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基于本土主义的设计

DESIGNING BY RADICAL INDIGENISM

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摘要

放眼全球重要农业文化遗产（GIAHS）和基于传统生态知识的基础设施（Lo–TEK），其中有众多能够与环境协同共生的基于自然的系统。本文指出，通过将Lo–TEK与高科技系统结合，GIAHS能够为设计师提供一套集经济、生态、文化和技术于一体的创新的工具包，从而帮助提高景观的生产力和韧性。尽管城市发展似乎将不可避免地磨灭其历史、本土性、文化和自然特征，但本文旨在探讨城市化如何成为农业文化遗产迁移和再生的媒介，而非威胁其存在的最大因素。城市发展可以摒弃典型的西方模式，不以同质化的高科技手段来取代本土多样性，转而将本土农业遗产景观——例如那些被纳入GIAHS的景观——拓展为能够应对气候变化的，具备延展性、丰产性和韧性的解决方案与技术措施。这需要人类转变对传统农业及人与自然关系的固有认知——即从凌驾其上走向共生。

关键词

基于自然的技术；全球重要农业文化遗产；基于传统生态知识的基础设施；气候变化；新本土主义

ABSTRACT

Looking to Globally Important Agricultural Heritage Systems (GIAHS) sites and traditional ecological knowledge-based infrastructures (Lo–TEK), we find nature-based systems that symbiotically work with the environment. This article suggests that by hybridizing Lo–TEK with high-tech systems, the GIAHS sites could offer designers a toolkit towards economically, ecologically, culturally, and technologically innovative systems that can improve productivity and resilience. Whereas urban development results in the erasure of history, identity, culture and nature, this idea explores how urbanization can be an agent for the migration and reapplication of agricultural heritage systems, rather than their greatest threat. Cities can leap-frog the typical Western model of displacing indigenous diversity for homogenous high-tech. Instead, catalyzing localized, agricultural heritage landscapes like those designated as globally important agricultural heritage systems, as scalable, productive and resilient climate change solutions and technologies. It requires a shift in the thinking about traditional agriculture and about the relationship to Nature, from superior to symbiotic.

KEYWORDS

Nature-Based Technology; GIAHS; Lo–TEK; Climate Change; Radical Indigenism

翻译 李慧彦 冉玲于
TRANSLATED BY LI Huiyan RAN Lingyu

1 迫在眉睫的韧性危机

2020年1月，印度尼西亚首都雅加达爆发洪水，导致近50万居民流离失所[1]。这座人口达千万的城市位于爪哇岛西北海岸，历来饱受沿海与沿河水患、海平面上升，以及地面加速下沉等问题的困扰，因而不得不面向全球征集以高科技为核心的水资源管理方案[2][3]。2014年，雅加达与荷兰政府达成合作，决定将荷兰的“堤坝”概念应用到雅加达海岸线的规划设计上。这项耗资400亿美元的提案拟建多个围海堤坝和人工岛屿，并预计于2050年左右完工——如不采取任何措施，届时雅加达将有约95%的领土被海水淹没[4]。在应对海平面上升问题时，常见的解决方案多是为富裕社区引入功能单一的高科技硬化措施等，但随着时间的推移，这些策略不仅无法从根本上解决地下水资源枯竭和具有灾害防御功能的生态系统的缺失等问题，还可能使城市变得更加脆弱[5]。从长远来看，原始的自然海岸环境反而比这些造价高昂的防御措施更具韧性。

2020年的这次洪水侵袭导致西爪哇省超过1万公顷的农作物歉收，受此影响的农民和以这些粮食为食物来源的人口达数百万[6]。另外，随着城市人口的激增，传统农业景观已逐渐工业化，森林砍伐、环境污染等问题日趋严峻，生物多样性和生态系统服务严重丧失[7]。因此，重新思考城市网络与乡村景观之间的断层现象，实现流域生态系统中各要素的共生，于人类生存而言至关重要。

城市发展可以摒弃典型的西方模式，不以同质化的高科技手段来取代本土多样性，转而将本土农业遗产景观——例如那些被纳入“全球重要农业文化遗产”（GIAHS）的景观——拓展为能够应对气候变化的，具备延展性、丰产性和韧性的解决方案与技术措施。目前联合国

1. 稻田养鱼区域由半米深的矩形稻田网格组成，长度2~4m。
2. 这一系统包括了一条沟渠、一个堤坝和4种类型的稻田：交配区、鱼苗区、熟苗区、交易区。不同稻田养鱼区在物种间的平衡共生关系中扮演着不同角色。

1. The rice-fish field is composed of a rectangular grid of paddies that are half a meter deep and range in size from 2 to 4 meters in length.
2. The system consists of a canal, a dyke, and 4 types of field: mating, fry, maturity, and market. Individual rice-fish paddies play different roles in directing a balanced symbiotic relationship among species.


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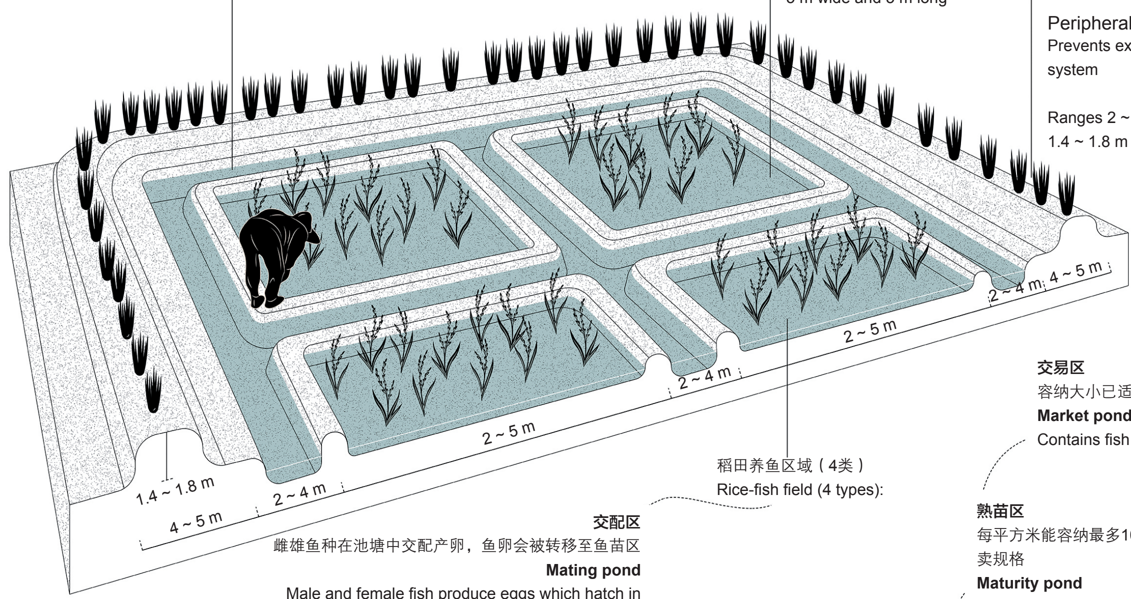
已在亚洲认定了34处GIAHS，这些颇具本土特性的人居系统能够为设计师提供灵感，以在完整的生命系统中构建丰产的共生景观[8]。城市的发展似乎将不可避免地磨灭其历史、本土性、文化和自然特征，但本文旨在探讨城市化如何成为农业文化遗产迁移和再生的媒介，而非威胁其存在的最大因素；进而指出，通过将基于传统生态知识的基础设施（Lo—TEK）与高科技系统相结合，GIAHS可以成为设计师的创新集成工具箱，帮助他们从经济、生态、文化和技术层面提高景观生产力和韧性。要突破遗产地的角色束缚，就需要转变对传统农业及人与自然关系的固有认知，即从凌驾其上走向共生。

2 爪哇岛的稻鱼共生系统

沿爪哇岛海岸线往东，可以发现位于雅加达潮间带陆地的一种洪水适应策略——在这些沿海低地上，持续的洪水泛滥促生了一种被称为“稻鱼共生系统”（sawah tambak）的独特的爪哇岛水产养殖技术（图1）。尽管该稻鱼共生系统与荷兰圩堤相似，也由堤坝、运河和池塘构成，但其运作方式却迥然不同。后者主要通过建造沿海堤岸并抽干潮间带生态系统中的水分来开辟耕地，而爪哇稻鱼共生系统则利用当地现有的资源，从周边运河中挖掘土壤形成护堤，以维持农业生产所需的水生环境（图2）。最初，为适应季节性水位变化，该系统逐渐由富含淤泥的淡盐水鱼塘演变为雨养稻田，改变了当地的生存环境和



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基础设施格局。到20世纪80年代，当地已有约16 500hm²的土地施行了该稻鱼共生系统，年产鱼量达35 000吨，足以养活15 000个家庭[9]。多年来，该系统已推广至东爪哇省的其他地区，目前在布兰塔斯河和梭罗河流域均有应用[10]。兼具防御和生产功能的稻鱼共生系统，可在降低洪水与干旱危害的同时，为众多物种提供栖息地，同时持续为当地社区供给食物。

3 基于传统生态知识的基础设施

上文所述形成的本土基础设施名为“Lo—TEK”，这一概念由“低科技”（low-tech）一词衍生而来，并融入了“传统生态知识”（Traditional Ecological Knowledge）一词的首字母缩写“TEK”，具体指利用了复杂生态系统所提供能源和生物多样性的自然技术。作为本土技术的构成基础，TEK是人类学的研究分支之一，生态学家菲克雷特·伯克斯将其定义为由知识、实践和信念结合而成的丰富体系，借助传统歌曲与起源故事的形式，在日常生活中代代相传[11]。对于那些最易受气候变化威胁但又缺乏资金和资源来建设昂贵高科技基础设施的社区而言，Lo—TEK无疑为设计与新本土主义的结合提供了契机。当前的窘境在于，尽管本土性创新方案汇聚了人们在环境与文化发展过程中的智慧结晶，生活在发展中国家的人们却常被灌输有关技术神话的信念——舶来的解决方案往往更胜一筹。

4 发展式响应或适应式响应

尽管TEK的应用在实证科学领域并不新鲜，但就完善科学研究框架而言，TEK仍然具备独创性[12]。联合国政府间气候变化专门委员会（IPCC）于2019年发表了《气候变化中的海洋和冰冻圈特别报告》[13]，其中对“发展式响应”与“适应式响应”进行了定义——“发展式响应”意味着开拓新的陆地来容纳水流，而“适应式响应”即允许水流进入现有陆地。本文依据该定义对本土性创新方案进行了分类，以使当代韧性设计方法能够将TEK囊括其中。多数本土性技术本质上均蕴含了这样一种策略——通过构建生物多样性和增加生态系统服务功能来提高景观绩效，继而使景观具备能够适应不同问题的韧性。

4.1 发展式案例

4.1.1 中国桑基鱼塘系统

在中国珠江三角洲及太湖流域，拥有2 500年历史的桑基鱼塘系统是一种基于发展式响应的GIAHS。在这一系统中，桑树被栽植于名为“塘基”的堤坝上，形成了鱼塘的堤岸（图3）。桑叶供蚕食用；蚕沙和蚕蛹掉落至邻近的池塘中，成为鱼的饲料；鱼的排泄物、残余的蚕沙，以及桑叶残渣再由水生微生物分解为氮、磷和钾等营养元素，最后随着塘泥一并被打捞上岸，成为营养丰富的桑树肥料——如此循环往复[14]（图4）。该系统不再需要依赖化肥、杀虫剂和除草剂，不仅降


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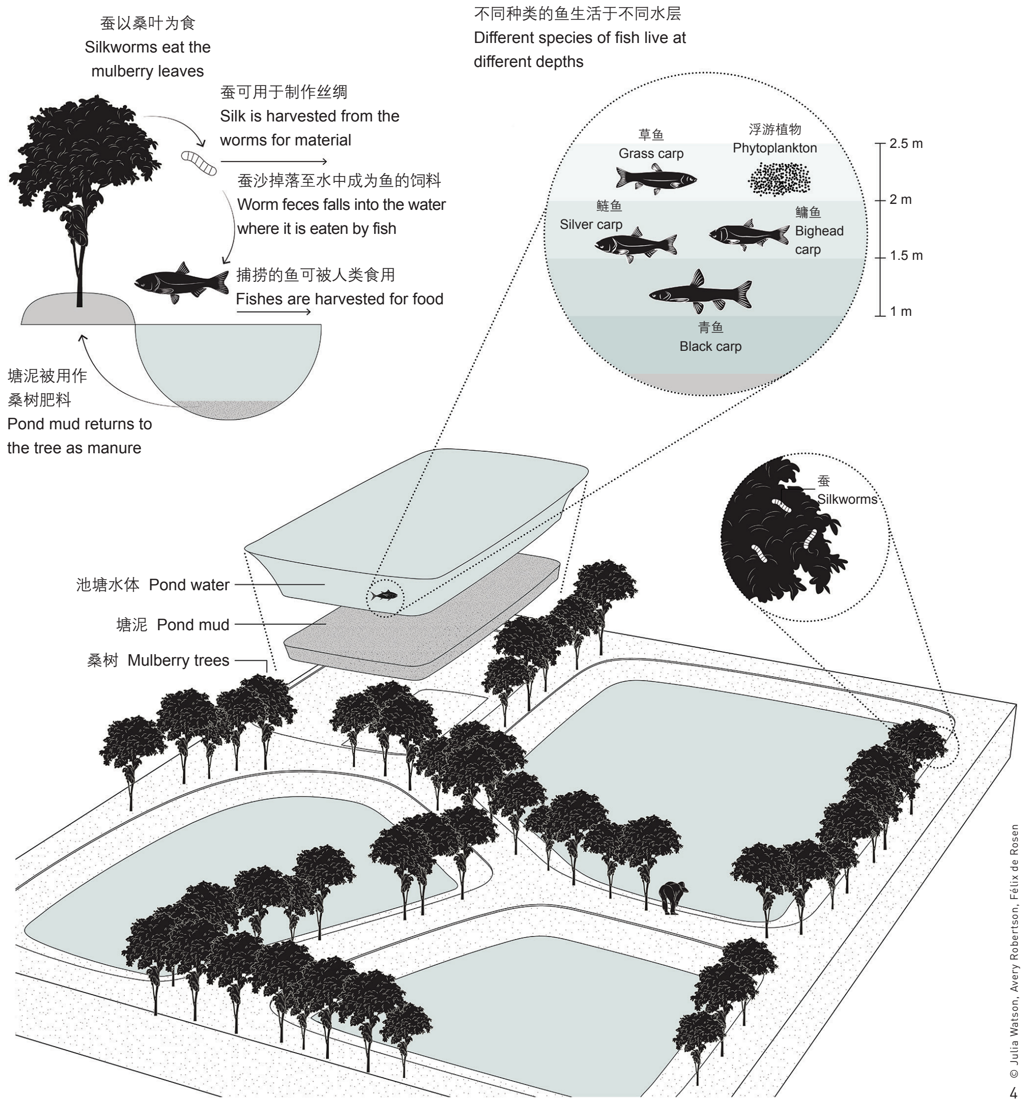
① “纵浦横塘系统”是湖州桑基鱼塘系统中一项古老的灌排工程。其中，“纵浦”亦可称为“溇”或“港”，指的是狭窄的、从南至北的纵向河道，“横塘”指的是宽阔的、自西向东的横向河道。

3. 一名养蚕人爬上鱼塘堤岸上的桑树，取下桑叶上的蚕。
4. 桑基鱼塘是一个循环系统，系统中的不同构成部分互相提供养分。

3. A woman is reaching out to pull silkworms from the leaves of a mulberry tree that is grown on the dyke of the fish pond.
4. The mulberry dyke and fish pond is a closed loop system, in which each element provides nutrients for another.



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② 数据来源：世界银行。
③ 水葫芦信息来自GIANSIS数据库。

5. 桑基鱼塘系统借助池塘与河流来平衡来自山间的流水，并能储存洪水。底部的塘泥可被挖出，用作堤岸建造材料，以增加池塘蓄水能力，并不断加高防护墙，同时还能向桑树提供养分。

5. The fish pond system uses ponds and rivers to balance the flow of water from the mountains and to store water from flooding. The mud from the bottom of the ponds is excavated to build up the dykes, increasing water storage capacity and wall height while bringing nutrients to the mulberry trees.

低了成本，而且对生态环境零污染[15]。这些鱼塘还是兼具蓄水、防洪和抗旱功能的“纵浦横塘系统”①的重要组成部分[15]。在当时，这一基于区域尺度的桑基鱼塘系统在河流周围创造出新的水体环境，使洪水得以在这些池塘中储存并沉淀，由此产生更多的疏浚淤泥用以加高作为防护墙的堤坝（图5）。

4.1.2 日本静冈县叠石式山葵栽培

如今，联合国也已将传统的山葵栽培认定为GIAHS。日本静冈县山区河谷内的河床上盛产一种本地植物——山葵（*Eutrema japonicum*），其根茎可研磨成芥末酱。从17世纪开始，日本农民就通过模仿山葵生长的自然溪流栖息地环境对其进行培育，这是一种由三层梯田构成的“叠石”式栽培结构，一层为大块岩石，一层为较小的卵石，还有一层为用来种植山葵的土壤（图6）。他们还利用管道将溪水导入梯田，并将其引至两个方向：沿农田表面流动的溪水为山葵植株提供营养和氧气；向下流动的溪水则回归山涧，用于淡水养殖和农业种植[16]（图7，8）。这些山葵田本身自成多种多样的生态系统，昆虫、鸟类、两栖动物和爬行动物数量众多，形成了山涧食物链的基础。得天独厚的条件使栽培山葵的茎干比野生的更加粗壮，味道也更为浓郁[17]。

“叠石”式的栽培结构也预留出更多的地表来供水流动和渗透，从而减缓了水的坡面流速。这一过程既减少了水土流失，也减轻了下游的洪水危害（图9）。通过将当地的强降雨引入田间，“叠石”式山葵栽培技术创造了一种能够适应气候变化的韧性之策[18]。

4.2 适应式案例

4.2.1 中国洞庭湖上的人工浮岛

在中国长江以南的湿地和水道中，农用的人工浮岛在唐宋时期曾盛极一时[19][20]。这些农业岛屿多是以竹子为构架的大型竹筏，在底部铺上菰（*Zizania latifolia*），并覆土其上，插上帆布即可漂移[19][20]。纵观全球，虽然基于自然而开发的技术经历了不断的改良，但随着海平面上升和人口增长，诸如此类的创新技术仍然面临着消失的风险。为了探索与洪水共生之道，岛屿构建等适应性策略不失为一种符合IPCC所提倡的“适应式响应”的应对措施——数百年来，许多社区在传统农业发展进程中也已践行这一策略[21]。例如，孟加拉国的漂浮农田即经受住了土地匮乏、严重水灾乃至季风的重重考验。

4.2.2 孟加拉国的水上菜园——拜拉

在孟加拉国这个拥有1.6亿人口的国家，有超过三分之二的国土常常受到洪水侵袭②[22]。为了克服这一问题，当地居民开发了另一种Lo—TEK——水上菜园系统，这一系统既抵御了日常的洪水泛滥，也持续控制着一种有毒杂草的蔓延。这些水上菜园被称为“拜拉”（baira），三个多世纪以来一直被用于种植苗木和蔬菜。作为GIAHS之一，这些菜园展现了在缺乏长久干燥土地的贫穷社区中施行可持续本地资源管理的潜能和社会经济韧性。

尽管水上菜园的大小、形状、材料，以及作物品种存在地区差异，但几乎所有地区都会栽种水葫芦（图10）。水葫芦（*Eichhornia crassipes*），多生长于温暖、流速缓慢的淡水中，会形成厚厚的、有浮力的“垫子”③。水上菜园巧妙地利用了水葫芦叶柄通气组织中的大气泡（图11）。每个菜园均由一层层被紧紧压实的水葫芦，以及塞有植物种子的豆荚状的“茧”（guti）构成。水葫芦很容易从水中吸收养分，并将其分解为天然堆肥，因此不需要再施用化肥。同时，岛屿的水生环境也意味着这些菜园既无需灌溉，也不易受到害虫或其他入侵性杂草的破坏。冬季，当洪水消退，这些岛屿又可被拉到岸边，变成一种名为“坎迪”（kandi）的富含营养的永久性栽培床[23]（图12）。

5 文化和气候韧性

纵观全球的GIAHS和Lo—TEK，其中有众多能够与环境共生的以自然为基础的系统。它们发挥着多重功能，除了进行粮食生产，还可作为韧性基础设施——在海平面上升和气候变化的影响下，甚至能比工业化农业“存活”更久，因为它们是以生态为导向的，而非能源、化学或资本密集型农业[24]。稻鱼共生系统等技术已经体现出人们在建筑技术、气候、土壤质量、降水水平和季节性周期等方面对当地文化及促生这些技术的潮间带生态系统的理解。本土技术的应用改进了潮间带的构成材料，巩固而非削弱了生态系统服务功能。

在寻求应对气候变化的适应性技术设计方法时，应当关注那些已被证明行之有效的系统，正如尤金·胡恩博士所说，“要在严密的生存实验室中经受住考验”[25]。LAF


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1 Imminent Risks to Resilience

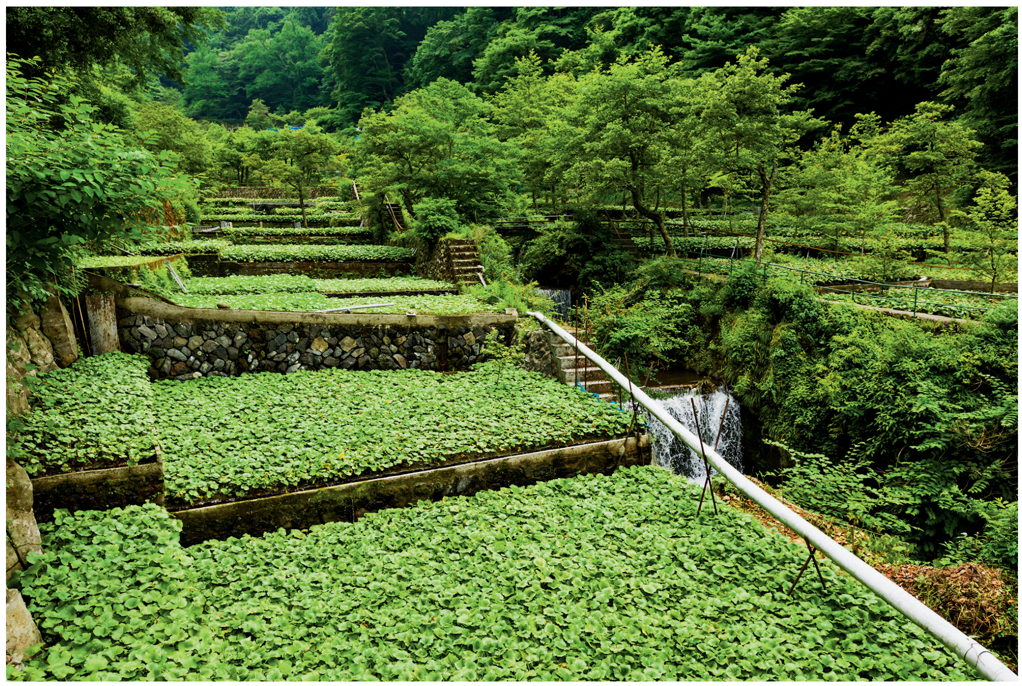
In January 2020, flooding in Jakarta, the capital of Indonesia, displaced almost half a million residents[1]. Vulnerable to coastal and river flooding, sea level rise, and exacerbated by accelerated subsidence, this city with a population of 10 million , located on the northwest coast of Java, has called upon the world for high-tech water management solutions[2][3]. In 2014, Jakarta collaborated with the Dutch government to apply their dyke concept to the coastline. This forty-billion-dollar proposal for multiple seawalls and artificial islands has set a completion date close to 2050, when an estimated ninety-five percent of Jakarta will be underwater[4]. Many mainstream solutions to sea level rise favor single-purpose, high-tech, and hard protection strategies designed by and for affluent communities, that will likely worsen vulnerability over time while failing to address the underlying causes, such as groundwater depletion and the displacement of defensive ecosystems[5]. These costly fortification measures are proving less resilient in the long term than the coastal environments they replace.

After the 2020 floods, over 10,000 hectares of crops failed in West Java, impacting millions of farmers, and the populations who rely on their production[6]. As urban populations have exploded, traditional agricultural landscapes have been industrialized, leading to deforestation, pollution, and an overall loss of both biodiversity and ecosystem services[7]. Rethinking the separation between the networks of the city and the landscapes of the rural, toward a relationship of reciprocity within a watershed, will be vital to human survival.

Cities can leap-frog the typical Western model of displacing indigenous diversity for homogenous high-tech. Instead, catalyzing localized agricultural heritage landscapes like those designated as Globally Important Agricultural Heritage Systems (GIAHS), as scalable, productive, and resilient climate change solutions and technologies. In Asia, the United Nations has designated 34 GIAHS. These sites are indigenous, living systems that serve as precedents for designers charged with constructing productive, symbiotic landscapes embedded within intact ecosystems[8]. Whereas urban development results in the erasure of history, identity, culture, and nature, this article explores how urbanization can be an agent for the migration and reapplication of agricultural heritage systems, rather than their greatest threat. This article suggests that by hybridizing Lo–TEK, i.e. traditional ecological knowledge-based infrastructures, with high-tech systems, GIAHS could offer designers a toolkit towards economically, ecologically, culturally, and technologically innovative systems that can improve productivity and resilience. To see these systems beyond relics requires a shift in the thinking about traditional agriculture and about the relationship to Nature, from superior to symbiotic.

6. 山葵幼苗被栽植于大约15cm深的土壤中。分流的溪水沿着梯台一层一层向下流动，直到回归山涧。
7. 静冈县山区河谷底部通过“叠石”的方式培植了大量的山葵。为给山葵提供庇荫并固土，日本桤木（*Alnus japonica*）经常被种植在这些梯田旁侧。

6. The wasabi seedlings are planted in a layer of fine soil approximately 15 centimeters deep. Diverted stream water flows from one terrace to the next, before returning back to the stream.
7. "Tatamiishi" wasabi farms occupy the valley floors of mountainous Shizuoka Prefecture. East Asian Alder, *Alnus japonica*, is frequently planted in the fields to provide shade to the wasabi plants and stabilize the ground.



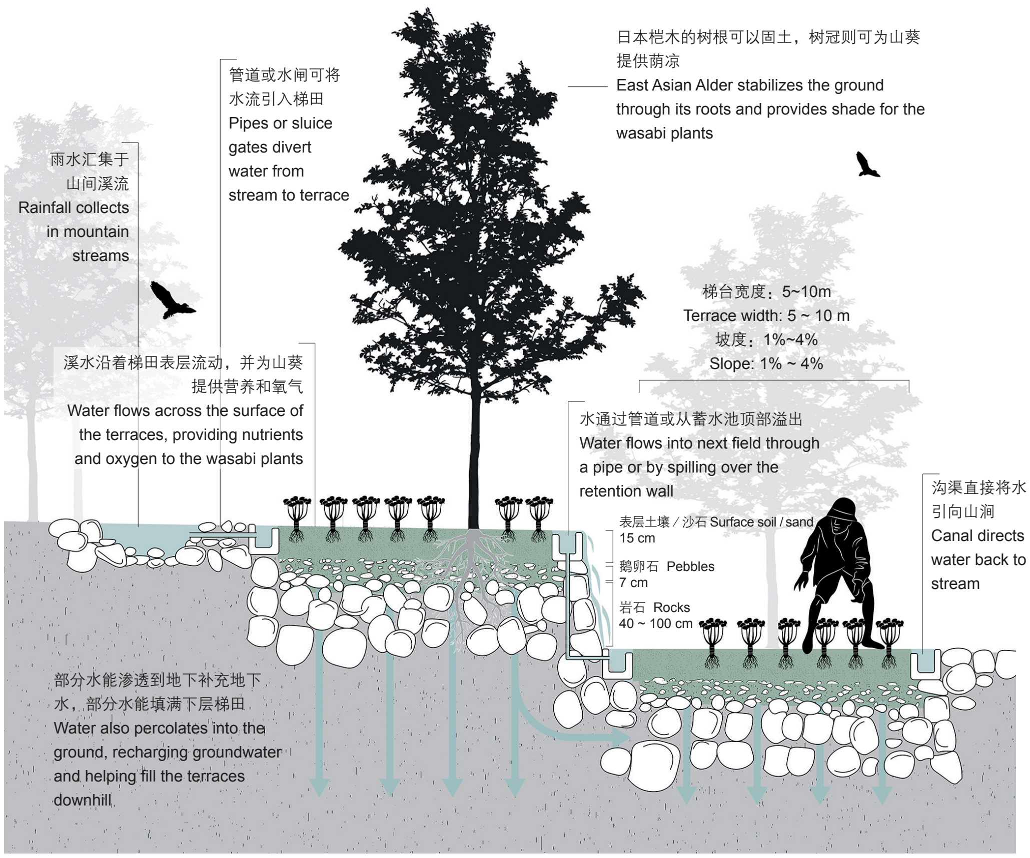
7 © FAO, Shizuoka WASABI Association for Important Agricultural Heritage System Promotion

2 Sawah Tambak of the Javanese

An alternative adaptation strategy for intertidal lands in Jakarta can be discovered nearby, heading east along the coastline of Java. Where the coastal lowlands continually flood, a uniquely Javanese aquaculture technology called the "sawah tambak" has evolved (Fig. 1). With a form similar to the Dutch polder-dyke, including a berm, a canal, and a pond, the "sawah tambak" performs remarkably differently. Rather than building coastal berms and drying up intertidal ecosystems in the transformation to arable land, the "sawah tambak" is built with existing local resources, forming berms out of soil excavated from a peripheral canal, to maintain an aquatic environment for farming (Fig. 2). The system initially evolved by converting silt-laden, brackish water fishponds into rain-fed rice fields, accommodating existing local livelihoods and infrastructures that responded to water-level changes. In the 1980s, this system was practiced on 16,500 hectares of land, yielding 35,000 tonnes of fish annually, supporting 15,000 households[9]. The "sawah tambak" system has expanded over the years to other areas of East Java, now inhabiting the basins of the Brantas and Solo Rivers[10]. Both preventative and productive, the system mitigates deluge or drought, while maintaining a thriving habitat for many species and a continuous food supply for a community.

3 Lo–TEK

This indigenous infrastructure is Lo–TEK. Adapted from the word "low-tech" but incorporating the acronym "TEK," which stands for Traditional Ecological Knowledge, Lo–TEK refers to nature-based technologies that harness the energy and biodiversity of the complex ecosystems they inhabit. Forming the foundation of indigenous technologies, TEK is a field of study in Anthropology that is defined by ecologist Fikret Berkes as a cumulative body of knowledge, practice, and belief, handed down through generations by traditional songs, origin stories, and everyday life[11]. Lo–TEK is located at the intersection of design and radical indigenism which is critical to communities most vulnerable to climate change, who lack the capital and resources for costly, high-tech infrastructures. The dilemma is that people living in developing nations are sold the belief—a mythology of technology—that imported solutions are superior to local innovations, even though the latter embody the intelligence of the environments and cultures that evolved them.



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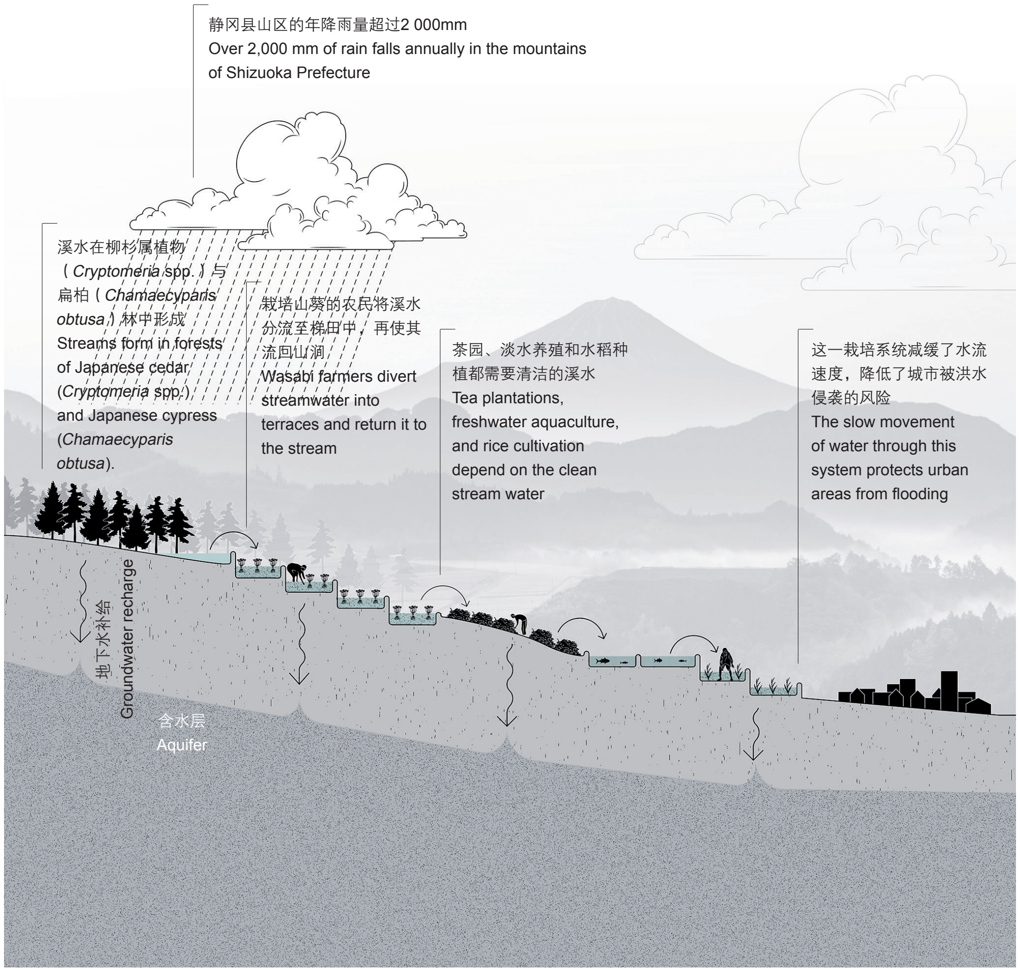
8. "叠石"式栽培法通过建造一系列梯田来分流溪水。水沿梯田表面流动时，有些会渗入地下，有些则会流向下层梯田。

8. "Tatamiishi" farming diverts stream water through a series of constructed terraces. Water moves horizontally across the surface of the terraces and downwards into ground and the terraces below.



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9. “叠石”式栽培法会为下游带来诸多好处，包括降低城市的洪水干扰、减少水土流失和维持溪流水质，以为茶叶种植和淡水养殖等其他产业提供良好的基础条件。

9. "Tatamiishi" farming benefits areas downstream: it protects urban areas from flooding and erosion, and keeps streamwater clean so that other industries such as tea cultivation and freshwater farming can use it.

① The "Zong Pu Heng Tang system" is an ancient irrigation and drainage project in the Huzhou Mulberry-Dyke and Fish-Pond System. The system integrates "Zong Pu"—also known as "Lou" or "Gang"—which are narrow rivers in the longitudinal direction from south to north, with "Heng Tang," which are wide rivers in the latitudinal direction from west to east.

4 Advance or Accommodate

While the use of TEK in empirical science is not new, applying TEK to a scientific framework is[12]. Categorizing the following indigenous innovations in accordance with the IPCC's 2019 Special Report on the Ocean and Cryosphere in a Changing Climate[13] definition of advancing or accommodating responses—accommodating being letting water in, while advancing is extending new land into the water—furthers our contemporary resilient design approaches to include TEK. Adaptive resilience can be achieved by building biodiversity and amplifying ecosystem services to increase performance—a strategy implicit in many indigenous technologies.

4.1 Advance

4.1.1 Mulberry-Dyke and Fish-Pond System, China

A GIAHS site that constitutes an advance response is the 2,500-year-old Mulberry-Dyke and Fish-Pond System of the Pearl River Delta and Taihu Basin, China. In this system, mulberry trees are grown on dykes called "tangji," that form the banks of the fishponds (Fig. 3). Mulberry trees provide leaves for silkworms to eat; silkworm feces and sloughs then fall into the adjacent pond providing feed for fish. The fish feces, along with the unconsumed silkworm and mulberry waste, are then decomposed by aquatic microorganisms which produce nitrogen, phosphorus, and potassium, finally returning to the mulberry tree as the mud is dredged from the bottom of the pools and applied to the banks as nutrient-rich manure—beginning the cycle over again[14] (Fig. 4). This system replaces the need for chemical fertilizers, pesticides, and herbicides, cutting costs and creating a zero-emission system[15]. The fish ponds are part of a larger scale system to store water, regulate floods, and mitigate drought, known as the "Zong Pu Heng Tang system"①[15]. In the past, this regional-scale system created new water bodies around existing rivers to allow for flood water storage in the ponds as well as increased sedimentation, ② Data source: The World Bank.

10. 单个菜园长度可达45.72m，但彼此之间的距离很窄。这样的空间布局能够方便农民乘船操作。

11. 建造“拜拉”时，农民将水葫芦从水中拉出、分层、压实（用脚），并常常使用竹竿来提供结构支撑，帮助加固水上菜园。

10. The farms can be up to 150 feet long but are narrow with space between them. This allows for farmers to easily access them by boat.

11. In constructing a "baira," water hyacinth is pulled from the water, layered, and compressed by farmers by foot. Often bamboo is used for additional support and reinforcement.

which provides more mud that can be dredged to build the dykes up as protective walls (Fig. 5).

4.1.2 Tatamiishi Wasabi Cultivation in Shizouka, Japan

Today, the United Nations also recognizes traditional wasabi farming as a GIAHS. Wasabi is made from the grated rhizome of *Eutrema japonicum*, a plant indigenous to the stream beds of river valleys in the mountains of Shizuoka Prefecture in Japan. Japanese farmers began cultivating the wasabi plant in the 17th century by mimicking its natural stream habitat. This “tatamiishi” style of wasabi farming uses terraces consisting of three layers: a base of large rocks, a finer layer of pebbles, and a layer of soil in which the plants are grown (Fig. 6). Pipes divert stream water into terraces where it moves in two directions: across the surface of the field, providing nutrients and oxygen to the wasabi plants, as well as downwards, returning to the mountain streams where it is used for freshwater aquaculture and farming[16] (Fig. 7, 8). The wasabi fields constitute diverse ecosystems in themselves, with high populations of insects, birds, amphibians, and reptiles, which form the foundation of the food chain in the mountain stream areas. The creation of these ideal conditions produces farmed wasabi that has larger, stronger stems, and a more pungent taste than its wild relative[17].

“Tatamiishi” cultivation slows down the rate of water flowing downhill by giving it more surface area to flow and percolate through. This process reduces soil erosion and prevents flooding downstream (Fig. 9). By channeling Shizuoka’s high rainfall into fields, “tatamiishi” wasabi farming constitutes an accommodating strategy to climate resilience[18].

4.2 Accommodate

4.2.1 Artificial Floating Islands on Dongting Lake, China

In the wetlands and waterways south of the Yangtze River in China, artificial floating islands used for agriculture were once popular during the Tang (618 - 907) and Song (960 - 1127) Dynasties[19][20]. These agricultural islands were large rafts built of bamboo frames and gausun grass (*Zizania latifolia*) which were covered with earth, and topped with sails for mobility[19][20]. Across the globe, nature-based technologies have been displaced by development and as seas rise and populations grow, similar innovations still in existence are at risk of being erased. To accommodate flooding, adaptation measures that align to the IPCC definition of accommodation such as islanding are a way forward, a strategy that has been practiced by traditional agriculture in many communities for hundreds of years[21]. In Bangladesh, we see an example of floating agriculture that has overcome environmental extremes including limited land and severe flooding, especially during the monsoon.

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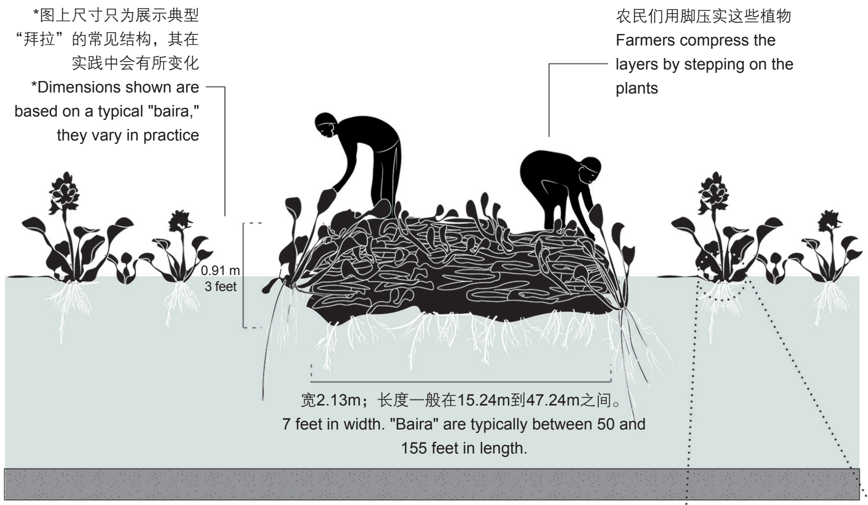
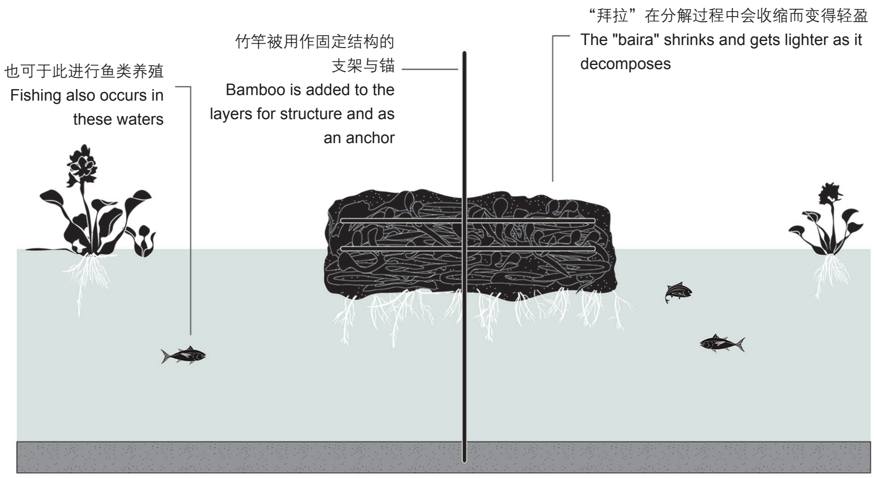
4.2.2 Baira Floating Vegetable Gardens in Bangladesh

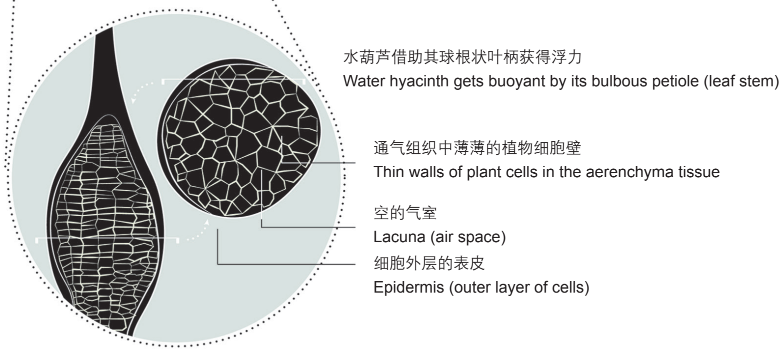
In Bangladesh, a country of 160 million people, more than two-thirds of the country is regularly flooded for months②[22]. To overcome this, a Lo–TEK hydroponic agriculture system of floating gardens has been developed that survives daily deluge while also sustainably controlling a noxious weed. These floating gardens are known as “baira” and have been used to grow seedlings and vegetables for over three centuries. The islands are one of the GIAHS sites, displaying sustainable local

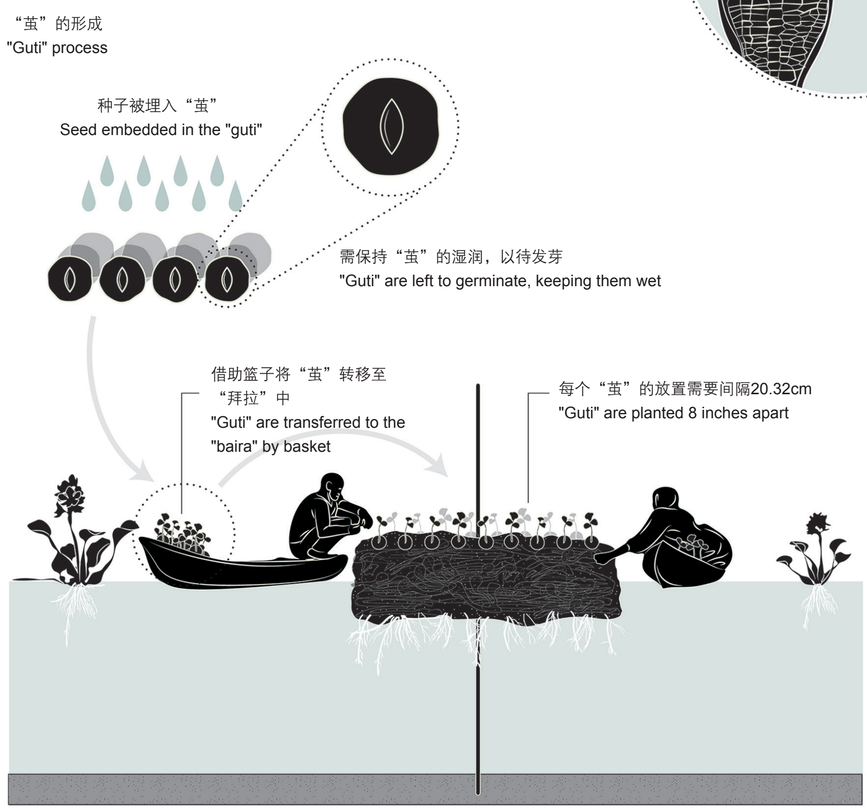


1. 农民从侧面拉起水葫芦，并将其在“拜拉”上铺展开。“拜拉”的顶层往往由天然的水葫芦构成，以为“拜拉”提供浮力，其他下层则可进行低密度堆肥。
1. Water hyacinth are piled onto the "baira," pulling them in from the sides. The first layer of the "baira" is a naturally matted mass of water hyacinth. The lower layers support buoyancy while the additional layers are low density compost.

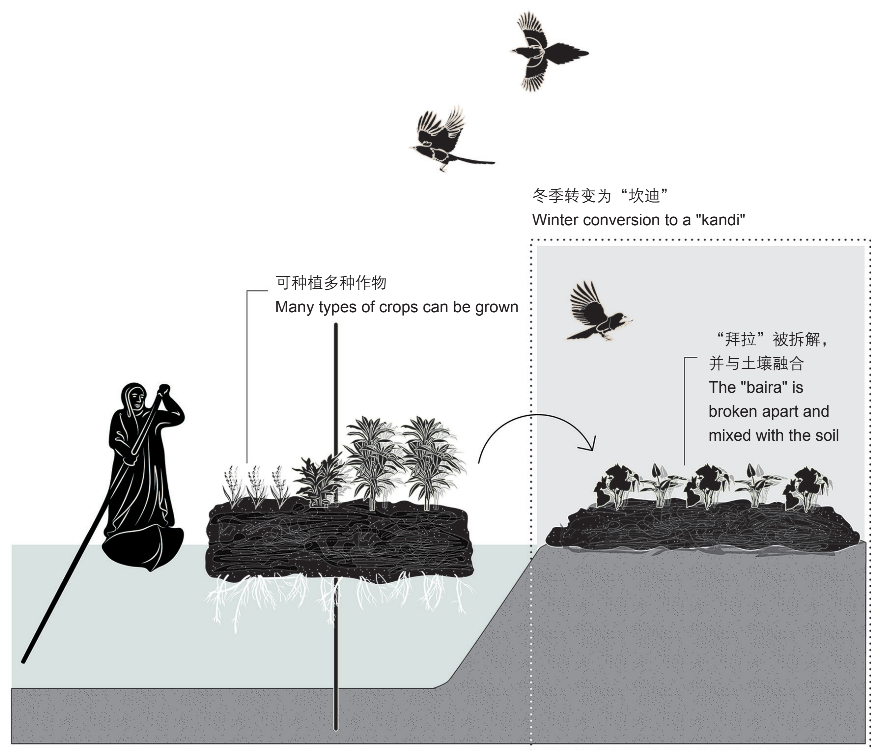


2. 利用一根竹竿进行垂直固定后，“拜拉”会在数周内被分解。在“拜拉”结构层内部，也会借助竹竿固形。
2. The "baira" is left to decompose for weeks, with a bamboo stick placed vertically to anchor it. In construction, bamboo is also placed in the layers of the water hyacinth for structure and to define the shape.





3. “茧”是由水葫芦和其他水生植物分解物制成的。“茧”中会被埋进种子，等到发芽便会被整体植入“拜拉”中。
3. The "guti" are made from decomposing water hyacinth and other aquatic plants. They are embedded with seeds and left to germinate until they sprout. "Guti" are then planted into the "baira."



4. 夏季蔬菜被种植在“拜拉”上直到收割。冬天，“拜拉”则被移至附近较高点，并被拆解，接着便可于此种植冬季蔬菜。
4. The summer vegetables are cultivated on the "baira" and then harvested. In the winter, the "baira" are planted on higher ground nearby, broken down, and then winter vegetables are cultivated on it.

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③ The data of *Eichhornia crassipes* is from Great Lakes Aquatic Nonindigenous Species Information Center.

12. 在水上菜园上种植农作物之前，种子需要预先在“茧”中发芽。等到冬天，这些水上菜园又可被拉到岸边，转变为一种名为“坎迪”的栽培床。

12. Prior to planting crops on the island, seeds are germinated in a "guti." In the winter these islands are pulled ashore and used as planting beds called "kandi."

resource management and socio-economic resiliency for poorer communities which lack access to continuously dry land.

The size, shape, materials, and crops planted on the "bairas" vary from region to region, but all use the water hyacinth (Fig. 10). Water hyacinth (*Eichhornia crassipes*) is found in warm, slow-flowing freshwater, where it naturally grows into thick and buoyant mats③. The island makes use of the plant's large air pockets in the aerenchyma tissue of the leaf stalk that allow it to float (Fig. 11). An island is formed by compressed layers of water hyacinth that decompose and are planted with a pod-like "guti," which contain the seeds. Water hyacinth is able to absorb nutrients from the water easily and in decomposing they act as a natural compost, so fertilizer is not required. The island's aquatic environment also means the gardens do not require irrigation, and are not vulnerable to vermin or invasive weeds. In the winter as the floodwaters subside, these islands are pulled to the shore and transform into "kandis": permanent nutrient-rich raised cultivation beds[23] (Fig. 12).

5 Cultural and Climate Resilience

Looking to GIAHS sites and Lo–TEK, we find nature-based systems that symbiotically work with the environment. These nature-based systems act multidimensionally, not only for the purpose of food production, but as resilient infrastructures that may survive industrial agriculture as the seas rise and the climate changes. They are ecologically-intensive, rather than energy-, chemical-, or capital-intensive[24]. Technologies, such as the "sawah tambak" already embody the construction techniques, climate, soil quality, precipitation levels, and seasonal understandings of the local culture and the intertidal ecosystem that evolved them. They expand intertidal materials and amplify ecosystem services rather than erasing them.

As we look for ways to design resilient technologies in the face of climate change, we must look to systems that already are proven to work, as Dr. Eugene Hunn puts it, "tested in the rigorous laboratory of survival."[25] LAF

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