangerously compromised by expert systems that produce knowledge in ways that leave much potential knowledge undone and minimize the ecological and social risks as a result (Frickel 2008; Frickel et al. 2009). In cases, like Vieques, however, much knowledge is left undone not necessarily

as an intentional result of the structure of how institutions produce knowledge, but because the data required to account for multiple decades does not exist. There is an inability to reconstruct past exposures based on sparse historical environmental sampling and bodily exposures that are rarely detectable in common biomonitoring procedures after some time. So too, it might be difficult to reconstruct past contaminant profiles in land and water based on current investigations, as contaminants get volatized and carried away in wind currents, soils erode, and seawater circulates. While it is difficult for communities to find redress for past harms within Superfund cleanup programs and public participation forums, ATSDR health assessments similarly exposed a difficulty in conclusively accounting for, and redressing any, health effects resulting from historical exposures.

The ATSDR acknowledges that past levels of contaminants will never be known, yet recommends conducting additional surveys and investigations to address data gaps with regards to present levels. Their recommendations include conducting a survey of Vieques residents to determine the types, frequency, and quantity of fish consumed, and sampling locally grown produce, the public water supply source and wells, and surface soils in the island's residential areas for contaminants. As the ATSDR advises in a non-regulatory capacity, EPA representatives emphasized in interviews that they do not have the authority to compel the Navy to follow ATSDR recommendations. According to interviews with Navy representatives, it might be illegal to implement ATSDR recommendations by utilizing monies from the Superfund program. For example, using program funds for soil testing in the residential areas is illegal as these areas are outside

Superfund boundaries. Likewise, the ATSDR does not have the funds, nor the authority, to enforce its own recommendations.

Table 3-1 Lack of data for health exposures in Vieques - General

Sample quotations from the ATSDR report (2013) that illustrate data gaps and exemplify issues of concern with detecting and characterizing past exposures of residents to military-related constituents for various pathways.

General
"The circumstances on Vieques typify many of the difficulties faced by the public and by officials concerned about the effects of hazardous substances. Numerous questions arise regarding exposures and people's health, and at times, relatively few measurements are available to answer those questions directly. Environmental data are often limited in spatial coverage, number, or analytical quality control documentation. Consequently, some degree of uncertainty always remains."(p13)

Table 3-2 Lack of data for health exposures in Vieques - Biomonitoring

Sample quotations from the ATSDR report (2013) that illustrate data gaps and exemplify issues of concern with detecting and characterizing past exposures of residents to military-related constituents for various pathways.

Biomonitoring
"Limitations to biomonitoring include the appropriate timing and collection of samples that will affect data interpretation. Also, in most situations, biomonitoring provides information about current or recent exposures; only in certain situations where a chemical may persist in the body (e.g., lead in bone) does biomonitoring provide information about exposures long past." (p.14)
"…heavy metals will be excreted and not visible in blood levels after a certain number of days."
"ATSDR is not recommending a comprehensive, systematic biomonitoring effort at this time. We found little evidence of current exposure to contaminants from past military activities. Many chemicals are short-lived in the human body and thus cannot be measured through a biomonitoring program if the exposure occurred some time ago." (p. xiii)
"Many chemicals [in biomonitoring efforts] are not measureable with current technology"(p.58)
" The important fact is, however, that biomonitoring data available for Viequenses cannot be used to determine whether residents of Vieques were exposed to past, military exercise-related constituents." (p.59)

Table 3-3 Lack of data for health exposures in Vieques - Soil pathway

Sample quotations from the ATSDR report (2013) that illustrate data gaps and exemplify issues of concern with detecting and characterizing past exposures of residents to military-related constituents for various pathways.

Soil Pathway
"Although limited in number, the CH2MHill 2000 data are otherwise ideal for assessing exposures to protesters during 1999-2000: they match the locations and time people may have been exposed….But the small number of samples compared with the large land area of the LIA leaves a great deal of uncertainty as to whether actual "worst case" samples were collected. This is a common limitation of environmental sampling."
"While inorganic contaminant levels are usually relatively stable over time, levels of other contaminants (e.g., volatile compounds, certain explosives) in surface soil might, through volatilization or chemical or biological degradation, substantially reduce over time. For this reason, the background soil data were not useful for conclusions about past exposures to explosives or present and past exposures for nonanalyzed potential contaminants."(p.142)
""Dispersal would result in contaminant concentrations even lower in the residential areas than in the background sampling areas. These background data, then, further support the hypothesis that contaminants in surface soil in Vieques residential areas are not at levels known to cause health effects today. Yet detection of explosive residues in the background samples also suggested that all areas of the island, including the residential area, might have been affected by explosive compounds from past bombing activities. Although residual levels are low today, it is impossible to say what past levels were." (p. 142)
"Those who occupied the LIA from 1999-2000 were not at increased risk of adverse health effects from exposure to surface soil contaminants. Supporting data are limited, but they are of good quality and represent the location and the period of interest. In the years before the late 1990s tests, contaminant levels in the LIA (especially explosives) might have been higher, but we have no historical data with which to evaluate this assumption."
"Limited available data from other locations and air pathway considerations suggest that the military exercises in the LIA did not result in current contamination of residential soils with inorganic or explosive compounds at levels considered harmful. ATSDR arrives at this conclusion using a scientific evaluation of the available data. But again, data from other areas are limited in number, data for all potential contaminants of concern are not available, and no adequate surface soil data are available from the residential area itself."
"Modeling described in the air pathway discussion has suggested that airborne transport of contaminants during past military exercises would not have been substantial enough to have affected soils in the island's residential area. Sufficient soil samples are not available to confirm this, nor will such data ever become available. Consequently, we cannot determine whether past exposures to explosives or other compounds in surface soil could have been heavy enough to increase a past risk of adverse health effects."(p143)
"Although this sampling might provide inferences about past exposures for compounds stable over time, such as metals or other inorganic compounds, it will provide no definitive information on past surface composition and no information on past levels of compounds that react or degrade over time."(p144)

Table 3-4 Lack of data for health exposures in Vieques - Drinking water pathway

Sample quotations from the ATSDR report (2013) that illustrate data gaps and exemplify issues of concern with detecting and characterizing past exposures of residents to military-related constituents for various pathways.

Drinking water pathway
"…ATSDR did not attempt to gather historical information on the water quality of these wells. Assuming data and testing reports were kept from the 1970s-1980s and could be located, numerous questions would remain, such as the accuracy and precision of the analytical methods used, the quality control measures employed, whether all contaminants of potential concern were analyzed, and whether the sampling in general was adequate to describe past water quality from the wells. Thus with regard to the past condition of any well-supplied public water, sufficient data will never become available to establish its safety fully." (p.151-152)
"In its previous assessment, ATSDR recommended that Puerto Rico authorities identify example systems and test them to ensure they delivered safe water. To our knowledge, this sampling has not yet occurred. If sampling were conducted today (i.e., years after active bombing ceased), it would not answer the question of whether contaminants might have entered such systems in the past. ATSDR also recommended sampling sediment from rainwater collection systems as an indication of potential past water quality. This sampling would be limited to insoluble contaminants or to contaminants that had precipitated out of solution, had settled out, and had remained unchanged over time. But as stated previously for well water systems, for rainwater collection systems complete information about every past potential contaminant and its past level will never become available." (p.152)

3.8.2. Difficulties in establishing excess risk: The issue with small and mobile populations

Reconstructing individuals' exposures to environmental contaminants is incredibly difficult due to limited data on past military activities and environmental conditions, leaving a contentious political climate over the extent to which historical military waste and weaponry testing can be implicated in illnesses and ecological degradation in Vieques. While the previous section looked at the implications of insufficient historical data on environmental conditions and biomonitoring studies in measuring exposures (i.e., the difficulties with establishing causality), this section examines the difficulties in even establishing excess rates of illness for small and mobile populations in the first place. Having precise and statistically significant results in differing rates of morbidity and mortality across social groups is challenging for small populations. Despite this, studies indicate a higher prevalence of chronic diseases, cancer incidence and mortality, and infant mortality in Vieques. Nonetheless, differences exist with how to interpret results, and what further studies are needed.

Most cancer cases are captured by registries as doctors are required by law to report cases of cancer to the Puerto Rican Department of Health. As such, the Central Cancer Registry of Puerto Rico (RCCPR) data represents the most comprehensive assessment of cancer incidence in Vieques[51]. A study of cancer incidence from 1960 to

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[51] Funding has, however, been inconsistent throughout the life of the registry. The RCCPR was funded in part by the National Cancer Institute's Surveillance, Epidemiology, and End Result Program from 1973-1989, operated on local funding from 1989-1997, and received funding from the Centers for Disease Control and Prevention (CDC) since 1997. Completeness and timeliness of the cancer registry has been problematic due to a lack of trained staff, a lack of funds, and a

1989, prepared by Dr. Diego E. Zavala, Director of the RCCPR, demonstrated that during the five-year periods of analysis of 1995-1999, the risk of developing cancer in Vieques was greater than any other municipality in Puerto Rico. In this period, the risk was 26% higher than the rest of Puerto Rico which, following the recommendations of the Toxic Substances Agency Guide and the Registry of Diseases of the United States Department of Health and Human Service, was sufficient to initiate a policy of epidemiological surveillance according to the parameters of cancer programs in the U.S (Figueroa,et al. 2009). Because of the small population size in Vieques, however, the confidence interviews are large (ibid). This is in contrast to periods before the 1980s, when the cancer rate in Vieques was lower than the main island (ibid). The rise in reported cancer rate in the 1970s correlates with the intensification of military practices in Vieques, which to some implicates military activities

As Vieques does not have oncology or other specialist medical services and, with limited transportation to the main island, those facing illnesses might relocate somewhere with better services and give the RCCPR their new address as their place of residence. Furthermore, populations might have changed from those exposed during peak military activity periods, for example in the 1970s or 1980s, including outmigration of those seeking expanded educational or employment opportunities. As one community interviewee stated,

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lack of reporting requirements by some facilities. Since receiving funding by the CDC, progress has been made and in 2003, a CDC review concluded that 95.3% of all cancer cases diagnosed or treated at Puerto Rican hospital facilities were reported to the RCCPR (ORC 2000).

> "Certain studies could be controversial because the population in Vieques has changed and the people who were living here during the peak of the military activity, many of them are gone…Even myself, I was here, I grew up here, I developed my cancer here, but I wasn't diagnosed in Puerto Rico. Even though I had all the symptoms here, it wasn't until I moved to the U.S. that they discovered what I had was cancer. . so I'm not showing up in any of the local statistics..."

An epidemiologist and faculty member from the University of Puerto Rico's School of Public Health agreed with this statement, believing that the cancer registry data does not accurately reflect the cancer rate for those living in Vieques during peak military activities. She emphasizes that reported cancer incidence rates in Vieques continually fluctuate from one measured period to the next. She states,

> "In terms of epidemiological data, such a trend should at least raise a flag that the data might not be sound. We would not expect these types of fluctuations when none of the exposures were removed. If the high rates were due to smoking, people are still smoking. They kept eating the same things. The navy was still bombarding the island throughout the 1990s. How can you explain these types of data unless it is an artificial reduction of the rates by migration and counting cases in other municipalities?"[52]

Due to the small population in Vieques, a small change in the number of diagnosed cases from the island can significantly change its recorded cancer incidence rate, whereas a larger population would not be as substantially impacted by similar small changes. Thus accurately estimating cancer incidence and mortality for those who were potentially exposed to military contaminants can be confounded for small and mobile populations, particularly given the latency period for most cancers.

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[52] Interview with author, July 9, 2014.

While the interviewed epidemiologist and resident were concerned that the RCCPR underestimated the true rate of cancer among Viequenses, the ATSDR conversely stated that it might overestimate incidence ratios of cancer in Vieques relative to the rest of Puerto Rico. According to the ATSDR, all cases indicating residence on the island of Vieques were age-confirmed, whereas cases were not actively sought out for confirmation in the rest of Puerto Rico. If a case did not have a known age, it was left out of rate calculations. As such, cases were potentially omitted from the reference population (i.e., Puerto Rico), whereas the proportion of cases captured in Vieques could be increased relative to the main island (ATSDR 2013). As such, an epidemiologist with known sympathies towards Vieques and a federal agency each emphasized different consequences for unknown or inconsistent data; the former emphasized the danger of underestimating, while the latter focused on the potential biases towards overestimating cancer incidences in Vieques.

As discussed above, for active military years, there were little environmental and biomonitoring studies, which make it difficult to reconstruct health exposures. Studies that rely on self-accounting to attempt to link exposures to elevated health risks might also be unreliable due to the politicized nature of the issue. As the epidemiologist from the University of Puerto Rico states,

> "If you do epidemiological studies, one of your best bets is when people don't know your hypothesis. If you could design a good study that could explore, for example, if smoking rates are similar to the rest of Puerto Rico, then you could eliminate that as a factor for excess risk. In the past, a lot of people were not aware of the problems of contamination from the Navy, so I think we would have been able to get more reliable responses, responses that were less political. You could get honest answers, such as 'I smoke, I do not smoke. I eat this, I worked here, I lived outside of the island'. By getting a picture of people's history of

> exposure, you could explain at least some of the excess risk. But now it is extremely difficult to get that type of information. Now you will just get responses that it is the Navy or it isn't the Navy…it would be very difficult now to do an epidemiological study that relied on surveying people about their exposures. I wouldn't do it."

Rather than focusing on causality, she believes that the focus needs to be on improving health care facilities in Vieques, including better detection and treatment of illnesses.

Table 3-5 Difficulties in addressing environmental justice in institutional structures that govern hazardous waste cleanup and public health

Superfund Legislation
• Meant to address current and future health exposures, but does not redress health effects of past exposures. • No compensation to victims of hazardous waste exposures. • Can only address specific site-related releases; cannot assess cumulative or synergistic risks from multiple exposures or cumulative or synergistic risks from chemical and non-chemical stressors (policy is thus limited both temporally and spatially).
Public Participation (RABs)
• Advisory capacity only; no mechanisms or program evaluations to ensure agencies are accountable to comments from the public or from technical grant advisors. • Lack of resources (technical and time) for communities to participate. • Historically strained community-public relationships; this can prevent certain stakeholders from participating or can cause agency representatives to be less responsive to community input. • Participation is restricted to input on the technical aspects of cleanup programs; there are no venues to address health or other concerns related to the residual effects of exposures or the sociotechnical aspects of cleanup (e.g., planned land use).
Federal Health Assessments (ATSDR)
• Little data exists on environmental conditions and health exposures for the many decades of military activities. • ATSDR health assessments have no regulatory authority (i.e., recommendations cannot be enforced by the ATSDR). • Under Superfund, base cleanup teams cannot use funds from the environmental restoration program to carry out ATSDR recommendations (e.g., for sampling outside site boundaries, surveying populations to delineate potential exposures).
Department of Health (e.g., Cancer Registries)
• Difficult to find statistical effects for small populations. • For temporally protracted periods, populations may change; outmigration by potentially exposed populations can significantly change disease incidence rates for small populations.

3.9. Conclusion

The history of militarism in Vieques is largely obscured by lush terrestrial vegetation that has grown over munitions, and clear tropical waters dotted with coral reefs and colorful fish. Present sampling efforts do not necessarily capture past contamination, as seawater circulates, air currents and soil erosion disperse contamination, chemicals volatize into the air or decay in marine and terrestrial environments, and many chemicals are eventually excreted or incorporated into the human body making them difficult to detect in standard tests.

While the last two decades have seen a widespread institutionalization of environmental justice concerns, the harmful residuals of militarism are difficult to address in regulatory, participatory, and scientific institutions. An examination of Vieques has pointed to a number of the difficulties in addressing environmental justice under the Superfund framework (see Table 3-5 for a summary of difficulties in addressing environmental justice). Conceptions of justice are temporally uneven. Hazardous waste legislation and public participation programs focus on controlling exposures to ordnance and contaminants, by removal or containment *in situ*, rather than on addressing the residual health, ecological, or socioeconomic claims that may accompany a history of military activities. Conversely, community members are concerned with the potential consequences of past and chronic exposures on public health and the socioeconomic and ecological effects of historical military tenure. Significant gaps exist, however, for past military activities and environmental conditions. Decades of military tenure makes it

difficult to attend to environmental justice as adverse effects on the ecology, health status, and social and cultural life of the island are broad and diffuse and data is sparse.

In Vieques, key absences (e.g., of a regulatory response for past effects, the participation of affected public stakeholders, and data for potentially exposed populations) confound the ability for the military to respond to its own adopted environmental justice strategies, as well as the broader health, ecological, social, and political conditions upon which the movement is based. While much theorizing has occurred over the spatial scales of environmental justice, the case of Vieques draws attention to the temporal scales of environmental justice: What responsibilities should agencies have for addressing the residual effects of military or industrial activity on ecological systems, health, and livelihoods? How far back should this responsibility extend? How should agencies adjudicate for a lack of data on past health exposures?

3.10. Work Cited - Chapter 3

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Chapter 4: Addressing Environmental Risks and Mobilizing Democracy? Policy on Public Participation in U.S. Military Superfund Sites

4.1. Abstract

While no longer commissioned for battle, former military lands around the United States have become sites of struggles over environmental remediation. Since 1988, hundreds of major military installations have been closed under the direction of the federal government. In most cases, a legacy of toxic contamination is left behind, with many of these installations being listed among the nation's worst hazardous waste sites. This chapter reviews the federal policy on public participation in the environmental remediation of former U.S. military sites, and uses a series of remediation cases to investigate actual practices of public participation and stakeholder inclusion. While I argue that citizen advisory boards are important venues for debate, as compared to public participation methods such as comment periods and workshops, deliberation is not necessarily democratic. While military sites expanded participation to include citizen advisory boards, there are few mechanisms built into these efforts to ensure agencies are responsive to public input. This can be particularly problematic in sites where long-standing socioeconomic and environmental inequalities have strained military-community relations and led to a lack of trust for governmental agencies. Through a case study approach of disbanded deliberative bodies, I argue that for citizen advisory boards to be meaningful vehicles for public participation in contentious environments, the boards need to have rigorous evaluations of governmental accountability. The design of

these programs should also pay attention to the historical and political variables that structure institutional relationships and reactions to environmental risks rather than be aimed at securing public trust in, or even acceptance of, cleanup programs.

4.2. Military contamination

Lands damaged by military activities grew substantially in the 20th century, both domestically and abroad, due to two world wars, the Vietnam War, and the Cold War. The closure and realignment of over a hundred major U.S. military bases and hundreds of smaller military installations increased public awareness surrounding military pollution.[53]

Before the 1980s, millions of acres of soil and water were contaminated in and near Department of Defense (DOD) sites in the United States and its territories, although a widespread lack of record keeping has made it difficult to comprehensively calculate the extent and nature of that contamination. In the mid-1990s, it was projected that there were approximately 20,000 potentially contaminated sites at 1722 active installations and about 8,000 potential sites at 1,632 former bases.[54] Contamination from "industrial" uses includes petroleum products, heavy metals, polychlorinated biphenyls, and volatile organic compounds. It can also include more "exotic" military compounds used in training exercises and experimentation, such as explosives (e.g., trinitrotoluene, dinitrotoluene), unexploded ordnances, radioactive materials, and nerve agents. Contamination is complex in the majority of sites, including contamination of multiple

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[53] In particular, since 1988 the DOD has streamlined its domestic base infrastructure in five rounds of base realignments and closures, governed by the Base Realignment and Closure Commission (BRAC). Early BRAC rounds focused on reducing infrastructure as the Cold War drew to a close, whereas the last BRAC round in 2005 focused on realigning military capabilities due to operations in Afghanistan and Iraq and counterterrorism activities.

[54] U.S. DOD, Annual Report for Fiscal Year 1993, 45

media such as groundwater, soil, and surface water.[55] In some cases, contamination spreads far beyond their points of origin in military sites, through transport by wind currents, leaching in groundwater, or bioaccumulation in food webs.

4.3. Environmental regulation of military lands

Decommissioned military bases are currently subject to federal, state, and local government oversight and they have attracted various forms of public and scientific scrutiny. Until the late 1970s, few laws regulated the disposal of hazardous wastes by private industry and none applied to the military. In 1980, the passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund Act, gave the EPA authority and limited funding to identify and compel responsible parties to remediate land with hazardous substances that may endanger public health and ecosystems. Within the Superfund Program, the EPA developed a National Priorities List (NPL), a list of the most contaminated and hazardous sites. CERCLA did not originally cover federal properties, and the military was at first exempt from environmental regulation. Congress passed the Superfund Amendments and Reauthorization Act (SARA) in 1986, which requires the Department of Defense to comply with CERCLA and with other state and federal environmental statutes and regulations. To date, the EPA lists 130 of the 1320 Superfund sites as military sites, thus comprising about 10% of the most hazardous designated sites in the

[55] See CERCLIS Public Access Database for profiles for individual Superfund sites, Available at: http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm; Accessed November 16, 2013.

United States.[56] Over 80% of the Superfund sites in which the responsible party is a federal agency are DOD sites. The Department of Energy comprises many of the remaining federal facilities on the Superfund list, in large part due to its nuclear weapons programs. Thus military-related activities are responsible for the majority of the contaminated federal lands in the U.S.[57]

DOD sites encompass some of the most difficult, largest, and expensive cleanup sites in the country. The DOD is the Lead Agency during cleanup under the Superfund program, meaning the military determines the resources it is willing to spend on cleanup, and can select its own cleanup strategies and post-remedial monitoring approach. CERCLA, however, gives the EPA oversight of investigations, cleanup, and plans for long-term operation and maintenance for sites on the National Priorities List. CERCLA does not establish regulatory standards for substances, but rather requires compliance with the standards established by the EPA or other regulatory agencies, when they are present[58]. Other governmental agencies, such as the state-level EPA and the Department of Toxic Substances Control, can be members of base cleanup teams and influence

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[56] The number of sites on the National Priorities List (NPL) of Superfund sites is a small percentage of the overall number of contaminated sites under the jurisdiction of the military. Other sites might be unlisted due to political pressure or subject to other environmental regulations such as the Resource Conservation and Recovery Act.

[57] Statistics compiled by author from data on individual sites from the EPA's National Priorities List database. See http://www.epa.gov/superfund/sites/query/queryhtm/nplfin.htm; Accessed November 16, 2013.

[58] Sometimes regulatory standards do not exist, such is the case with arsenic, and the military can establish its own safety levels for cleanup. Other times, regulatory standards are controversial and unsettled. For example, the DOD challenged the EPA's efforts to set new pollution limits on two common military contaminants: perchlorate, a munitions ingredient, and trichloroethylene, a solvent.

remedial activities. While local governmental entities have a limited role under the Superfund program, remediated land is often transferred to cities or counties and the military will enter into negotiations with these actors over acceptable cleanup standards.

4.4. Policy surrounding public participation in military superfund sites

In order to increase accountability and incorporate the priorities of the public into scientific policy decisions, academic scholars, activists, and practitioners called for extending public participation programs. The call for participatory methods appealed to the democratic ideal of the public having a fundamental right to participate in decisions that affect them. In addition to expanding participatory processes on democratic grounds, academics and the public have outlined substantive rationales. According to these arguments, 'lay' judgments are important due to the chronic uncertainty[59] of risk calculations and to influence federal and state authorities to incorporate societal values into decision-making processes.[60] Incorporating public participation can bring about more precautionary sampling and monitoring, evaluate the credibility of experts based on potential conflicts of interest, and critique the issues receiving priority policy attention.

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[59] For example, there is uncertainty due to assumptions being made in the selection of samples, sample and size, models for exposure to contaminants and from the inherent complexity of biological and technological systems.

[60] Brown*, Science in Democracy*; Wynne, "Public Participation in Science and Technology"; "Collins and Evans, *Rethinking Expertise*; Corburn, "Environmental Justice"; Wynne, "May the Sheep Safely Graze?"; Irwin, *Citizen Science*; Funtowicz and Ravetz, "Post-Normal Age"; Shrader-Frechette, *Risk and Rationality*.

As the disastrous environmental consequences of militarism and certain technological developments became increasingly apparent[61], it stood to reason that new hazardous waste legislation, such as the Superfund Act, passed in part as a response to public advocacy[62], would have provisions to incorporate public participation into decisions on environmental remediation. The National Contingency Plan (NCP), the primary regulation of the Superfund program, mandates public notices and formal public comment periods during key stages of the cleanup, including when the Proposed Plan (a document that outlines a preferred cleanup remedy) is released. The NCP establishes nine criteria for selection of a cleanup program, with community acceptance being one criterion.[63]

The traditional mechanisms for public participation required by the NCP, such as public notices and comment periods, have been critiqued as focusing primarily on agency-to-public communication and soliciting a limited set of public views.[64] As a result, public participation efforts have been criticized as attempts to defuse public challenges and ensure agencies have credibility rather than allow community engagement efforts to

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[61] Jasanoff, Designs on Nature; Nelkin, Controversy.

[62] The Superfund Act itself was passed in response to the environmental activism of residents seeking relocation and compensation after becoming aware that their homes were located above an abandoned toxic waste dump in Love Canal, New York. Before that EPA did not have the authority to respond to environmental emergencies such as Love Canal.

[63] There are nine criteria for the acceptance of a cleanup alternative. Community acceptance is a modifying criteria, meaning that it is not mandatory but rather is a factor that shapes the adoption of a cleanup alternative.

[64] Adams, "Democratic Process"; Moote, McClaran, and Chickering, "Theory in Practice"; Susskind, "The Siting Puzzle," 159.

shape political decisions.[65] Later initiatives for public participation thus aimed to guarantee that community involvement would be more meaningful and effective. In addition to meeting its public participation requirements as per the NCP, the DOD established citizen advisory boards[66] as the primary way for the public to have a two-way dialogue with the military and regulatory agencies over the cleanup of these lands. Restoration Advisory Boards (RABs), a type of citizen advisory board, were established in 1994 through a DOD/EPA partnership at most major closing bases, later expanding the program to cover more than 300 active, former and closing facilities.[67] The RABs are intended to be the primary forum for partnership among local residents, community and environmental groups, the installation, EPA, and local and state agencies, and provide a mechanism for public input on remedial programs, including cleanup strategies, standards, and technologies.[68] A committee, made up of state and federal officials, environmental activists, labor unions, and representatives of Native peoples, originally advised the DOD and EPA on the structure of citizen advisory boards. The committee produced the Consensus Recommendation of the Federal Facilities Environmental Restoration Dialogue Committee, also known as the Keystone Report.[69] A year later, the DOD/EPA partnership promulgated its own joint guidelines on the RAB, which drew

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[65] Irwin, "Citizen Science"; Szasz and Meuser, "Anticipatory Cooptation?"

[66] Citizen advisory boards are increasingly used by government agencies. The Department of Energy and the Environmental Protection Agency have also established a variant of these boards.

[67] Laurian, "Deliberative Planning," 420.

[68] DOD/EPA, *RAB Workshop Guidebook*.

[69] FFERDC, *Final Report*; FFERDC, *Interim Report*.

from and modified the Keystone Report. The Keystone Report called for RABs to be independent of officials and envisioned the ability for community members to produce inclusive agendas including such topics as land use and social, cultural, and aesthetic issues. In contrast, according to the DOD/EPA guidelines, RABs cannot address future land use of the site and also have a base official as a strong co-chair.[70]

Despite the widespread implementation of these boards and the resources dedicated to them, there has been little formal study of their effectiveness in practice. While there has been academic interest in public participation programs, there is no consistent measure to evaluate the success of participatory methods[71], with the criteria for successful participation changing across settings, participatory forms, and the expectations of stakeholders. Measures for evaluating the success of participatory mechanisms, however, include informing the public of specific issues or a general increase in public awareness[72], incorporating residents' values and preferences in policy decisions[73], as well as increasing the legitimacy of decision-making and institutions.[74] Social scientists have critiqued more instrumental approaches to public participation, which aim, for example, to increase the trust in government institutions or assist in policy compliance.[75] According to the RAB Guidelines, the boards are meant to offer

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[70] Szasz and Meuser, "Anticipatory Cooptation?," 221.
[71] Abelson et al. "Deliberations"; Beierle and Cayford, *Democracy in Practice.*
[72] Laurian, "Deliberative Planning," 416.
[73] Kasperson et al., "Social Distrust."
[74] NRC, *Understanding Risk.*
[75] Brown*, Science in Democracy*; Szasz and Meuser, "Anticipatory Cooptation*?*"; Irwin, *Citizen Science*; Arnstein, "Ladder of Citizen Participation."

communities an opportunity to provide input into the remedial process and ensure that cleanups are "responsive to community needs".[76] The programmatic objectives convey that they are meant to have substantive outcomes for how the public engages the issues at stake in environmental remediation.

In this chapter I analyze two case studies of RAB implementation where there was active participation by the public and the environmental risks of site pollution were perceived to be high. Despite the enthusiasm around citizen advisory boards in the participatory era, I discuss how the actualization of this policy was contentious in the military context, with struggles over the authority of these boards, the accountability of agencies, and the social responsibilities of the military beyond technical environmental remediation.

4.5. Case studies and methods

The remainder of this chapter uses two Californian case studies, Hunters Point Naval Shipyard and the Former Fort Ord, to assess how DOD-EPA public participation programs have functioned in practice. I designed and conducted a case study approach to examine the implications of policy and program design for public participation. I investigate the gap between policy promise and outcomes and analyze why certain RABs were disbanded. In both case studies the military disbanded the RAB; in Fort Ord it was disbanded in 1999 (five years after formation) and in the Shipyard in 2009 (16 years after

[76] DOD/EPA, RAB Workshop Guidebook.

formation) due to competing visions concerning their purpose and significant conflict among actors. Both sites currently rely on public outreach programs that focus on newsletters and fact sheets, meetings and workshops, site tours, and Technical Assistance Grants. Why did the citizen advisory boards fail to function as intended? I argue that deliberation is an essential part of public participation, but more attention is needed as to how deliberation is structured. How in particular can deliberative spaces function when military-public relations are strained due to historical and institutional variables and there are disagreements over board authority and agency accountability?

The Shipyard and Fort Ord are located in California, where approximately 10% of military Superfund bases are found. In 2012-2013, I conducted 18 semi-structured interviews and numerous informal discussions that encompassed key players and institutions, including former RAB members, community technical advisers, community involvement coordinators and remedial project managers from the EPA, and project managers from the DTSC (the primary state oversight agency), as well as military personnel. In the interviews, I ask about the purposes and goals of community involvement activities, the scope of issues that should be considered, and about the development of agendas, decision-making processes and meeting facilitation. Ethics approval was obtained for this research and interview participants are kept confidential throughout this piece, with only reference to their community status or agency affiliation. I recorded interviews and quotes are verbatim. I also relied on participant observation of 24 workshops, meetings and tours in both sites from 2011-2014. Meetings were not recorded and quotes are taken from field notes and thus may be paraphrased. These

methods are complemented by additional available documents, including community involvement plans, policy guidelines, and minutes from RAB meetings.

Both Fort Ord and the Shipyard have complex contamination and wide-ranging cleanup programs. They both had active involvement from community members and groups exposed to disparate environmental hazards, causing tensions among public participants and agency representatives. While RABs have common problems with implementation across sites, particularly related to issues with time commitment and access to information, some RABs have been less acrimonious. In both case studies, community members invested significant time in public participation processes and a high level of public awareness existed, due to factors such as local media coverage, legal disputes, and issues arising during cleanup. Surveys across different sites have found that a majority of respondents are often not aware that there is a Superfund site near their home.[77] An absence of public challenges on a cleanup program is not necessarily indicative of community acceptance, but rather can be a result of lack of public awareness or acquiescence.[78] Examining public participation in areas with high interest and debate over cleanup programs gives insights into the opportunities and barriers for these programs to incorporate public input, particularly when issues of social rights are at stake.

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[77] Laurian, "Deliberative Planning," 425; Laurian, "A Prerequisite for Participation," 263.
[78] Wynne, *Risk Management and Hazardous Waste*.

4.5.1. Hunters Point Naval Shipyard

The San Francisco Bay area of California became deeply entwined with militarism in the twenty century. Located in southeastern San Francisco, adjacent to the San Francisco Bay, Hunters Point Naval Shipyard consists of 866 acres, 420 acres on land and 446 acres under water. Between 1941 and 1991, the Shipyard was subjected to a number of naval and industrial activities that left its land, groundwater and bay sediments polluted with heavy metals, polychlorinated biphenyls, volatile organic compounds, pesticides, petroleum compounds, and radionuclides.

The Shipyard's main activities during World War II were building, repairing, and maintaining naval ships and submarines. The Shipyard was the site for radiological decontamination efforts of ships involved in Operation Crossroads, the two underwater nuclear blasts at Bikini Atoll in 1946, as well as ships involved in other atomic weapons tests. The Shipyard's Naval Radiological Defense Laboratory (NRDL), operational from 1946 until 1969, did research and experiments on the effects of radiation. The NRDL decontaminated these irradiated warships of residual plutonium from bombs and fission products through sandblasting ship bodies and burning fuel in the Shipyard's boilers. From the time of its commission to throughout the 1950s, the NDLR did experiments on tens of thousands of live animals to investigate the biological effects of radiation exposure, as well as conducted research on nuclear by-products sent from other laboratories. While much of the waste was removed in barrels to be sunk near the Farallon Islands, 30 miles off shore, radionuclides were discharged into the sewer and storm drain lines from buildings used for radiological research and maintenance, littered

the laboratory and storage rooms, as well as a landfill on site.[79] These areas are currently being investigated and remediated under CERCLA.

From 1976 to 1986 the site was leased to a private ship repair company, and, in response to violations of safeguards for toxic substances and massive illegal toxic dumping, the facility was eventually raided by the U.S. Federal Bureau of Investigation and the San Francisco District Attorney's Office.

The surrounding community in Bayview-Hunters Point is composed predominately of low-income people of color, including African-American and Asian-identified populations.[80] At its peak employment level during the close of World War II, the Shipyard employed over 17,000 civilians, many of them African-American migrants from the Southern states, escaping Jim Crow laws and in search of more steady employment. These new immigrants arrived in San Francisco to still be faced with segregation laws and customs in the form of a restrictive job market and discriminatory housing polices for many of the city's neighborhoods. As a result many African-Americans settled in the Bayview-Hunter's Point neighborhood, around their main source of employment, the Shipyard. When naval operations ceased at the Shipyard in 1974 thousands of people lost their jobs. Currently, the Hunters-Point Shipyard

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[79] Base Realignment and Closure, "Final Radiological Addendum," 2-2.

[80] Self-identified Blacks/African-Americans constitute 19.7% and self-identified Asian populations constitute 34.6% of the Hunters-Point Shipyard community, as defined by three zip codes. In the poorest zip code in the area, Blacks/African-Americans constitute 38.0% and Asians 29.2% of the populations (Neilsen Company, 2010.

community has approximately 54% unemployment.[81] This has contributed to high concern regarding the possibility for jobs in environmental cleanup and concern over the gentrifying potential base redevelopment. The Shipyard is the most expensive redevelopment project of a former naval base in the U.S. and will house business and commercial centers and private residences.

In 1989, the EPA placed the Shipyard on its National Priorities List, making it the only federal Superfund site in San Francisco. The Department of Public Health, the Federal and State agencies, community organizations, and the media disagree about the nature and extent of environmental risks from the Shipyard. Studies by the Department of Public Health indicate the surrounding communities have the highest levels of cancer and respiratory disease in San Francisco, although there is etiological uncertainty in regards to the relationship between the health issues and specific environmental effluents originating from the Shipyard as the area is heavily industrialized. Other issues that strained community relations in the Shipyard include a landfill fire in 2000, for which the Navy was fined by the EPA for its failure to notify the agency or the community, and problems with air monitoring during redevelopment activities. Significant conflict has occurred between the Navy and community groups on various remedial strategies, including containment measures that create a physical barrier between contaminated soil and the surrounding environment. In 1994, the Navy was sued by a coalition of environmentalists, anglers, and public interest groups, including original RAB members,

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[81] Navy, *CIP*, Appendix D-7.

for 19,000 violations of the Clean Water Act. The lawsuit, based on the Navy's own self-monitoring reports, alleged toxic discharges, including metals, vinyl chlorides, and polychlorinated biphenyls, from the Shipyard's deteriorating sewer and storm system were entering San Francisco Bay.[82]

4.5.2. Fort Ord

The almost 28,000-acre Fort Ord, located in Monterey County, California, was established in 1917 as a basic army training base and closed in 1994. The site was added to the National Priorities List in 1990.

At closure at least 12,000 acres were contaminated by munitions used in training exercises, including land mines, hand grenades and bombs, and groundwater plumes remain an issue. Prior to closure, the base employed more than 15,000 active military personnel and around 5,000 civilians. Many individuals immigrated to the areas for employment, and became unemployed or underemployed after operations were shut down.[83] Environmental justice concerns have not been as prominent at Fort Ord as in the Shipyard, although several nearby towns have large Latino, African-American, and Asian-American populations and an environmental justice organization has been a long-term member of public participation efforts. Much of the land is now designated as a nature reserve, a state university, and has been transferred to local cities to be developed for commercial and residential purposes.

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[82] Bjorhus, "Group to Sue Navy."
[83] Army, *CRP*, 17.

Cleanup activities have been controversial in the past, drawing several lawsuits from community members. Heavy metals, particularly lead, originating from munitions and explosives, are found across Fort Ord in levels higher than the recommended standards of the state and federal EPA. Members of the RAB brought a lawsuit against the Army for burial of lead contaminated soil in an on-site landfill, charging that the plan to bury was not appropriately reviewed under environmental legislation. As part of the cleanup program there have been prescribed burns to clear vegetation so that munitions can be removed and this has raised concerns about health impacts from particulate matter exposure. In 1998, some RAB members spearheaded a lawsuit that maintained the Army's unexploded munitions cleanup program had violated the requirements of CERCLA to thoroughly evaluate alternative detection and remediation technologies for unexploded munitions and solicit public oversight. Shortly after a judge issued a tentative ruling in the plaintiffs' favor, the Army voluntarily conceded to clean up unexploded munitions at closing bases in accordance with CERCLA. Following this conflict, the Army also implemented an extensive notification and relocation program during prescribed burns. The same year that RAB members and the Army entered a settlement on the unexploded munitions case, the RAB was disbanded. RAB members then brought another suit against the Army, claiming that the RAB was disbanded in retaliation for their prior lawsuit and was not done "in consultation with the community as a whole."[84] This lawsuit was ultimately unsuccessful.

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[84]Allen, "Notice of Intent to Sue."

4.6. Representation in non-deliberative forums

After the failure of the RABs in both sites, the military emphasized their dedication to the participatory process by instituting a variety of public participation activities. These activities, however, revert back to an older conception of public participation as based on the transmission of information from agencies to public rather than providing similar opportunities as the RAB for debate about environmental risks and challenges to cleanup programs. In effect, none of these forums solicit deliberation, generally defined as a process of debate and discussion, meant to give opportunities for political challenge and orient the political and policy processes around incorporating the positions and concerns of interested and affected groups.[85]

Current community involvement initiatives, including surveys, newsletters and fact sheets, meetings and workshops, public comment periods, site tours, a website, and mailing lists, are outlined in the Community Involvement Plans (CIP), a document formally required by Superfund's National Contingency Plan (NCP). The Shipyard CIP is modeled after the plan produced for Fort Ord. The activities, delineated in the current CIPs for both sites, go beyond the basic criteria for public participation required by Superfund's NCP. Interviewees from the military and regulatory agencies emphasized repeatedly that current activities to engage the public are not just more diverse and inclusive than many other private and federal Superfund sites, but also more so than the RABs they replaced. As one military representative put it for Fort Ord: "We see a lot

[85] Chambers, "Deliberative Democratic Theory," 309; Brown, Science in Democracy; Jasanoff, Designs on Nature; Abelson et al. "Deliberations"; Dewey, The Public.

more diverse crowds, not just the same people coming to the same meetings, but different people, which is wonderful. This was not the way things were when the RAB was active. That was a very static group of people that came."[86] An EPA representative at the Shipyard discussed a similar phenomenon at her site remarking, "What is good about the new system is we do see new interests from a broader sense of the community that we didn't see in the past. It seemed like the RAB was locked down with a specific group of people."[87] These interviewees presented the RABs as the standard approach, an inversion of the original policy intention for these boards to be more innovative and meaningful approaches to public participation.

Although certain current variants of public participation, such as site tours, may include more individuals than the RABs, whose membership typically will range from 10-25 individuals, these activities are more oriented towards outreach, education, and disseminating information rather than on sustained and in-depth discussion and debate on remedial activities. One community group commented in the 2011 Shipyard CIP that their fundamental concern with the community involvement activities is that "all of the action and activities are geared toward one-way communication from the Navy to community."[88] The Navy responded to this comment by asserting that two-way communication occurs in activities such as community meetings with a question and answer period, presentations at established group meetings, and a dedicated call-in line.

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[86] Interview with Author, August 26. 2011.
[87] Interview with Author, August 6, 2013.
[88] Navy, *CIP*, Appendix J-10

In the new activities, however, participants do not have the time to readily assimilate the information presented, weigh the evidence on issues, and discuss and debate potential alternatives, nor do these forums provide the technical resources for the general public to critically engage in the analysis. Unlike the RABs, where community members would become informed and debate on issues over, typically, multiyear tenures, workshops consist mainly of presentations by the military, and occasionally regulators and contractors. At the community information workshops that I attended over the period of 2011-2014, the majority of time is spent transitioning through slides outlining cleanup remedies and describing schedules for completion of work. Some workshops also have breakout groups for community members to ask specific questions of agency representatives. One community interviewee stated that an issue with the community involvement workshops is that public participants cannot ask questions about issues for which they have limited knowledge. While remedial approaches were prone to deconstruction in more politically-oriented and adversarial settings, such as the RABs, within workshops public participation is more restricted to a question and answer format. While some workshops and meetings have received high turnout, for both sites, community members have complained that the attendance is skewed towards military, regulators, and paid contractors and this has been substantiated by agency attendance records.[89]

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[89] For example, in 2009 and 201, there were four community involvement workshops held each year in Fort Ord. An average of 34 people attended these meetings, of which an average of 8 people were community members (Army, Community Survey).

At both sites the military and regulators emphasized the success of the site tours, including bus and walking tours, for attracting a large and diverse group of public participants not previously involved. The tours give participants a chance to see the areas of the sites which are typically closed off to the public and allow military representatives to explain the different cleanup remedies employed. Similar to workshops and meetings, while participants have the opportunity to have specific questions answered, the focus is on unidirectional transfer of information (i.e., from agencies to the general public) and there is less opportunity for challenging of cleanup activities. In Fort Ord, at the beginning of every bus tour, the organizer emphasizes that there "will be no three Ps on this tour, that is politics, protests, and petitions."[90] When I asked a community organizer from an environmental justice group in Fort Ord what she thought of the bus tours and community involvement meetings, she replied, "You know the problem is that there always seems to be a contest for the governmental agencies about how good everything is. They want everything to be accomplishment, accomplishment, accomplishment. But how can you have accomplishments all the time with no failures?"[91] She stated that in response to military-led bus tours her group organized an alternative Fort Ord Tour that had discussion points that included potential risks from leachate at the landfill and stops at the low income housing on Fort Ord that has issues with lead and asbestos contamination.

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[90] Community Bus tour in Fort Ord, Monterey, August 23, 2011.
[91] Interview with Author, February 12, 2012.

Participatory programs should not be seen as engaging an already fully developed and intransigent public perspective, but simultaneously creating, transforming, and eliciting different public "faces" based on their design. Current methods of public participation in these sites often mobilize a more passive participant than deliberative forums which assemble a different understanding, acceptance, and interest in environmental cleanup. The military currently uses surveys to assess the effectiveness of public participation approaches. Surveys are, however, limited in their ability to communicate and stimulate in-depth views about complex issues and have elicited less controversial responses than the interactions that occurred during the RABs. A 2009 public survey in Fort Ord, for example, constructed a general public that is more trusting of the Army's cleanup program and satisfied with the public participation response.[92] This is in contrast, however, to the reactions to the cleanup by community members who became involved in ongoing discussions. The RABs facilitated a participatory process that was temporally extended to allow community members to be effectively integrated into the process, familiarized with the site, conversant in issues, and able to formulate recommendations on the cleanup program. Particularly in the environmental risk arena, where knowledge is not settled, these debates can become particularly important.

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[92] Army, Community Survey.

4.7. Issues with the implementation of RABs

The legitimacy of a political response is predicated not only on the amount of participation, but also on the quality of that participation. While RABs mobilize small segments of the population, they do solicit ongoing discussions and debate. Despite the resources devoted to the restoration advisory boards, however, the deliberative process failed in the cases of Fort Ord and the Shipyard.

Regulators and community members, with experience collaborating with RABs in multiple sites, have highlighted numerous issues with the implementation of the RAB model across the country. Many cited in interviews that the technical complexity of cleanup decisions has been a barrier to public participation. RAB members do not necessarily have the time or the technical expertise to review the immense amounts of technical reports produced nor do citizen advisory boards have the funds to hire independent technical consultants. While there is available EPA funding for technical assistance grants, funding is limited and grants are typically awarded to just one community group. Others have argued that the RABs should have ongoing, independent technical support or a better balance between public interest representatives and those with technical expertise from non-military academic and environmental sources. Several scholars have likewise documented that public participation activities can have a lack of participants due to the time commitments of evaluating the large number of documents

produced, attending meetings and events, and keeping track of rapid changes in problem definitions.[93]

The RABs in the Shipyard and Fort Ord were particularly adversarial. Both sites experienced similar issues with the RABs, including fighting amongst community members, regulators, and the military, and infighting within the community. Both RABs were said to be exclusionary in practice. Long-term board members became highly familiarized with issues and this, in addition to hostile interactions within the boards, sometimes created an intimidating environment for new board members at the beginning stages of understanding the cleanup program. The Fort Ord RAB members included federal, state, and local agencies, former civilian base employees, environmentalists concerned with conservation and technical aspects of cleanup, environmental justice advocates, a lawyer involved in the litigation against the Army, and (according to skeptical members) politicians and business representatives with designs on local office positions and particular reuse plans. In the Shipyard a mix of individuals and organizations sat on the RAB including government agencies, those with interests in human rights and environmental justice, and a local environmental organization with technical expertise. Both RABs, however, were not representative of the racial, cultural, and economic diversity of the surrounding communities, for example Latino and Asian populations.

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[93] Laurian, "Deliberative Planning"; Abelson et al., "Deliberations"; Fiorino, "Citizen Participation and Environmental Risk."

The RAB was disbanded in both sites by the military, in consultation with regulators, who noted the "hostile tone" of the meetings and the focus on issues outside of RAB purview, such as employment and site reuse.[94] In both case studies, the participating community members were held responsible for the problems in the restoration advisory boards as evidenced in statements of officials during interviews and by government documentation submitted to disband the RABs.[95] The participatory trend in science comes rooted with expectations. While the RABs turned out to be contentious settings, underlying much of this conflict were questions about the authority and accountability of these boards, as well as the type of redress these boards provided for historical and present-day social and environmental health inequities.

4.8. Dysfunctional RABs: The structure and function of citizen advisory boards

Participants had different expectations of the boards for the interrelated issues of accountability and authority. What do different social actors believe should be the authority of these boards? How is accountability connected to these efforts and in what ways is it measured? Accountability to whom and for what types of issues?

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[94] Navy, Notice to Dissolve the HPS RAB, 1-2; Army, Letter to Disband the Fort Ord RAB, 1-2.
[95] Navy, Notice to Dissolve the HPS RAB, 1-2, Army, Letter to Disband the Fort Ord RAB, 1-2.

4.8.1. Authority of the Boards

Conflict ensued as public participants witnessed a gap between discussion and agency action and came to see citizen advisory boards as lacking significant authority, undermining the democratic rationale for public participation. The original DOD-EPA policy clearly states that the RAB is not intended to be a body that directly makes cleanup decisions, but rather a way for the communities to become informed and deliver advice to agencies, as the name *advisory* indicates. RAB participants though had differing views of the purpose of the boards. As one community interviewee stated with regards to the RABs: "It was the only process that they seemed to come up with that we are supposed to have some sort of voice, and hopefully some sort of equality in the decisions that are being made."[96] The guidelines of the DOD-EPA policy stress, in contrast to this participant's understanding of the process, that the RAB "is NOT a decision-making body" (emphasis in original document).[97]

In Fort Ord, in particular, conflicts about the lack of authority were often reflected in arguments over procedural matters. Facilitators at Fort Ord stated that "the underlying cause of the Fort Ord RAB's procedural difficulties is a widespread apparent misunderstanding of the RAB's role in the cleanup decision-making process…RAB procedures at Fort Ord and the attitude of many of the participants, seem to treat the body as if it were a city council or other local decision-making body."[98] While RAB

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[96] Interview with Author, February 10, 2012.
[97] DOD/EPA, *RAB Workshop Guidebook*, 4.
[98] Hougton and Siegel, *Fort Ord RAB Report*, 1.

meeting minutes reveal that many topics related to the remedial program were addressed in these bodies, the military, regulators, and community members in Fort Ord unanimously agreed that a disproportionate amount of time was spent arguing over procedural matters and this distracted from the ability of the RAB to focus its efforts on the cleanup programs. Actors differed, however, in the weight of importance that they gave to the procedural aspects of the advisory boards. For community members, procedural matters could be controversial as they reflected differences in opinion over the authority of the board, the resources and support dedicated to the board, and what constituted a procedurally fair and legitimate public participation process. There was significant disagreement over procedural matters such as the facilitation of meetings, whether meeting minutes were reflective of dissenting opinions, or intentionally edited key conflicts out of the public record, and the military's role in selecting the original membership of the RAB boards.

For Fort Ord, there was conflict over a lack of transparency in the original RAB selection process, which the Army reasoned was for privacy issues. The first RAB co-chair, a retired Army Colonel and businessman, sat on the original selection committee for the twelve RAB community members. Some saw this as symbolic of the infiltration of army and business interests on the community side of the RAB[99]. A former RAB member asserted that "[the RAB] became procedural because the Army was ignoring what the community wanted to do in so far as self-governance and the Army kept

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[99] Fort Ord RAB Meeting Minutes, February, 1994, p. 56.

inserting these people into the RAB that had conflicts of interest, like those affiliated with the Army and commerce. They were exploiting the criteria for community members. Community members were very loosely defined."[100] As such the member demanded more openness and community input into the early formations of the boards.

In both sites, public concerns that participation was not factored as an important input into policymaking came up repeatedly during RAB meetings and interviews. Community members complained that remedial decisions were made in closed meetings of the base cleanup team, which consists of the military, and federal and state regulators. Due to constraints in public authority over decision-making, the process would frequently become displaced. Community members participated in the RABs to acquire information and skills, yet would frequently appeal to the media and courts to compel agency action in the face of an absence of power sharing. As one EPA representative from Fort Ord stated with respect to the munitions lawsuit: "They needed to go through the lawsuit to impact munitions cleanup because the Army wasn't listening. They were blowing up munitions in place and no one was being notified. No one was really part of that process."[101] An activist from Fort Ord stated he was happy when an environmental lawyer joined the RAB because "I always knew that we'd have to sue. That was just a given, because the powers that be were not going to listen until you put teeth in your argument."[102]

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[100] Interview with Author, April 17, 2013.
[101] Interview with Author, September 29, 2011.
[102] Interview with Author, February 9, 2012.

As the Army's decision to disband the RAB came shortly after the settlement of the successful munitions suit, community members argued that it was a retaliatory response to members' legal activism. While official documents point to the antagonistic interactions that occurred during RAB meetings as the rationale for disbanding the citizen advisory committees, one military personnel did indicate that the lawsuits further strained relationships. As this individual stated, "… members of the RAB were suing the Army which made things particularly difficult, because we were in a lawsuit situation. It just doesn't make for easy conversation."[103]

Conflict over prescribed rules and proceedings became the locus of political struggle, particularly for Fort Ord, as they reflected disagreements over the function of the boards and the political power afforded to them. How much control the military, as lead agency, had over the cleanup and public participation programs was contentious, and this conflict was compounded by its power, albeit with regulatory approval, to disband these bodies. A Fort Ord former RAB community member undermined this when he asserted, "They'll point the finger and say I ended the RAB, I will point the finger and say they did it. But they had all the money, they had all the means, and they had an obligation to follow the guidelines. I was arguing for a legitimate participation process and they say we ended up in process hell…"[104] Deliberative dialogues have typically been evaluated within a narrow theoretical frame (e.g., is there mutual respect

[103] Interview with Author, August 26, 2011.
[104] Interview with Author, February 9, 2012.

among actors?).[105] Scholars have challenged the exclusion of an analysis of the role of power within political institutions and status inequalities when evaluating deliberative dialogues[106], as communities react to risks based on a lack of control to influence and consent to the source of risks rather than on technical evidence alone.

4.8.2. RAB Accountability

A lack of authority for these boards became particularly contentious without a stringent and open process of accountability to ensure public input was considered. Participatory bodies such as citizen advisory boards are not directly elected, or otherwise authorized, by their communities and it is difficult for the larger public to hold them accountable. Some democratic theorists thus argue that these bodies limit themselves to a consultative capacity rather than making legally-binding decisions[107]. Representatives from the military, EPA, and other main decision-makers are, however, typically appointed rather than directly authorized by the public, while community members might bear more resemblance to their publics. As those who bear the burdens of environmental and health problems, they may push for more precautionary cleanup programs and be more responsive to public concerns.

The RABs revealed fault lines among different actors in appropriate standards for evaluating evidence and meriting action, including the investigation of hazards. In

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[105] Abelson et al. "Deliberations."
[106] Peterson et al. "Myth of Consensus"; Hindess, *Discourses of Power*; Hajer, *Politics of Environmental Discourse*, 6.
[107] Brown, *Science in Democracy.*

many instances, community members pushed for positions that admitted more uncertainties and embraced precautionary measures. There are no mechanisms, however, to ensure the military is responsive to public concerns, particularly if they viewed them as being unduly cautious. In Fort Ord, community members contended that base officials should expand sampling efforts outside of site perimeters, to investigate how elevated levels of contaminants might have spread downstream into surrounding communities. While these concerns were initially dismissed by the military, contaminated groundwater plumes were later discovered to extend outside of the boundaries of the base. As one EPA Representative put it:

> ".. military bases take pride in that they can contain the plume on the base and so when it goes offbase they go crazy and that's exactly what happened…if there's any way for the military to say to the community that 'we can sample that', just to say that "we understand your concerns", it would help."[108]

While community members may need help from experts and may be characterized as overly cautious in their input, Fuller calls for a type of responsive public deliberation that is protected by "the right to be wrong."[109]

Agencies have been responsive to some community requests during multiyear tenures of public participation. For the Shipyard, the military and regulators have increased air monitoring, adjusted work hours, and varied truck routes in response to

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[108] Interview with Author, September 29, 2011.
[109] Fuller, *Governance of Science*.

public input.[110] In Fort Ord, the Army has modified prescribed burn programs and investigated at least one area previously designated a "no action site."[111] Most struggles applied knowledge acquired from the RAB to advocacy across multiple communications, policy, and legislative venues. The outcomes of the process, however, were not always knowable and transparent to participants and community members expressed concern that much of their input failed to gain resonance with federal and state bodies. In this context, disenchanted participants came to see deliberative forums as "just talk", a process that does not substantively shape agency goals.[112] One community member stated **"**The military just wanted to have a box checked off that said they talked to the community."[113] , indicating a perception that the RAB was merely incorporated as a result of regulatory specification.[114]

Deliberative democrats have, however, envisioned accountability in democracy as "giving an account" for the reasons for political decisions. While this is not equivalent to a framework that assures that all public preferences and concerns influence decision-making, "giving an account" could require implementing a stringent and transparent process that weights reasons for incorporating or not incorporating the input of interested and affected groups. An evaluation process for the RABs could indicate whether public feedback systematically fails to influence decision-making processes. This

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[110] Shipyard, *CIP*, 54.
[111] Wernstedt and Hersh, *Land Use, 40.*
[112] Carpini et al., "Review of the Empirical Literature".
[113] Interview with Author, May 5, 2012.
[114][114] Brown, Science in Democracy; Chambers, "Deliberative Democratic Theory".

includes considering at what point in decision-making public input is solicited (e.g., are there still opportunities to make fundamental changes to cleanup programs?) and what types of public input have influence. Some recommendations from public participants, such as changes to website design or additions to an information repository, are easier to implement than more substantive changes, such as modifications to land use, monitoring or the selection of experts.

In addition to the types of issues to which agencies should be accountable, are questions as to whom should they be accountable? Defining a community is an act which necessarily draws boundaries around which concerns matter. For example, the Keystone Report, produced by a committee made up largely of environmental activists, labor unions, and Indigenous groups, originally advised the DOD-EPA to "seek out and solicit the full diversity of public stakeholders in communities, particularly communities of color, indigenous peoples, low-income communities, and local governments."[115] Furthermore, the document recommends the inclusion of "representatives of citizen, environmental, and public interest groups whose members live in the communities or regions affected by the environmental contamination and related cleanup efforts at the facility."[116] In interviews with government officials and DOD/EPA promulgated guidelines[117], stakeholders were also emphasized to be the business community, installation officials, and homeowner associations. Thus Keystone laid out a more

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[115] FFERDC, *Final Report*, xiii.
[116] FFERDC, *Final Report*, 57
[117] DOD/EPA, *RAB Workshop Guidebook*

restricted vision of who is significantly impacted by contamination and cleanup activities. Some saw agency demands to incorporate more diverse views on the boards not as directed towards addressing racial and ethnic exclusion, but rather as a ruse for packing the boards with individuals who were supportive of preferred reuse plans and not as critical of environmental restoration projects. The selection process for the citizen advisory boards thus became both a question of who has the authority to influence member selection and to whom should the boards be accountable?

Conflict could negatively impact accountability processes, with interviewees alleging military authorities discounted their advice due to "bad blood" or in retaliation to their activism. An interviewee from the Shipyard drew parallels to another closed military base, McClellan Air Force Base, where he assisted with litigation against the Air Force after the RAB was disbanded due to extended disagreements between community members and base officials. As the interviewee stated, "The Air Force complained 'the community is nasty to us', but they were nasty because they were scared that their surrounding neighborhoods were contaminated. Many of these people worked on McClellan Air Force Base as military employees and buried the waste… But [the Air Force] didn't like the RAB members and to look into their concerns would have been to encourage these people".[118] Soon after the RAB dissolution, the Air Force discovered barrels of buried radioactive waste.[119] Evaluations of deliberative processes could

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[118] Interview with Author, May 22, 2013.
[119] Stanton, "Radioactive Waste."

account for whether or not institutions are less responsive to concerns when publics are perceived as adversarial.

4.9. Addressing a Federal Mandate for Public Participation, Redressing Local Issues?

The design of the RABs does not address full democratic participation nor do they have stringent and transparent mechanisms to ensure accountability for public participants. This in part contributed to a failure of policy implementation as intended, as participants felt frustrated over a lack of influence over decision-making. In addition, in both sites military and regulatory agencies cited that community members pressed issues outside of the purview of RAB, namely employment and base reuse. As a result, presentations and discussions about environmental cleanup were not always completed. While according to policy, RAB discussions are meant to be restricted to the technical aspects of base cleanup, for some public members environmental remediation could not be separated from concerns relating to economic well-being, social inclusion, and health. It is not, however, in the design of RAB or CERCLA policy, nor is it within the jurisdiction of the military, to address these more inclusive agendas. An emphasis, however, on technical progress forward, without necessarily addressing the residual impacts of long-term military land tenure, affected agency-community relations, particularly in the neighborhoods surrounding the Shipyard where many disenfranchised groups reside.

Community RAB members critiqued the technical aspects of remedial strategies, as evidenced, in struggles around remedial alternatives (e.g., prescribed burns and on-site

capping of contaminants), as well as, the thoroughness of investigations, monitoring, and risk assessments. Beyond particular technical comments, however, publics have challenged the bifurcation of politics and science in the framing of environmental remediation. While environmental remediation is framed primarily as a technical endeavor in documents and current public forums, cleanup decisions are made in a climate of conflicting accounts of environmental, ecological, and social risks, mutable environmental standards, competing political priorities, budgets, and resources, and varying degrees of private and public investments into land reuse and redevelopment projects. For example, publics insisted that who carries out environmental remediation, and under which the legislative process, matters. The Defense Authorization Act of 1997 contained a provision that allows for the DOD to "defer" the CERCLA covenant that all necessary remedial actions have been taken prior to transfer of contaminated property.[120] Community RAB members worried that the transfer of still contaminated parcels could encourage faster regulatory approval of insufficient cleanups if the benefits of reuse are high and that public input would be more restricted than under traditional CERCLA oversight. In Fort Ord, when questioned whether RAB members would review property scheduled for early release to local reuse committees, the Army co-chair emphasized that the RAB addresses the technical aspects of the cleanup not site reuse.[121] While community RAB members tackled technical issues, and critiqued the

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[120] "National Defense Authorization Act for Fiscal Year 1997" (PL 104-201, 23 September 1996), 110 United States Statutes at Large, pp. 2421-2870.
[121] Fort Ord, RAB Meeting Minutes, February 1994, p.41.

representation of science and politics into neatly partitioned spheres, the boards were also strategically used by participants in the Shipyard and Fort Ord to advance a broader political agenda on employment and reuse. The forums thus turned out to be more discursively undisciplined and disorderly than a well-intentioned federal policy had originally envisioned.

The Shipyard, once the economic driver for that part of San Francisco, is currently bordered by one of the most economically depressed areas of the city. A technical adviser to the community commented that for a community with long-term socio-economic and environmental inequalities environmental remedial activity would be seen as an important source of employment and economic renewal. He further critiqued the Navy of failing to take advantage of a city-based citizens' advisory subcommittee on contracting and other employment concerns that was created in part to take pressure off the RAB by instituting an alternative forum for these discussions. He alleged that had "the Navy partnered with the Subcommittee as was proposed, the RAB might not have been burdened by these questions over the past sixteen years." The reply to this was that "The Navy disagrees with the idea that if it had invested more time in the [Citizens Advisory Committee] subcommittee that the RAB would have been more effective.[122]

Similarly, in Fort Ord the discussions could veer towards local contracting and employment as RAB members included workers who had lost their jobs with base closure. Not all RAB community participants agreed with what they considered to be a

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[122] Navy, *CIP*, Appendix J-25.

disproportionate focus on employment and other livelihood issues. A former Fort Ord community RAB member stated "[one environmental justice activist] would come to a RAB member where the whole agenda was to address cleanup issues, but she would argue about jobs and housing."[123] A community member in the Shipyard emphasized to me that "We warned the group that kept bringing it up that the Navy would use employment arguments as a justification to get rid of the RAB. And that's exactly what happened".[124]

Land reuse is also considered by DOD-EPA policy to be a topic outside of the scope of the RABs. Despite this the issue would continually surface during meetings. The Shipyard is the largest swath of land left in the city for redevelopment. Surrounding low-income residents expressed fears that they would be displaced through a process of gentrification, and thus those who for years endured the Shipyard's environmental hazards would not benefit from its subsequent cleanup and reintegration into a profitable urban real estate market. As such, a project of environmental remediation could not be understood apart from one that could potentially deepen existing inequalities as the marking of the area as one that is economically and socially desirable.[125] Likewise, a former RAB community member from Fort Ord particularly interested in the site's reuse stated, "[The agencies] say 'we are cleaning up this land, this parcel, and we are cleaning it up for a purpose, so that we can have redevelopment here'.

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[123] Interview with Author, April 17, 2013.
[124] Interview with Author, June 11, 2013.
[125] Dillon, "Race, Waste, and Space."

But, what redevelopment is going here, who will benefit, how will the community benefit?"[126]

Just as RABs were not designed to tackle employment or reuse issues, they did not satisfactorily address residents' concerns about elevated rates of acute and chronic health problems in their communities. Public health assessments and epidemiological studies are not encompassed in the jurisdiction of base cleanup teams. As a DTSC stated, "We aren't epidemiologists, we can't study people. And it's because of the regulatory structure that we are limited to overseeing remediation of the properties."[127] Cleanup remedies are intended to be protective of present and future human health, and, although uncommon, external health consultations can be solicited for an issue with significant public concern, such as EPA requested with an industrial landfill fire in the Shipyard. The military representatives and regulators, however, in charge of identifying and addressing pollution are not epistemologically or legislatively equipped to address public health concerns. When I asked a former Fort Ord RAB member if she trusts how the cleanup team characterizes environmental risks, she responded, "They are not doctors, that's self-evident. They have no business interpreting anything that has to do with health. They can't be experts on everything."[128] Furthermore, CERCLA is oriented towards reducing human and ecological risk through current remedial activities rather than redressing past health exposures, for much of which the data is lacking and

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[126] Interview with Author, February 10, 2012.
[127] Interview with Author, August 13, 2013.
[128] Interview with Author, February 10, 2012.

inconclusive. As one EPA regulator said to me, "Superfund is more forward thinking than backward thinking, even though the liability goes way backwards as you know [i.e., early land managers can be held potentially responsible for contamination]. But as far as what we are trying to do in terms of protecting human health and the environment, it's present and future risk. Our whole motto is protecting future generations and the health effects of what may or may not have happened is not in CERCLA at all."[129] Another EPA regulator reiterated this during a RAB meeting in response to a community inquiry as to the possible associations between high asthma rates in Bayview-Hunters Point and Shipyard remedial activities. He stated, "this cannot be determined, as the EPA is dealing with the substances at present and not with past levels or activities."[130]

Community members were often referred to other committees, such as reuse authorities, when they tried to bring up issues relating to land use, redevelopment, and employment. It sometimes proved difficult to attend additional meetings for those involved in a volunteer capacity. While community involvement workshops are spent transitioning through slides on remedial achievements, hence portraying the military's role as environmental restorer[131], RABs, in contrast, troubled themselves with the persisting health, social, and economic impacts of a history of militarism. Cleanup programs encompass vast projects of digging and hauling away tons of known contaminated soils, engineering durable covers to keep other contaminants in place,

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[129] Interview with Author, August 6, 2013.
[130] Hunters Point Shipyard, RAB Meeting Minutes, August 25, 1999.
[131] Havlick, "Logics of Change."

designing and installing groundwater treatment technologies, and removing subsurface volatile organic compound gases with vapor extraction systems. For the Shipyard alone, over 24, 000 dump trucks of chemical and radiological contaminated soil has been removed from the shipyard as of mid-2012 and several groundwater plumes have achieved required cleanup levels through *in situ* chemical degradation of contaminants into non-toxic components.[132] These activities are impressive technological feats meant to degrade, remove, or contain over a quarter century of military waste production. Just as some contaminants cannot be physically broken down, however, only contained in place or displaced, as is the fate for both sites' industrial landfills, some harm is not easily redressed. The technical task of environmental remediation thus moved into social and political domains of justice that institutions and regulatory frameworks, such as CERCLA, are ill-equipped to address.

Public participation programs now seek to have less adversarial climates, or, as a military representative evoked, settings that are free from "politics, protests, and petitions." The technical imaginary is that these problems can be remediated, posing a dilemma for how to re(member) science in these contexts, that is both re-member the scientific decision-making process with those affected while recalling the variables that structure public reactions to institutions and cleanup programs.

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[132] EPA, "Hunters Point".

4.10. Distrust and contestation

For both sites hostility was cited as a reason to disband the RABs. As one EPA representative from the Shipyard stated, "Towards the end of the Navy's RAB, it just got too political and too personal, too attack-driven."[133] While the conflict was often reduced to an interpersonal problem during interviews with agency representatives, debates over authority and accountability, as well as institutional, political, and historical contexts, structured these relationships and contributed to community distrust. Some of these issues were stronger contributing factors to conflict in different sites and at different times (i.e., procedural issues plagued the Fort Ord RAB, whereas discussions in the Shipyard could become mired by issues of employment). Nonetheless, these issues reflected and intensified issues of distrust surrounding the responsiveness of military authorities and regulators. This underpins a shift in analysis from the distrusting community member, and the interpersonal conflicts that manifest as a result, to an evaluation of the trustworthiness of institutions.[134]

Public participation has transitioned from contentious RABs to community events that aim to solicit good relations and mutual trust. As a Fort Ord Army representative stated, "on the bus tour, people can argue and ask questions, but in the

[133] Interview with Author, August 6, 2013.
[134] Ruha, People's Science, 153.

end we all sang a song together and that's a reminder of trust".[135] This representative also emphasized that a hotline during the prescribed burn programs in Fort Ord is there to offer "reassurance" to people nervous about smoke impacts. Agency representatives in the Shipyard, in contrast, have not put the same overt emphasis on trust. When a technical adviser commented that it was unrealistic for the Navy to believe that RAB members would "immediately give over their trust to an entity whose actions in 1974 helped drive the community into poverty", the agency response was that "The Navy has never stated that a goal of the RAB is for community members to "give over their trust" to the Navy."[136] Current events, however, at the Shipyard often minimize conflict amongst social actors, focusing more on information transfer than animated debate.

Policy documents and agency representatives often emphasize that a key goal of public involvement initiatives is to develop trust, respect for different perspectives, and a spirit of collaboration among stakeholders, and scholars will cite distrust as a barrier to public participation.[137] Distrust, however, can be a productive response to past state violations and current environmental and political conditions. According to this view, rather than a barrier to overcome, distrust is treated as a rational response to living within a stratified society.[138]

Military culture could itself be a source of public mistrust. Institutional issues associated with transitioning to a more open process were complicated by a military

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[135] Interview with Author, August 26. 2011.
[136] Navy, CIP, J-24.
[137] Slovic, "*Perceived Risk, Trust, and Democracy*."
[138] Ruha, *People's Science*, 146.

culture that traditionally viewed disclosure and broad participation as breaches of security.[139] Early regulation under the Superfund Program was in particular plagued by difficulties as the military adjusted to the new environmental regulations, requirements for cleanup and documentation of remedial activities, and mandates for public openness after decades of secrecy surrounding base operations and little experience in cooperating with publics. Moreover, RAB formation is typically a community-led initiative, a process which requires 50 people petition for its implementation. In this case a federal mandate from above is spearheaded from below, with local base officials in the middle responsible for board formation despite not requesting the boards themselves or having previous experience working with publics. While some members identified with or trusted military authorities more, the military careers of staff, either as civilian or uniformed, caused some participants to feel intimidated and heightened their distrust of officials' commitment to the RABs.

According to a San Francisco Civil Grand Jury Report, the high level of community distrust of the agencies responsible for managing the Shipyard's cleanup and reuse was exacerbated by unexplained fires, a lack of complete data and documentation of the extent of contamination, missed deadlines for cleanup and reuse, and failures to study and account for cluster illnesses among nearby residents.[140] This report was published two summers after a 2000 landfill fire containing industrial wastes exacerbated

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[139] Laurian, "Deliberative Planning"; Rahm, "Controversial Cleanup"; Szasz and Meuser, "Anticipatory Cooptation?"
[140] CGJ, *Report on HPS*.

military-community relations. The US-EPA fined the Navy for their failure to notify the regulatory agency during the first three weeks of the fire and directed the Navy to install air monitors and establish a community outreach program. Sentiments that the Navy did not initiate notifying community members and instigate collecting air data continually appears during meetings and in the popular press. Less than one year after the fire, a published investigative report drew on historical research of declassified documents and accused the Navy of conducting nuclear research and mishandling radioactive waste on a scale greater than previous revealed. When accused of insufficiently investigating and informing regulators and the public of the site's nuclear history, the Shipyard's base environmental coordinator replied that the Navy was not purposely obfuscating this information but, until 2002, no one with the technical and scientific expertise to do so had constructed a formal radiological assessment.[141] Nonetheless, the narrative of nuclear fallout particles captured the imagination of residents and contributed to an ongoing social fallout between less trusting community members and the Navy.

Key struggles in Fort Ord centered on the boundaries of contaminated groundwater plumes, the munitions remedial approach, and lead concentrations in the beach dunes. These conflicts escalated when participants did not feel that institutions were accountable to their concerns. For example, an environmental testing firm for the Shipyard and Fort Ord was suspended by the EPA for failing to follow proper testing

[141] Phelan, "Nuclear Fallout."

procedures and falsifying results in another base.[142] A Fort Ord community RAB member felt his inquiries as to the implications of this for Fort Ord's data from the lab were dismissed. He stated, "When it came up this lab was fraudulent, it all went back to the issues we were raising at the RAB. When we raised issues, they told us not to worry about it. I didn't have confidence in their ability to do what they say they are doing and therefore I told them that we need a very strong RAB."[143] In addition to providing a venue for input on public values, this assertion forwards citizen advisory boards as public oversight committees, a position that entails scrutiny. With respect to ensuring cleanup programs are adequate, it could be productive for deliberative forums like the RABs to invite public expressions of skepticism and make space for conflicting interests.[144] This conflict would be different than one rooted in intimidation or interpersonal attacks, as characterized much of the fighting in these sites.

In the Shipyard and Fort Ord, public trust eroded in the military and the oversight capabilities of regulatory agencies and, conversely, agencies did not have faith in the intentions of community members for joining these boards. Different social groups perceive and experience institutions and environmental risks differently and the removal of the military, regulators, and the politicians from their representative communities was a recurring theme. When a community member in the Shipyard asked an EPA regulator during a public meeting if he would ever live in Bayview-Hunters

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[142] Ingram, "EPA Ends Suspension."
[143] Interview with Author, April 17, 2013.
[144] Mouffe, *Democratic Paradox*.

Point, his response was 'If I had an opportunity to move to the Shipyard after the cleanup, I would absolutely do that. I'm close to the data. I watch the samples be taken to the lab and that gives me confidence in the data'.[145] Agency representative emphasized the veracity of scientific data, while residents, on the other hand, emphasized the gulf between agencies and publics, governmental failures in containing hazardous waste, disagreements among experts, inadequate past notification systems, and the experiences of being sick.

4.11. Conclusion

Debates about toxins dissolved to questions about authority and accountability, the social responsibilities of agencies, and the motivations and trustworthiness of institutions. Public reactions to environmental hazards and regulations are not solely responses to perceived physical risks, but also take into account the equity of risk distribution, the social identifiability, competence, and trustworthiness of institutions and their actors, and the public's power to influence and consent to the source of the risk.[146] As such, public participation programs need to recognize that public participants in the citizen advisory boards often have a different suite of evaluative criteria as compared to state authorities for what constitutes an adequate investigation and monitoring of site conditions, as well as for judging which risks are acceptable and which are not. While

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[145] Community Involvement Meeting, April 12, 2012.
[146] Jasanoff, "Bridging the Two Cultures"; Shrader-Frechette, *Burying Uncertainty*; Wynne, *Risk Management and Hazardous Waste*; Sandman, "Getting to Maybe."

community members were often officially blamed for the failure of the RABs, the unraveling of these experiments in participation and democracy brought other questions to the fore. For example, how much influence should community input have over remedial programs? Who should the programs be accountable to and for what types of issues? How should accountability be assessed?

Both the Shipyard and Fort Ord have participatory processes that are more expansive and diverse than many other federal sites and the majority of "private" sites regulated under Superfund. In both case studies, current public participation activities are defined largely in terms of making technical information accessible and allowing the public to submit recommendations. There is no participatory process, however, that encourages ongoing discursive challenges to the ways in which state actors represent and respond to risks. While deliberative bodies only mobilize a small segment of the population, they complement broader public participation activities by facilitating cultivation of the skills and knowledge required to evaluate technically and politically complex cleanup issues.

While deliberation incorporates the important democratic principles and procedures of debate and representation, citizen advisory boards are not panaceas for democracy and guaranteeing that cleanup programs are receptive to social concerns and values. In practice, RABs allowed for a more managed form of public participation than that envisioned by scholars, activists, and social movements who have called for a direct

influence and substantial contribution to decision-making.[147] Many participants were unsatisfied with the lack of formal mechanisms within the citizen advisory boards to ensure that the military and regulators would investigate public concerns and make substantive changes to cleanup programs and agency practices. Rigorous evaluations that assess whether or not community input is systematically excluded from decision-making processes could be particularly important when relationships among stakeholders are strained, as a result of a lack of trust in the institutions that manage risk and current and past threats to civil liberties and health.

4.12. Acknowledgements - Chapter 4

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[147] London et al., "Problems, Promise, Progress, and Perils"; Holifield, "Neoliberalism and Environmental Justice."; Arnstein, Ladder of Citizen Participation

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Chapter 5: Conclusions and Recommendations

5.1. Summary of Research Findings

In chapter 2, I found that the nature and extent of contamination tend to exert the most significant effect on how quickly sites progress through several cleanup milestones. An increase in the severity of contamination will cause the likelihood of a first cleanup response to happen earlier, while certain types of contamination will delay the finalization of environmental decision-making and remedial activities at the site. This appears to indicate a prioritization of more environmentally risky sites by Superfund regulators and the military. If environmental remediation needs to address munitions and radioactive waste then military Superfund sites take longer to reach more advanced stages of cleanup activities. This can be expected given certain types of contamination are more technically complex to address. The Department of Defense's munitions cleanup programs have been criticized as making limited progress in identifying, assessing, and cleaning up sites that are potentially contaminated with military munitions (GAO 2003). These findings do signify that there could be greater policy attention towards resolving delays in the remediation of sites containing munitions.

I did not find evidence that host communities with larger proportions of non-white residents and lower median household incomes experience either slower or faster site cleanups. While there does not appear to be an environmental justice problem with the rapidity of risk abatement, future studies should investigate the target risk levels and remediation methods selected for military Superfund sites to investigate whether

socioeconomically disadvantaged communities receive lower quality cleanups. There is some evidence that hazardous waste sites in areas with socioeconomically disadvantaged communities experience less comprehensive and permanent cleanups relative to locations with majority white communities (Lavelle and Coyle 1992). Pace is also not the only indicator of whether or not the environmental remediation is just. Other studies have found that majority non-White and/or poor communities are less likely to be added to the Superfund's National Priorities List or take significantly longer to be listed (Anderton et al. 1997, O'Neil 2007), preventing or delaying potential remediation. As Superfund listing can be a political process, future work should look at whether there are racial or class biases in whether sites even make it into this program meant to address the risks of living next to a hazardous waste site.

Furthermore, proximity to a Superfund site, and its pace of remediation, does not translate into information on actual health exposures. The extent of exposure to hazardous substances among communities living near military Superfund sites is currently unknown. My qualitative case work does indicate that there are concerns that some racially and socioeconomically marginalized communities were exposed to high intensity training activities. Environmental justice-oriented research can examine whether military sites correspond with higher rates of exposures to contamination and poorer health status for such communities.

While my quantitative research gave me insights into trends in hazardous waste remediation across all military Superfund sites, my qualitative case studies for Chapters 3 and 4 imparted finer-level detail into cleanup decision-making dynamics. Specifically, I found that there is not the institutional support or structures to guarantee that federally

adopted policies on environmental justice and public participation will influence cleanup programs.

In Chapter 3, I outline a number of difficulties in addressing the historical legacies of long-term past exposures to environmental burdens within regulatory, participatory, and scientific institutions. The Superfund legislation, and accompanying public participation initiatives, limit cleanup programs to reducing current and future risks of exposure to contaminants for site-related releases; residual health effects from past and persistent exposures to military activities are outside regulatory purview. The Superfund policy also limits risk assessments to contamination occurring within official site boundaries. Despite commitments to doing so within formally adopted environmental justice policies, federal agencies involved in Superfund cleanups are impeded from expanding health research on at-risk populations or assessing the cumulative impacts of exposure to multiple contaminants.

Moreover, a lack of historical data on military activities and environmental conditions make it difficult to reconstruct past health exposures to military toxins. This difficulty in linking military activities to poorer health status is further confounded by the potential outmigration, over several decades, of exposed individuals in small populations.

As a result of structural limitations to the Superfund program and a lack of historical data, communities are constrained in their ability to address health concerns, and other socioeconomic and ecological effects related to long-term military tenure.

In chapter 4, I looked more in-depth at the barriers and opportunities for communities to influence cleanup programs through public participation initiatives. There have been some notable gains made with respect to trying to diversify and expand

public participation in military Superfund cleanup programs; for example, inroads have been made with respect to holding meetings at evening times that accommodate most working-class residents and translation of key public documents and notices. Nevertheless, it can be difficult to recruit and retain community members or avoid adversarial climates within these participatory programs. One key issue is that there are no mechanisms to ensure that significant time investments into the process by community members will translate into influence over decision-making. Without a systematic and transparent process that accounts for which community recommendations are incorporated into the cleanup response, and which are not adopted, community participants cannot evaluate whether their involvement is meaningful and effective. Many participants in the citizen advisory boards were unsatisfied with the lack of formal mechanisms to ensure that the military and regulators would investigate public concerns and make substantive changes to cleanup programs and agency practices.

5.2. Recommendations

Given the above findings, I make the following policy recommendations:

5.2.1. Recommendation 1: Implement peer-reviewed evaluations of citizen advisory boards.

Citizen advisory boards need to rigorously evaluate governmental accountability. This could require implementing a stringent and transparent peer-review process that weighs reasons for incorporating or not incorporating the input of interested and affected groups. An evaluation process would indicate whether public feedback systematically fails to influence decision-making processes. This includes considering at what point in decision-making public input is solicited (e.g., are there still opportunities to make fundamental changes to cleanup programs?) and what types of public input have influence. Some recommendations from public participants, such as changes to website design or additions to an information repository, are easier to implement than more substantive changes, such as modifications to land use, monitoring or the selection of experts. As such, it would be important for evaluation processes to distinguish whether participation can substantively change actual cleanup programs rather than just increase public access to information. Unlike environmental restoration programs for the Department of Defense and other federal agencies, the EPA does have a Superfund evaluation project to assess public participation in environmental decision-making (Charnley, S., & Engelbert 2005). It is the only ongoing, systematic project of its kind and further study can be directed at critiquing, building upon, and improving efforts such as this one.

5.2.2. Recommendation 2: Implement mechanisms that formally incorporate community input into the decision-making process.

As of now, there are no mechanisms to ensure that the substantial amount of time community members contribute to the process translates into meaningful outcomes. Communities can be involved more in selecting issues, designing studies, and research in investigation, cleanup, and monitoring activities. There have been some instances where the Department of Defense has done further investigations based on community concern. Program changes should thus not be limited to just incorporating evaluation systems, but they should also focus on increasing community capacity to influence the process, as well as have access to sufficient technical support.

5.2.3. Recommendation 3: Focus on increasing community capacity to participate in and influence cleanup programs rather than diverting distrust.

Rigorous evaluations that assess whether or not community input is systematically excluded from decision-making processes could be particularly important when relationships among stakeholders are strained, as a result of a lack of trust in the institutions that manage risk and current and past threats to civil liberties and health. In these cases community members have expressed concern that agencies have discounted their input simply because of adversarial relationships. While interpersonal conflict can be minimized, public participation initiatives should also see public distrust as a productive response to past state violations and current

stratified environmental and political conditions. It is more critical to increase community capacity to engage in the process, for example, by focusing on influence over decision-making, accountability, and the ability to interpret technical documents, rather than on diverting distrust.

5.2.4. Recommendation 4: Provide ongoing, independent technical support to participants in citizen advisory boards and expand already existing technical assistance grants.

RAB members do not necessarily have the time or the technical expertise to review the immense amounts of technical reports produced during cleanup activities. While there is available EPA and DOD funding for technical assistance grants, funding is limited, qualifying and administering them can be a highly time-consuming process, and grants are typically awarded to just one community group. Citizen advisory boards should have funding support for ongoing, independent technical support that is provided to all participants. Support can also be provided to community members to write and manage grants to solicit technical help.

5.2.5. Recommendation 5: Have mechanisms to incorporate the input of TAG advisers into the cleanup decision-making processes and evaluate the degree to which this input changes cleanup programs.

While the technical assistance grants are critical, similar to community input, there are no mechanisms to ensure technical advisors themselves influence cleanup programs. Advisers with the EPA's Technical Assistance Grant (TAG) program likewise communicated to me that they did not think their input was incorporated

into cleanup programs. The government-funded technical assistance programs should thus also have mechanisms and evaluations that ensure community advisers can meaningfully participate in and influence cleanup activities.

5.2.6. Recommendation 6: Expand education on and official guidance around incorporating environmental justice policy.

Ground level remedial managers and other cleanup team members need education on environmental justice policy and more consistent guidance on how to implement it. The EPA has not fully implemented environmental justice policy into its day-to-day operations, particularly with respect to identifying disproportionately at-risk populations (O'Neil 2007). Environmental justice strategies and directives can be vague and steps to implement them have widely diverged across regions (ibid). Many agency representatives I spoke with were not very familiar with opportunities to incorporate environmental justice policy into cleanup programs or stated that environmental justice policies conflicted with Superfund's jurisdiction (e.g., Superfund does not deal with past levels of exposures and cannot assess cumulative exposures beyond site-related releases).

5.2.7. Recommendation 7: Better coordinate Superfund cleanups with already existing federal research, programs, and funding to assess and address disproportionate health impacts.

The EPA and other federal agencies have undertaken programs and research into how to better incorporate environmental justice into scientific practices. For

example, in 2010, the EPA held a symposium on the science of disproportionate health impacts in order to produce knowledge on science and environmental justice that can be considered in governmental decision-making processes. Much of the research and discussions focused on how to best characterize and evaluate environmental disparities, individual and social vulnerabilities, cumulative exposure risks, and the combined effects of chemical and non-chemical stressors (e.g., see Chakraborty et al. 2011, Couch and Coles 2011, McEwen et al. 2011, Nweke et al. 2011, Schwartz et al. 2011, Sexton et al. 2011). As discussed, however, it is difficult to consistently and comprehensively evaluate disproportionate health impacts and cumulative exposure risks within Superfund programs. Superfund sites, which encompass the largest, most hazardous land in the country, however, are precisely where these types of studies and initiatives can be so important. More work needs to be done to develop opportunities for and coordinate Superfund cleanups with research, programs, and funding to address and assess disproportionate health impacts.

5.2.8. Recommendation 8: Strengthen and increase the coordination of government-led health assessments with the activities of Superfund base cleanup teams.

Public health assessments and epidemiological studies are not encompassed in the jurisdiction of base cleanup teams. As one regulatory stated, "We aren't epidemiologists, we can't study people. And it's because of the regulatory structure that we are limited to overseeing remediation of the properties." There should be

better coordination between cleanup teams and health assessments from the Agency of Toxic Substances and Disease Registry; the former is often unaware of their recommendations for further studies or do not see any opportunities for inclusion of these recommendations. Furthermore, the ATSDR does not have any regulatory authority, is largely understudied, and rarely conduct their own studies (rather relying on other data that can be of poor quality and incomplete). The process for government-led health assessments should be strengthened and better coordinated with independent expertise and community groups.

5.2.9. Recommendation 9: Orientate public health studies not at disproving or proving causal relationships of health claims to military activities but rather establishing what basic healthcare and diagnostic tools are needed for communities.

The claimant currently bears the burden of proof regarding exposure type and duration to environmental contaminants; in some cases, these claims are expected to be substantiated over decades of an individual's life. This requirement poses a major barrier to redressing health claims since historical data on exposures are extremely limited or nonexistent and there is little data on how cumulative and synergistic exposures determine overall health impacts. Furthermore there is often a lack of research into quantifying the toxicity of substances on biological functions and disease incidence. In addition to little data on historical environmental conditions and releases, many health exposures are difficult to detect in biomonitoring protocols (e.g., blood and urine tests) a short time after exposures have ended and rarely detectable decades later. Epidemiological studies also have difficulties with detecting

poorer relative health status in small populations due to a lack of statistical confidence and the outmigration of individuals from these small populations. Given these difficulties with both exposure and epidemiological studies, public health studies should not be aimed at disproving or proving causal relationships of health claims to military activities but rather establishing what basic health care and diagnostic tools are needed for communities.

5.3. Work Cited - Chapter 5

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