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ĐỔI MỚI DIY: TACTICAL RURALISM AND TANGIBLE MODELING IN THE MEKONG DELTA

Phillip Fernberg
pfernb1@lsu.edu

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A Thesis

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ABSTRACT

In recent years, the integrity of the Mekong Delta has been put at risk by a combination of environmental and institutional factors. Understanding that the degradation of the Delta would have far-reaching socioeconomic implications for both Vietnam and the Indochinese Peninsula, The World Bank has responded to the situation by implementing initiatives for climate-smart planning tools and improved water management practices throughout the lower Mekong basin. Seeing the potential for tangible modeling as a participatory planning tool, the Bank has hired a team of consultants from Louisiana State University to introduce a methodology called Tangible Landscape to its climate resilience toolkit. This thesis aims to contribute to the consultancy by using literature review, interpretive case studies in a design approach called *tactical ruralism*, and geospatial analysis to inform the design and fabrication of a conceptual Tangible Landscape model for the Mekong Delta. The author identifies the environmental problems facing the delta, compiles an array of relevant design solutions that can be used to address those problems at the site scale, and creates a series of mappings that identify suitable sites to apply those solutions. He also develops a conceptual transect of rural livelihoods of the Mekong Delta which can be used to inform a forthcoming Tangible Landscape workshop to be held in Viet Nam as part of the World Bank Consultancy. Providing solutions at every scale and level of governance is of particular importance to this project, especially those considered to be "grassroots" or "bottom-up" interventions implemented by individual households, communes, wards, and districts.

INTRODUCTION

Over the past century, the integrity of the Mekong Delta has been put at risk by a combination of environmental and institutional factors. The Mekong is an integral region for Vietnam. It is the main contributor to the socio-economic development and prosperity of the country and greater southeast Asia. Accelerated sea level rise, disruptive land use regimes, and the construction of dams in the upper reaches of the basin, among other things, have put this prosperity at risk. Understanding that the degradation of the Delta would have far-reaching socioeconomic implications for both Vietnam and the Indochinese Peninsula, The World Bank has responded to the situation by implementing initiatives for climate-smart planning tools and improved water management practices throughout the lower Mekong basin. In its Strategic Country Diagnostic (SCD) for Vietnam, the Bank included amongst its priorities steps to modernize agriculture and use of natural assets, to enhance climate change resilience, and to strengthen institutional foundations.[1] It is thus supporting the region through an initiative called the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project, which seeks "to enhance tools for climate-smart planning and improve climate resilience of land and water management practices in selected provinces of the Mekong delta in Vietnam."[2] A sizable number of reports, consultancies, non-profit initiatives, and government interventions have been delivered in response, proposing vast feats of coastal engineering, new commissions for implementation, and regional scale adaptation measures for infrastructure. While their models are rigorous and their plans encompassing, nearly every entity has expressed the need for strategies at the most local levels of governance (i.e. district, ward, commune, household). As the Bank searches for more grassroots or bottom-up solutions to add to the resilience toolkit, they have taken interest in a methodology called "Tangible Landscape".

Tangible Landscape is a new approach to modeling that involves sculpting a landscape (e.g. a watershed or delta) with your hands and tools while a computer model scans the resulting manipulation and superimposes results (e.g. water inundation, flows, water quality) visually back on the physical model.[3] The World Bank has hired Louisiana State University Professor Brendan Harmon, one of the architects of the method, and a team of consultants to develop an application of Tangible Landscape for the Mekong Delta to illustrate key issues and scenarios through a series of participatory workshops. This thesis aims to contribute to the consultancy by answering two questions: What are the most pressing issues affecting Mekong Delta livelihoods? And what role does Tangible Landscape play in addressing those issues? Using literature review, interpretive case studies in a design approach called *tactical ruralism*, and geospatial analysis, I will identify the environmental problems facing the delta, compile an array of relevant design solutions that can be used to address such problems at the site scale, build a conceptual Tangible Landscape model to implement the solutions, and create a series of mappings that identify suitable sites to apply those solutions. I will also develop a conceptual transect of rural livelihoods of the Mekong Delta which can be used to inform a forthcoming Tangible Landscape workshop to be held in Viet Nam as part of the World Bank Consultancy.

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[1] Nagaraja Rao, Harshadeep and Acharya, Anjali, "Terms of Reference for Consultancy Service: Bringing Disruptive Technology to the Mekong Delta: Tangible Landscape."
[2] The World Bank, "Projects: Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project."
[3] Nagaraja Rao, Harshadeep and Acharya, Anjali, "Terms of Reference for Consultancy Service: Bringing Disruptive Technology to the Mekong Delta: Tangible Landscape."

CHAPTER 1. Becoming the *Mother of Waters*: Contextualizing the Mekong Delta

To propose any truly meaningful climate resilience strategies for the Mekong Delta Region (MDR) requires first an understanding of the greater context in which it fits geographically, economically, culturally, and especially ecologically. Any environmental problem experienced in the MDR, whether it be flooding, erosion, or water contamination, is likely correlated with activities in the upper reaches of the watershed—the uncoordinated construction and operation of dams, deforestation from illegal logging, or high polluting agricultural and manufacturing industries, to name a few examples[4]—and should therefore be considered in rather than divorced from the discussion around climate change adaptation. The ensuing section seeks to shine light on this relationship through the lens of landscape morphology, vernacular (in both the linguistic and aesthetic sense), and socioecological history.

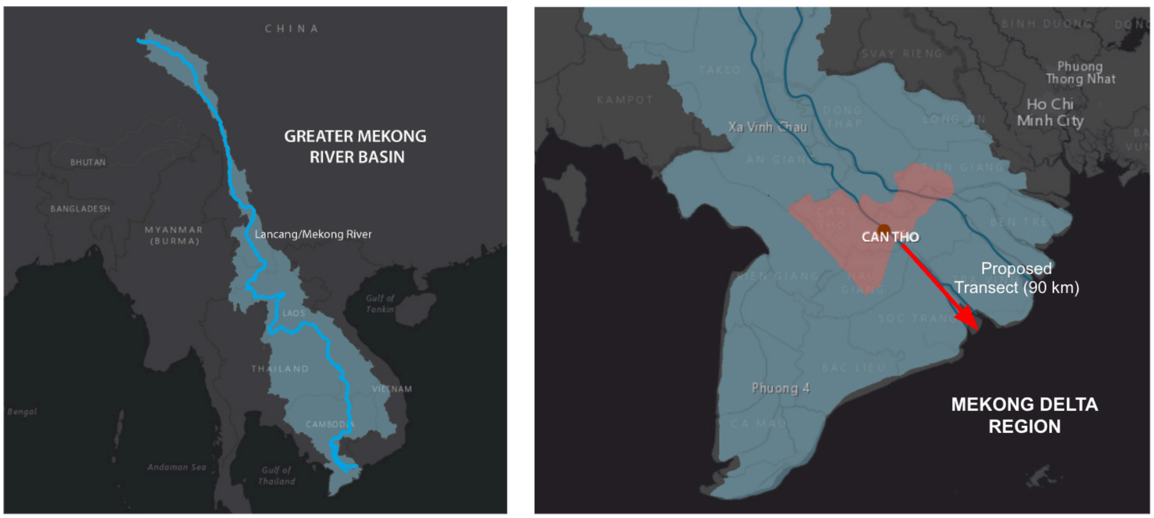

Figure 1. Greater Mekong River Basin (left) and proposed project area in the Mekong Delta Region (right*)*

Project Context

The Mekong River is the twelfth longest in the world and seventh longest in Asia. Starting in China's Yunnan Province and ending in southern Vietnam, its watershed transcends the boundaries of six countries (see Figure 1) worldwide and receives ">50% of the fluvial freshwater and >60% of the associated sediment entering the ocean."[5] The general project site for the World Bank consultancy lies in the Mekong Delta Region of Vietnam, an area comprising 15,666 sq. mi, 12 provinces, and a population of 17.5 million people. For the sake of a more focused scope, the team has chosen to hone in on a 90 km stretch of the Song Hau river between the provincial city of Can Tho and the coast, from which we will use remote sensing to draw general observations about the area and implement them in the development of an abstract Tangible Landscape model to be utilized in a forthcoming workshop. A more detailed breakdown of this process is discussed in Chapter 4.

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[4] Anthony et al., "Linking Rapid Erosion of the Mekong River Delta to Human Activities."

[5] Allison Mead A. et al., "Sedimentation and Survival of the Mekong Delta: A Case Study of Decreased Sediment Supply and Accelerating Rates of Relative Sea Level Rise."

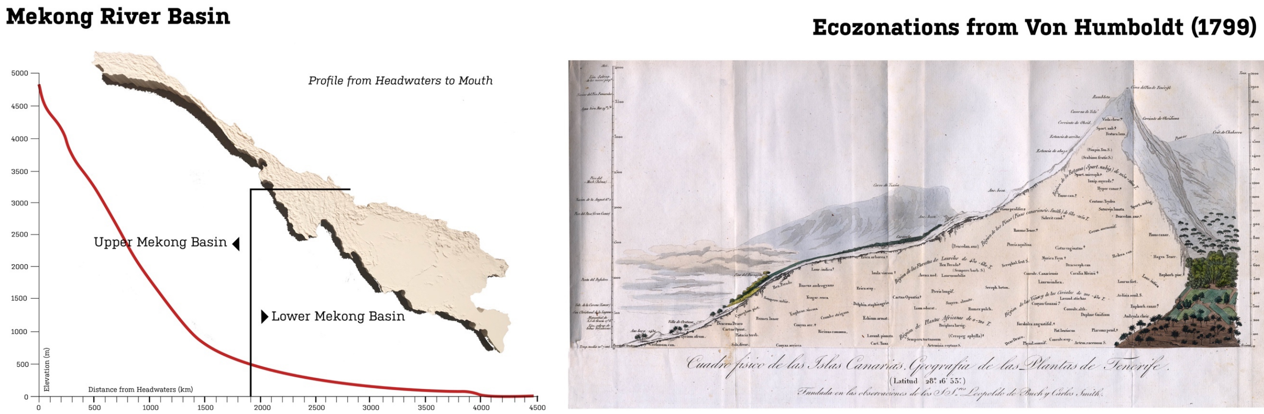

Figure 2. Elevation profile of Mekong River Basin compared with Alexander Von Humboldt's Cuadro físico de las Islas Canarias. Geografía de las Plantas de Tenerife (1799-1804)

Basin Morphology

At about the same time the Kronosaurus ruled the sea, T. Rex walked the earth, and the Cliffs of Dover were getting their white, the fragmented Gondwanaland collided with Eurasia. Their union sparked a succession of rapid topographic uplift that would eventually give birth to what is now known as the Tibetan Plateau, and in turn, the source of the mighty Mekong. From its headwaters that navigate the tilting tertiary deformations of the Three Rivers drainage basins, through the bedrock-confined stretches in Thailand, Laos, and northern Cambodia--where the river's direction is tectonically controlled with certain rapids and local detail under lithological influence--over the rhyolites, tuffs, and sandstones of the Dangrek escarpment into the Quaternary floodplain of southern Cambodia and Vietnam and finally discharging in the offshore Vung Tau graben[6] the Mekong's succession sculpts a geomorphological system that is varied and complex; and with complex geomorphology comes a diverse transect of ecological communities (see *Figure 2*).

The anglicized designation of Mekong derives from a hybrid of the Thai and Lao *Mae Nam Khong*. *mae nam* meaning "mother of water[s]", and *Khong* being the proper name.[7] Given the biological richness the river supports, describing the Mekong as a lifegiving mother seems only fitting. Her nurturing basin catches over 25% of the global freshwater supply and fosters a species diversity that is second only to the Amazon.[8] Landscape theorists find this to be no surprise, given the morphological variety in the region.

In his review of theories of biodiversity, Huston describes the contribution of spatial heterogeneity to diversity of species, stating, "heterogeneity on large scales is contributed by geologic processes that influence the amounts and types of minerals found in bedrock and thus in the soil derived from it…" These processes coupled with climate also shape patterns of topography driven by erosion, and "topography influences the distribution of water, soil nutrients, solar energy, and other factors across a landscape."[9] Nichols and Killingbeck confirm this notion, and posit that such a confirmation makes it appropriate to assume "the conservation

[6] Carling, "The Geology of the Lower Mekong River."

[7] "Mekong River and the Struggle for Indochina: Water, War and Peace."

[8] Ziv et al., "Trading-off Fish Biodiversity, Food Security, and Hydropower in the Mekong River Basin."

[9] Huston, *Biological Diversity: The Coexistence of Species on Changing Landscape*. 40.

of geomorphological heterogeneity would enhance the long-term preservation of biodiversity because it is not subject to the vagaries of the transitory nature of contemporary plant communities."[10]

Delta Morphology

The Mekong Delta is one of the largest deltas in the world. Gupta et al. among others have observed that "the Mekong demonstrates predominantly downstream transfer of sediment for most of its course (about 80%) and limited lateral fluxes for more than 4000 km."11 Sediment storage is normally channel-confined and irregular along most of the river's length. It is then "distributed overbank by flooding and channel shifting for the last several hundred kilometers."[12] Campbell describes the ecological transect created in the Delta by these fluxes:

> "The Mekong Delta includes three broad landforms…In the northern and central part of the delta is floodplain, which includes the area known as the 'Plain of Reeds'. This area was historically seasonally flooded by the waters of the Mekong and contained large areas of wetland forest and diverse grasslands. There is also a coastal system of sand ridges, mangroves and mud flats in the eastern and southern parts of the delta. Mangroves occurred primarily in the Ca Mau Peninsula and around the river mouths. Thirdly there is a low-lying area in the interior of the Ca Mau Peninsula which derives freshwater largely from rainfall, and which contains peat swamps as well as scattered spectacular limestone outcrops of the Kien Giang karsts."[13]

This physiological setting makes the Delta a very biologically rich environment. One that has supported human settlement for millennia.

The Importance of Food Systems

"To know what a people eats is to understand how its society works, why it goes to war or sues for peace. To understand how a group of people eat is to acknowledge how they both differ from and are similar to oneself."

-Vu Hong Lien, *Rice and Baguette: A History of Food in Vietnam*

When the proto-Viet Son Vì culture came to the Indochina Peninsula ca 21,000 BCE, they found an abundance of animals to hunt, stocked waterways to fish, and forests to scavenge. So much abundance that through time the potential for sedentary sustenance would transform the region's host of hunter-gatherers into an established society of agriculturalists. Archaeological evidence suggests that rice became a staple of Chinese and Vietnamese food culture very early on, with some cultivation sites in the south of the Yangtze River dating back to 8,000 BCE.[14] As people pushed further south into the plain, the Hòa Bình, Phùng Nguyên and Dông Son cultures made pottery, diversified their plant palette, and utilized Bronze Age implements for a more sophisticated wet rice cultivation, including the variety *Oryza sativa*. Though the arrival of

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[10] Nichols, Killingbeck, and August, "The Influence of Geomorphological Heterogeneity on Biodiversity: II. A Landscape Perspective."
[11] Gupta et al., "Evaluation of Part of the Mekong River Using Satellite Imagery."
[12] Gupta and Liew, "The Mekong from Satellite Imagery: A Quick Look at a Large River."
[13] Campbell, "Biodiversity of the Mekong Delta."
[14] Lien, *Rice and Baguette: A History of Food in Vietnam*.

the first Chinese ruler around the 2nd Century BCE and the subsequent Chinese Millennium heavily influenced the ingredients and preparation styles of food, it did not stop the development of a specifically Vietnamese cuisine in the 19th century. This was in part due to the introduction of the Nguyen Dynasty's Cham and Khmer foods just a century before, a union that with the help of Ming refugees would give birth to the food systems of the Mekong Delta.[15]

The French then brought their food; the 20th century brought wars and famine; and independence brought literal growing pains to smallholder farmers as they were pressured to focus more on centralized food collectives than their own yields—these pains would be relieved with economic reforms of the 1980s and 90s, which allowed for more economic independence opened up foreign investment.[16] Through it all, the Mekong Delta has become and remains the backbone of Vietnamese culinary culture. To this day agriculture is still more intense in the MDR than anywhere else in the basin. The Delta produces about 50% percent of Vietnam's annual food requirements in rice, fish, fruit and vegetables, and performs a vital role in feeding the country; but also, "because Vietnam is a rice exporter, the Delta is also an important source of foreign income."[17]

The Human Hand

In speaking of Mien Tay (which his observation applies generally to the Delta), Brocheux notes "the climate and the natural environment…do not present insurmountable obstacles to human settlement. On the contrary, they offer rich agricultural possibilities. The climate and the soil are suited to flooded rice culture. But settlement is only possible if the water is controlled."[18] It is important to note as Gupta and Liew do that "the delta's water delivery system differs from conventional irrigation systems in upland areas."[19] There are no centrally controlled pumps or large regulators. Irrigation, drainage, and local water transport systems share the same canals and waterways in the delta, most of which are hydraulically operated by tides from the South China Sea and the Gulf of Thailand. Farmers often use low-lift pumps to control water in and out of their fields according to crop needs. Water is pumped for irrigation during the dry season, when the water level in the canals is lower than the fields. In some places, it is pumped for drainage during the rainy season when the tidal drain is inadequate. Water availability alternates between surplus and shortage every six months in the Delta, a product of a tropical monsoon climate.[20]

Between July and December heavy rainfall and run-off cause waters to cover over 25 per cent of the area for extended periods as it spills out from rivers in the upstream part of the delta and has difficulty draining away nearer to the sea. Short periods of inundation provide the benefits of flushing acidic soils and depositing of sediments on floodplains, bringing nutrients to inland fisheries. During the first and last parts of the January– June dry season, the low level of discharges in the river is sufficient to meet water requirements for in-stream and off-stream uses. But during the end of March–April, sea-water intrusion can be severe and limits the availability

[15] Lien.
[16] Lien.
[17] Campbell, "Biodiversity of the Mekong Delta."
[18] Brocheux, "Mekong Delta: Ecology, Economy & Revolution, 1860-1960."
[19] Gupta and Liew, "The Mekong from Satellite Imagery: A Quick Look at a Large River."
[20] Gupta and Liew.

of freshwater for irrigation.[21] In order to make up for this, farmers downstream have turned to more robust irrigation techniques while farmers upstream have sought to clear more land for industrial agriculture or other extractive industries; activities that, especially during the latter half of the 20th century, have caused major disruptions to the ecosystem.

[21] Gupta and Liew.

CHAPTER 2. Degraded Delta: Ecologies and Livelihoods at Risk

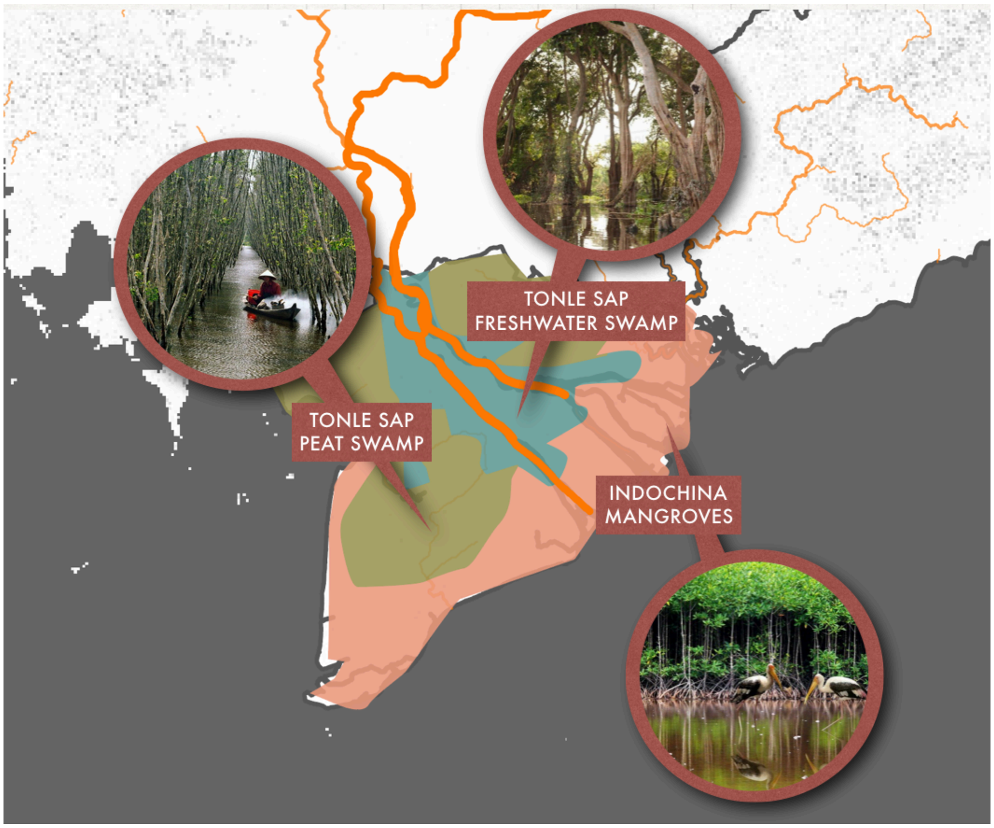

Figure 3. Terrestrial ecoregions of the Mekong Delta

Ecologies at Risk

In 2001, the World Wildlife Fund (WWF) released a biogeographic regionalization of Earth's biodiversity. Entitled Terrestrial Ecoregions of the World (TEOW), the document maps out 867 distinctive ecoregions and classifies them according to biomes, with the goal of illustrating conservation issues around the world and proposing a logical framework for large-scale conservation strategies.[22] It remains a living document with consistent updates and is widely used by governments and decision makers for strategizing wildlife conservation efforts. Given the extent of WWF's involvement with the Vietnamese government and the World Bank, I have chosen to utilize the TEOW report as a baseline for characterizing the MDR—more specifically, I rely on the report in which WWF focuses on the Indo-Pacific. The Mekong Delta is comprised of three distinct ecologies: Tonle Sap Freshwater Swamp Forests, Tonle Sap-Mekong Peat Swamp Forests, and Indochina Mangrove Forests (see *Figure 3*). Each of these ecoregions has unique morphology, flora, and fauna, and a distinguishing set of threats to their wellbeing, all of which are described in the ensuing section.

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[22] David M. Olson et al., "Terrestrial Ecoregions of the World: A New Map of Life on Earth : A New Global Map of Terrestrial Ecoregions Provides an Innovative Tool for Conserving Biodiversity."

Tonle Sap Freshwater Swamp Forests

The seasonally inundated forests that surround southeast Asia's largest lake, the Tonle Sap. The Tonle Sap Freshwater Swamp Forests comprises a shrubland covering the majority of the area and a stunted swamp forest around the lake itself. Diverse soil moisture conditions and seasonal flood dynamics form the structure and composition of woody vegetation on the floodplain. Much of this ecoregion is flooded for at least a six-month period extending from August to January or February. The dominant woody species of the shrubland generally tend to form a nearly continuous canopy of deciduous species reaching no more than 4 m in height, depending on soil moisture conditions, with the tallest individuals occurring closer to the permanent lake basin and smaller individuals at the margins of the floodplain area. Among the more dominant flora of the shrublands are species of *Euphorbiaceae*, *Fabaceae*, and *Combretaceae*, together with *Barringtonia acutangula*. *Terminalia cambodiana* is an important local endemic.[23]

Flora

WWF notes there once was a band of stunted swamp forest, 7-15 m in height, dominating the dry-season shoreline of Tonle Sap, covering about 10 percent of the floodplain, and a similar community once occurred as a gallery forest along the seasonal floodplains of the Mekong, Bassac, and other major rivers in southern Cambodia and Vietnam. It is covered by water for six to eight months each year, at which time the majority of species lose their leaves. This community is broken into a mosaic of stands of large trees and open areas with floating aquatic herbs rather than forming a continuous forest. *Barringtonia acutangula* and *Diospyros cambodiana*, are the primary dominants of tree species.[24] The ecoregion also includes extensive areas of seasonally inundated grasslands growing in a mosaic of scattered individuals of *Barringtonia acutangula*. These savannas are commonly saturated for at least six months of the year. The Tonle Sap floodplain has been heavily affected by human activities, and this impact has accelerated over the past decade. Very little of the original forest cover remains in pristine condition today. WWF states that "although most of the ecoregion, including the lake, was declared a protected area recently, it was too little too late. The protected area is a paper park with no protection or management, and it was declared protected after most of the habitat had been cleared for agriculture."[25]

Fauna

Mammals of conservation significance include the endangered pileated gibbon (*Hylobates pileatus*), tiger (*Panthera tigris*), and several threatened species, including wild dog (*Cuon alpinus*), sun bear (*Ursus malayanus*), clouded leopard (*Pardofelis nebulosa*), common leopard (*Panthera pardus*), and banteng (*Bos javanicus*). There is one near-endemic bat species. Despite not being suitable for agriculture, areas that have been degraded to reed beds are still important sites for waterfowl, providing feeding grounds for the eastern

[23] Wikramanayake, Eric D. et al., "Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment."
[24] Wikramanayake, Eric D. et al.
[25] Wikramanayake, Eric D. et al.

sarus crane (*Grus antigone*), white-shouldered ibis (*P. davisoni*), and near-endemic giant ibis (*Pseudibis gigantea*).[26] [27]

Status and Threats

This ecoregion once consisted primarily of permanent and seasonal freshwater swamp forests, but much of the natural habitat has been cleared. Forest exploitation has reduced many areas of once permanent and seasonal freshwater swamp forests to scrub or secondary forest matted by invasive species, the natural regeneration of large species is very slow Most of the remaining stands are in northern Cambodia, around the Tonle Sap and Tonle rivers. WWF laments that "although most of the ecoregion, including the lake, was declared a protected area recently, it was too little too late." None of the protected areas have effective management or protection, making the area a "paper park with no protection or management," and one that was declared protected "after most of the habitat had been cleared for agriculture."[28] Furthermore, the vast floodplains of the Mekong River and Tonle Sap are extensively cultivated during the dry season for double cropped rice, and local fishing communities have greatly altered the swamp forests through overexploitation.[29]

Tonle Sap-Mekong Peat Swamp Forests

The Tonle Sap-Mekong Peat Swamp Forests ecoregion encompasses areas permanently inundated with shallow freshwater, with some mosaics of swamp forest and herbaceous wetland interposed with upland areas of dry forest. WWF authors emphasize, however, that "care must be given in separating permanently flooded swamp forests of southeast Asia from seasonal swamp forests that characterize extensive areas of the Tonle Sap Basin and the floodplain of major Cambodian rivers. Conditions of permanent flooding compared with flooding for 6-8 months produce differential selective factors and thus a distinctive floristic assemblage." Such an assemblage produces several unique characteristics of the floodplain habitats. Native palms, for example, are often a staple of typical swamp forests, but they are generally absent from the Tonle Sap floodplain with the exception of some local occurrences of rattans in gallery forests.[30]

Flora

The poorly drained, surface-reaching water tables of the Haut Chhlong and Blao regions of Vietnam support large areas of swamp forest. Their soils are saturated and rich in organic matter. Several formations of swamp forest have been described, with the most widespread occurring at an elevation of 600-900 m. This stand is characterized by a dominance of *Livistona cochinchinensis* (*Arecaceae*), a palm reaching up to 30 m in height. Many associated dicot canopy species have stilt roots or pneumatophores. These include species of *Eugenia* (*Myrtaceae*), *Elaeocarpus* (*Elaeocarpaceae*), and *Calophyllum* (*Guttiferae*). Extensive areas of grass and sedge wetlands are also included in the peat swamp

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[26] Synge, Hugh, *Annual Report 1991: IUCN The World Conservation Union.*
[27] Wikramanayake, Eric D. et al., "Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment."
[28] Wikramanayake, Eric D. et al.
[29] Wikramanayake, Eric D. et al.
[30] Wikramanayake, Eric D. et al.

ecoregion. *Phragmites karka*, *Saccharum arundinaceum*, and *Coix gigantea* generally dominate fertile alluvial clay sediments, while less fertile soils support diverse assemblage of *Poaceae* and *Cyperaceae* and other herbaceous species.[31]

The brackish and freshwater wetlands in Cambodia and the Mekong delta area of Vietnam are typically dominated by dense stands of *Melaleuca leucadendron*—they are often called the paperbark swamps or rear mangrove communities. According to WWF's assessment, "paperbark swamps are low in plant diversity but have a great significance in maintaining natural ecosystem function. These swamps reduce water flow in the wet season and thus minimize flooding, store fresh water, reduce soil acidification, promote biodiversity of many aquatic organisms, and provide a sustainable source of wood for construction and fuel."[32] Paperbark swamps once blanketed large areas of seasonally inundated acid sulfate soils in Mekong delta region. The largest remaining stands occur on peat soils in the U Minh area of Minh Hai Province and in the acidic soils of the Plain of Reeds and Ha Tien plain of Vietnam.[33]

Fauna

Mammal species of conservation significance include the possibly extinct wild water buffalo (*Bubalus arnee*), Eld's deer (*Cervus eldii siamensis*), Indochinese hog deer (*Axis procinus annamiticus*), and banteng (*Bos javanicus*). The reed beds are important sites for waterfowl, and the habitats provide feeding grounds for the eastern sarus crane (*Grus antigone*), the near-endemic giant ibis (*Pseudibis gigantea*), white-shouldered ibis (*P. davisoni*), glossy ibis (*Plegadis falcinellus*), black-headed ibis (*Threskiornis melanocephalus*), Asian openbill (*Anastomus oscitans*), and possibly the lesser adjutant (*Leptoptilos javanicus*).[34] [35]

Status and Threats

The Tonle Sap-Mekong Peat Swamp Forests of today represent only a fragment of their former range and function. More than 90 percent of the ecoregion has been converted to scrub or degraded forests. Intensive agriculture and alterations to regional hydrodynamics have disrupted the natural river fluctuations, adversely affecting the remaining vegetation.[36] Less than 10 percent of the original habitat is left. Like the Tonle Sap Freshwater Swamps, excessive forest exploitation has reduced many areas to scrub or secondary forest including invasive species. According to WWF, "very little (<1 percent) of the ecoregion is protected. Large areas of acid sulfate peat soils have been drained, cultivated, and subsequently abandoned, and these areas have become extensive reed beds."[37] Though the mangroves and Melaleuca forests of the Mekong delta were severely affected in the Vietnamese wars, they have partially recovered through replanting

[31] Wikramanayake, Eric D. et al.
[32] Wikramanayake, Eric D. et al.
[33] Wikramanayake, Eric D. et al.
[34] Synge, Hugh, *Annual Report 1991: IUCN The World Conservation Union*.
[35] Wikramanayake, Eric D. et al., "Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment."
[36] Wikramanayake, Eric D. et al.
[37] Wikramanayake, Eric D. et al.

programs.[38] [39] The area of the Mekong delta that lies in southern Vietnam has also been severely affected by deforestation in water catchments in Laos, Thailand, and southern China. The river is now prone to flood more frequently and violently in the wet season but to reach very low levels in the dry season, creating increasing problems for local agriculture.[40]

Indochina Mangrove Forests

This ecoregion is among the most diverse and extensive mangrove ecosystems in the world. Mangrove forests occur in coastal areas of regular flooding by tidal or brackish water and develop on saline gleysols. The largest area of remaining mangroves in Vietnam is around Camou Point at the southern tip of the country, with smaller areas in the Mekong delta region, in south central Vietnam around Cam Ranh Bay, and in northern Vietnam in the Red River delta area. The central coast of Vietnam is largely free of mangroves because of the exposed coastline, absence of major river deltas, and low tidal fluctuations in this area. The extent of mangroves in coastal Thailand, Cambodia, and Vietnam was once high, but much of this area has been destroyed. The largest block of Indochina Mangroves in the Mekong River delta suffered large-scale habitat loss from defoliants sprayed during the Vietnam War, but these areas are slowing recovering under active reforestation programs today.[41] [42]

Flora

Mangrove diversity in the Indochina Mangroves ecoregion is high, with the presence of approximately 60 percent of the mangrove species known from anywhere in south and southeast Asia and Indonesia. The most diverse mangrove communities occur in areas that are inundated at high tide but are otherwise influenced by freshwater flows. Mangrove forests in the Red River delta and associated estuaries and mud flats have lower diversity than mangrove habitats in the south. This low mangrove diversity in the Red River delta area is the result of a combination of cooler growing conditions and a longer and more intense period of human impact.

Mangrove forests often show clear species zonation. The pioneer species along the open coastline is usually *Avicennia alba*, followed by a gradient of decreasing exposure and submergence by sea water supporting *Rhizophora apiculata* and *Brugiera parviflora*, which become established after five or six years. They grow to replace *Avicennia* after about twenty years. Higher ground with more brackish water is dominated by *Avicennia officinalis*, *Sonneratia caseolaris*, *Nypa fruticans*, and *Phoenix paludosa*.

Fauna

There are no endemic mammals in the ecoregion, but many species are known to use mangroves, including the tiger (*Panthera tigris*), tapir (*Tapirus indicus*), and siamang (*Hylobates syndactylus*). Indochina mangroves support some of the rarest water birds in the

[38] Wikramanayake, Eric D. et al.
[39] "Vietnam's Forests on the Upswing after Years of Recovery."
[40] Synge, Hugh, *Annual Report 1991: IUCN The World Conservation Union*.
[41] Wikramanayake, Eric D. et al., "Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment."
[42] "Vietnam's Forests on the Upswing after Years of Recovery."

world, many of which are endangered. Included in this assemblage are the lesser adjutant (*Leptoptilos javanicus*), Storm's stork (*Ciconia stormi*), white-winged wood duck (*Cairina scutulata*), and spot-billed pelican (*Pelicanus philippensis*). There are several reptile species of conservation significance in this ecoregion, including the monitor lizard (*Varanus salvator*), the false gavial (*Tomistoma schlegeli*), and the estuarine crocodile (*Crocodylus porosus*).[43]

Status and Threats
Indochina mangroves are highly threatened in nearly every site where they occur. Although seven small protected areas have been created for conservation, they cover a mere three percent of the ecoregion. WWF points out that "mangrove forests often are treated as wasteland to be cleared for development. In Vietnam, large areas are cleared for aquaculture, salt ponds, and agriculture. Poaching and illegal trade of animal products are another important threat, especially to estuarine crocodiles and monitor lizards. Fishing with explosives and trawlers with drag-nets has also caused extensive damage to this sensitive ecosystem."[44] [45]

Biodiversity Loss

While each ecoregion within the MDR has a unique set of challenges in maintaining its ecological integrity, they all share a common story of forest conversion and biodiversity loss. According to the United Nations Food and Agriculture Organization (FAO), the rate of deforestation in Southeast Asia accelerated during the 1980s, doubling between 1976–80 and 1986–90.47. Another estimate found a drop of approximately 17 per cent in the region's forest cover between the late 1960s and the late 1980s. Vietnam had one of the most rapid rates of deforestation between 1970 and 1990, 68.8 per cent, or over 124,820 sq. km, which has subsequently affected biodiversity.[46] Both the Mekong Basin and Delta Region show evidence of having at least three of Jared Diamond's 'Evil Quartet' of biodiversity loss factors (habitat loss/destruction, overkill, introduced species, and second extinction) if not all.

Campbell lays out the most important causes of biodiversity loss in the Delta, citing population pressure, agriculture, fishing, water quality, exotic invasive species, dams, and climate change as the more notable culprits. He notes that "population growth is a fundamental driver of much environmental degradation." With its abundant freshwater, easily worked flat land, rich soils which are cyclically washed by the river, tropical weather, and plentiful sunlight, the Mekong Delta "is capable of supporting, and does support, a high human population density which has grown rapidly over the past 200 years, and continues to grow." As that population grows, so do its demand and stresses on the environment. "More land is cleared for farms, existing agriculture intensifies, more roads, houses, offices and factories are built."[47]

The hand of agriculture has always been heavy in the MDR. Forest clearing and draining of swamps and wetlands for cultivating "has been historically one of the major contributors to the

[43] Wikramanayake, Eric D. et al., "Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment."
[44] Wikramanayake, Eric D. et al.
[45] Synge, Hugh, *Annual Report 1991: IUCN The World Conservation Union*.
[46] Acharya, *The Making of Southeast Asia: International Relations of a Region.*
[47] Campbell, "Biodiversity of the Mekong Delta."

evident loss of biodiversity within the Delta." It has been reported that "only 20% of the mangroves present in 1943 now remain," and that "areas unsuitable for rice or crop production have been cleared to construct aquaculture ponds, mainly for shrimp." Though the rate of clearance has dropped in recent years, Campbell emphasizes this is "mainly because there are fewer uncleared areas remaining."[48]

Perhaps the most important agricultural issue, in Campbell's view, is the introduction of poldering to the MDR. He describes the process and the impacts this shift in practices has had:

> "One of the great changes that has occurred, and continues to occur in the Mekong Delta has been a huge increase in the area of poldering…Poldering involves the construction of levee banks around areas containing rice paddies in order to exclude the flood waters. Instead of rice being planted at the commencement of the natural flood and growing as the flood waters naturally rise, the level at which the water rises is controlled by allowing flood water to enter through water control structures. The advantage for the farmers is that instead of rice being grown in seed beds and the seedlings transplanted, the seed can be directly planted in the fields. With the natural flood, rice had to be planted as seedlings because the taller seedlings were less liable to be "drowned" through a sudden rise in water level. But direct planting of seed is far less labour intensive, so is preferred by farmers. In addition, where water levels are closely controlled rice cropping has increased from one crop a year to two or even three crops."[49]

While there is short-term prosperity from poldering, it comes at the cost of ecological disruption, which Campbell describes thus:

> "The development of large-scale polders has had a dramatic effect on the water flows within the delta. Essentially the floodplain now contained behind the levee is no longer connected to the river as it once was and is no longer available to store flood waters. Consequently the flood heights in non-poldered areas are substantially higher, because they now have to store greater volumes of water than previously. So those areas are now being inundated for longer periods and to greater depths than previously, disrupting their ecology, while the natural ecosystems within the levee are also completely modified."[50]

As with many estuaries, the Mekong Delta's water quality suffers from a twofold infringement of polluting activities upstream and localized inputs. With increased population and more intense levels of agriculture there is higher use of fertilizers and pesticides which accumulate and eventually overload waterways with nutrients, creating an issue that impacts aquatic biodiversity and augments the risks of toxic algal blooms, especially in the dry season.[51] According to Campbell, "The waterways of the delta have the poorest quality water of any locations sampled by the Mekong River Commission within the Mekong basin. Nutrient levels are high and are increasing, presumably through runoff of fertilizers used in agriculture, as well as the food and waste materials derived from instream aquaculture activities and sewage and urban wastewater."[52] Recent studies have detected high levels of DDT and PCBs, particularly near urban areas, with the DDT inputs being decidedly recent.[53] Campbell and colleagues found that this was almost entirely due to human activities within Viet Nam. They say "the contribution of pollutants from Cambodia is trivial," a fact that gives Viet Nam more power to address the issue head on without

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[48] Campbell.
[49] Campbell.
[50] Campbell.
[51] Campbell.
[52] Campbell.
[53] Carvalho et al., "Agrochemical and Polychlorobyphenyl (PCB) Residues in the Mekong River Delta, Vietnam."

having to get caught in fraught transboundary debate. It is crucial that this problem be addressed quickly. As the author puts it, "poor water quality has certainly impacted on aquatic biodiversity in the Delta already, and unless Vietnam begins to seriously address the sources of contamination, the problems will become much more serious, and impact on industries like the export aquaculture industry as well as the biodiversity."[54]

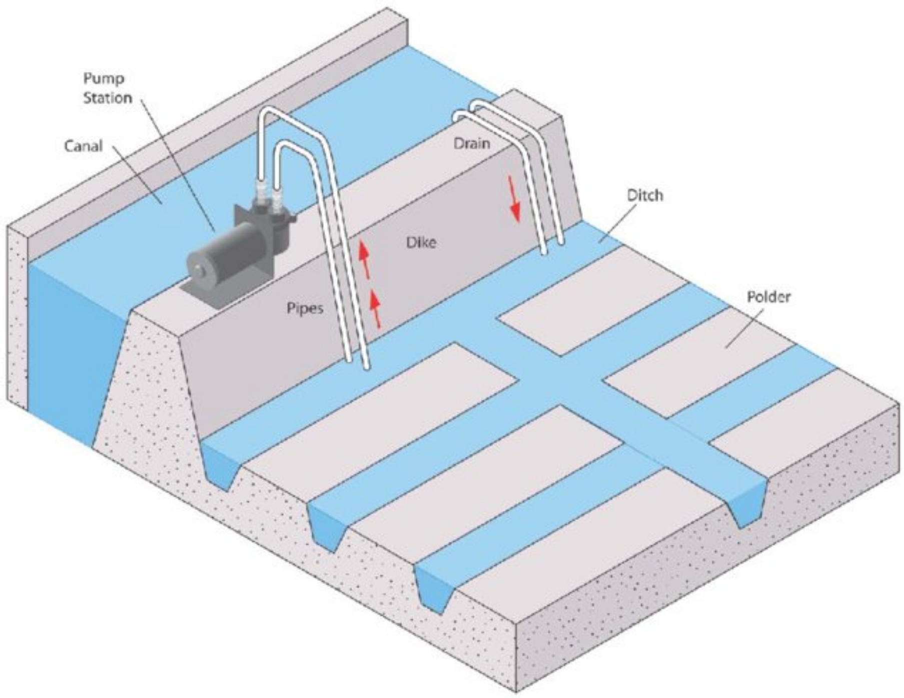

Figure 4. Dike and polder drainage and irrigation system (drawing by Mic Greenberg)

While the documentation on fishing activities as the most important causes of fisheries decline, there is at least enough to conclude that they have played a role. The river and delta are intensively fished using various techniques, and while there has not been a notable decline in overall fish catch as of yet, there has certainly been a decline in large species, which for their longer lives and age of maturity are more susceptible to fishing pressures. There is, according to Campbell, "no doubt that fishing has caused at least a reduction in abundance of some species."[55]

The Mekong is not immune to the global threat of invasive species. There are a number of destructive exotics, some of the more salient are *Chromolaena odorata*, *Ageratum conyzoides*, *Amaranthus spinosus*, *Bidens pilosa*, *Mikania micrantha* and *Mimosa diplotricha*, which tend to populate disturbed areas such as in secondary forests;[56] but the one attracting the most attention

[54] Campbell, "Biodiversity of the Mekong Delta."
[55] Campbell.
[56] Bernard Dell, Pham Quang Thu, and Dang Thanh Tan, "Invasive Plant Species in the National Parks of Vietnam."

in recent years is *Mimosa p*igra, the giant mimosa plant. It grows at an alarming rate in tropical wetlands and once established is incredibly difficult to control or eradicate (see *Figure 5*).[57] [58]

Figure 5. Mimosa Pigra invading Mekong wetlands

The above-mentioned threats to the biodiversity of the Delta are compounded when placed in the hydrological context of the greater Mekong River basin. Anthony et al. make the astute observation that "the vulnerability of the Mekong delta thus involves a conjunction of various hot issues that are attracting international scientific and political attention, underpinned by the tensions raised by the planned large hydropower dam projects."[59] Indeed, the rise of China presents Southeast Asia "not only with a powerful economic challenge, especially in terms of the diversion of investments, but also raises the danger (though exaggerated) of Southeast Asia being absorbed into a Chinese sphere of influence."[60]

[57] Campbell, "Biodiversity of the Mekong Delta."
[58] Le and Truong, "Quick Assessment of the Invasiveness of Non-Native Plant Species by Using Eco-Physiological Parameters in Tram Chim National Park, Vietnam."
[59] Anthony et al., "Linking Rapid Erosion of the Mekong River Delta to Human Activities."
[60] Acharya, *The Making of Southeast Asia: International Relations of a Region.*

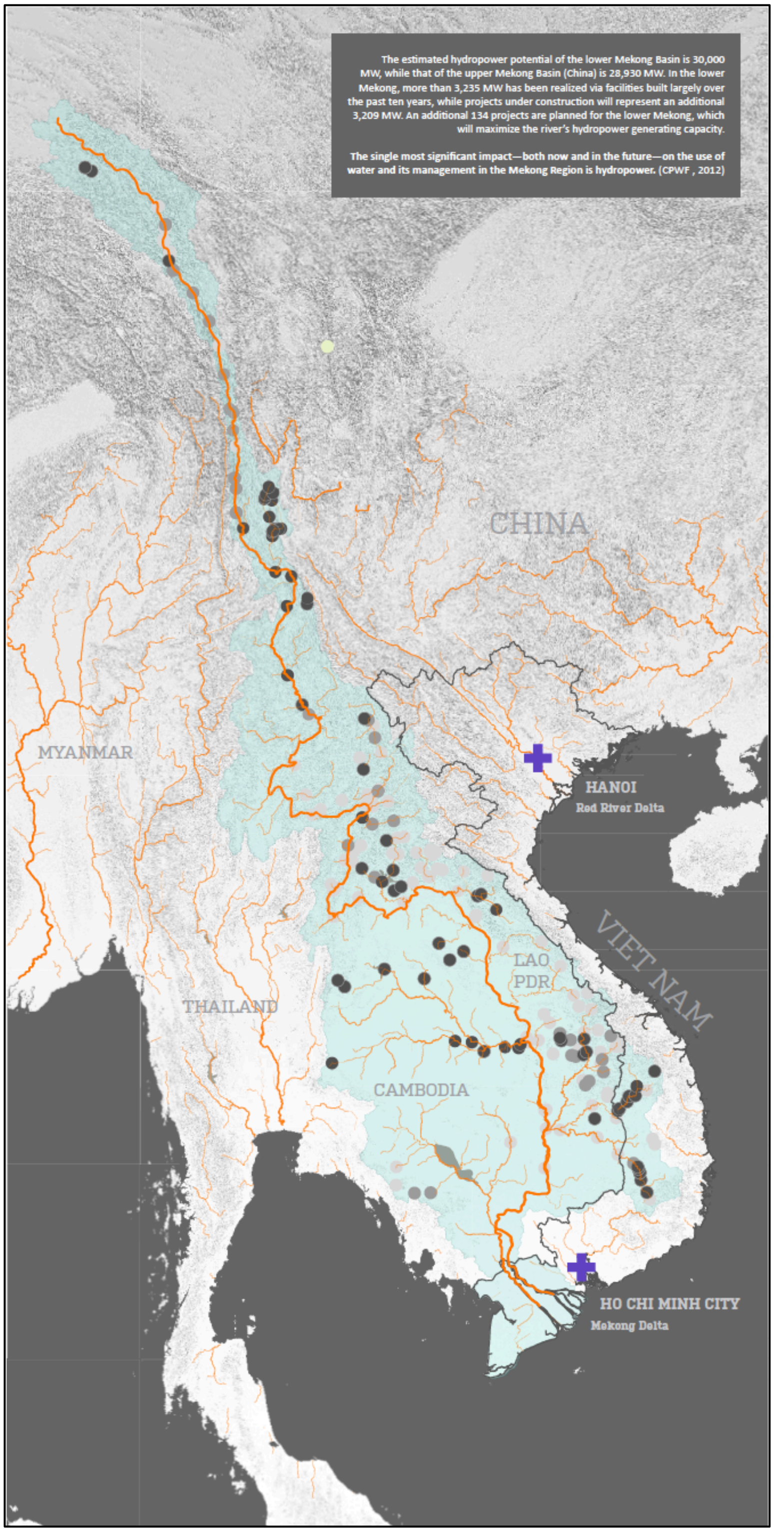

Figure 6. Hydropower in the Mekong Basin. Dark gray represents operational dams, medium gray under construction, and light gray planned (data from Open Development Mekong)

Those Dam Hydropolitics

One of the most profound impacts human activities have had on the Mekong Basin in recent years is the construction (or planned construction) of dams in the upper reaches of the river, the vast majority of which are in China. With each new dam have come far reaching hydrological changes down river, affecting everything from sediment load to fish migration to groundwater recharge. Bakker makes potent observations about the dicey geopolitical struggles dams create. In her words, "dams serve as important nodes of control in the interrelated processes of the changing territoriality of the state, the commodification of water, and the increasing penetration of the interests of a largely urban elite into rural areas." They also serve as a "material manifestation of the need for domestic wealth creation and the pressure for regional economic cooperation, they are a potent symbol of change." She emphasizes however that dams are only one of the most "visible and contentious outcomes of development," and that "the processes that give rise to dams imply, more generally, a shifting of control and renegotiation of the allocation of benefits and costs of water use at different spatial and temporal scales."[61]

Anthony et al describe how these changes in allocation are especially impactful in the MDR:

> "The recent persistent decrease in suspended sediment concentrations off the delta is attributed essentially to dam impoundment of sediment, and corroborates the conclusions of a study that has quantified significant sediment retention by dams at the scale of the Mekong basin. Although there is a consensus, however, on the negative impacts of existing and planned dams on the sediment supply of the Mekong to its delta…the poorly estimated Mekong river load and, therefore, the uncertainty regarding what fraction of this load may be trapped behind dams, precludes linking without doubt the present delta erosion to existing dams."[62]

The authors recognize however that "dams are not…the only source of a potential decrease in sediment supply to the coast. The massive channel bed mining in the Mekong deemed to be leading to significant reductions in bedload supply to the coast, should be considered a major concern in the stability of the delta's shoreline."[63] Brunier et al. add to this insight, pointing out that, "the loss of bed material in the deltaic channels may be exacerbating recent problems that have been observed or reported in the delta, such as salt-water intrusion, and river-bank and coastal erosion."[64]

Climate Change and Sea Level Rise

The effects of climate change will be manifested in several natural phenomena, one of which is a rise in mean sea level as surface temperatures increase globally and glaciers melt in the poles. By the end of the 21st century, 70% of the world's coastlines will experience a sea level change ranging from 0.26m to as high as 0.82m. This increase will be detrimental to economies and

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[61] Bakker, "The Politics of Hydropower."
[62] Anthony et al., "Linking Rapid Erosion of the Mekong River Delta to Human Activities."
[63] Anthony et al.
[64] Brunier et al., "Recent Morphological Changes in the Mekong and Bassac River Channels, Mekong Delta: The Marked Impact of River-Bed Mining and Implications for Delta Destabilisation."

ecosystems of deltas and other coastal low-lying areas especially those in areas lacking essential infrastructure.[65]

The Mekong Delta is considered one of the most vulnerable regions in the world expected to experience sea level rise. [66] [67] [68] [69] As it is one of the most fertile, prosperous, populated, and developed areas in Vietnam this vulnerability is of great concern to the nation and the South Eastern Asian region as a whole.[70] Through literature review and flood risk assessment, Boateng identifies that sea level rise will impact the Mekong Delta through changes in river hydrodynamics (flow velocities, water levels, etc.), sediment dynamics (erosion and deposition), floodplain inundation (depth, extent and timing), groundwater resource availability (salt water intrusion), food security (agriculture, aquaculture and fisheries), coastal settlement (destruction and population displacement), ecosystem health (degradation and loss).[71] These deltaic elements will be further impacted by the increases in waves, tidal forces, storm surges, typhoons, rainfall, winds, and flash floods associated with the expected climate change for the region.[72]

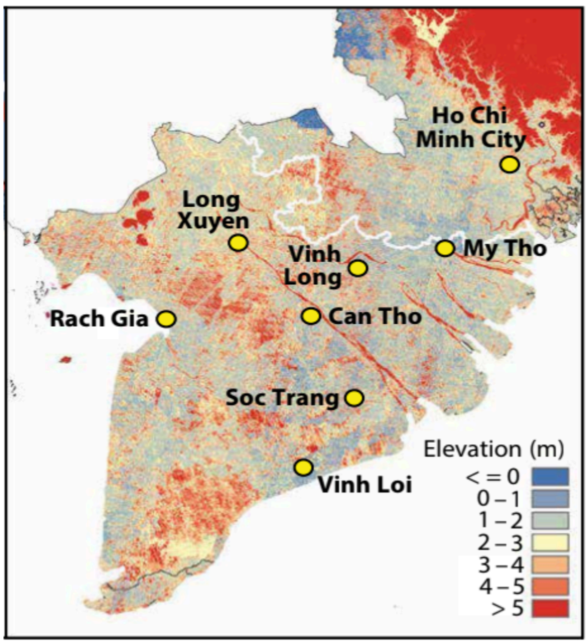

Figure 7. Delta Elevation (from Allison et al.)

[65] IPCC, 2014, *Climate Change 2014: Synthesis Report.*
[66] Thanh Duc Dang et al., "Future Hydrological Alterations in the Mekong Delta under the Impact of Water Resources Development, Land Subsidence and Sea Level Rise."
[67] Neil Adger, "Social Vulnerability to Climate Change and Extremes in Coastal Vietnam."
[68] Reiner Wassmann et al., "Sea Level Rise Affecting the Vietnamese Mekong Delta: Water Elevation in the Flood Season and Implications for Rice Production."
[69] Nam et al., "Local Planning for Climate Adaptation: Vietnam's Experience."
[70] Isaac Boateng, "GIS Assessment of Coastal Vulnerability to Climate Change and Coastal Adaption Planning in Vietnam."
[71] Intergovernmental Panel on Climate Change, *Global Warming of 1.5°C.*
[72] Solomon, Intergovernmental Panel on Climate Change, and Intergovernmental Panel on Climate Change, *Climate Change 2007.*

A large portion of the Mekong River delta sits at an elevation below 2 m (see *Figure 7*). These low-lying areas will be the first affected by sea level rise in the near future. Hanh and Furukawa measured sea level rise at 1.9 mm/yr (from 1960-2000, in Northern Vietnam) while others have calculated estimates ranging from 1.75mm to 6 mm per year.[73] [74] [75] These results complement the USGS modeled emissions-based rise scenarios for the Mekong Delta during the remainder of the 21st century using IPCC 2007 projections.[76] Scenario results ranged from 0.18 m with the best-case scenario (relying on minimized global emissions) to the worst-case scenario of 0.59 m of sea level rise by the year 2100. It should be noted that these rates will be further accelerated by subsidence in many areas. Erban et al. describe the cycle between sea level rise, infrastructure and subsidence. They suggest that as water levels change infrastructure will concentrate to less affected areas leading to urbanization and its inherent increase of groundwater extraction. This increased extraction will in turn result in lowered elevation (subsidence) and increased risk of flooding (see *Table 1*).[77]

Table 1. Expected elevations of sea level by the year 2100 based on IPCC 2007 emissions scenarios combined with viable expected net land subsidence rates (from Doyle 2010).

Net subsidence rate, in mm/yr	B1 min, 0.18 m by 2100, in meters	B1 max, 0.38 m by 2100, in meters	A1F1 min, 0.26 m by 2100, in meters	A1F1 min, 0.26 m by 2100, in meters
0	4.30	4.47	4.38	4.68
1	4.39	4.57	4.47	4.77
3	4.57	4.75	4.65	4.96
6	4.85	5.02	4.93	5.23
9	5.12	5.30	5.20	5.50

In summary, the inhabitants of the Mekong Delta find themselves virtually boxed in by the uncertainties of upstream hydropolitics and coastal sea level rise, both of which are exacerbated by unsustainable farming, industrial, and water management practices within the Delta Region. Their ecological infrastructure is on the brink of collapse is dire need of repair; their lands are at risk of buckling under the pressure of population growth and decentralized resource extraction, both legal and illegal; and their livelihoods are threatened by fraught hydropower projects, climate change, and sea level rise with all of their accompanying side effects. Without immediate efforts to collaborate and negotiate adaptation efforts across the basin, Southeastern Asia and all of its partners are on track to have a transboundary ecological crisis affecting human life, the regional economy, and global food security.

[73] Hanh and Furukawa, "Impact of Sea Level Rise on Coastal Zone of Vietnam."
[74] Tuong, N.T., "Sea Level Measurement and Sea Level Rise in Vietnam."
[75] Syvitski et al., "Sinking Deltas Due to Human Activities."
[76] Day, Michot, and Doyle, "Development of Sea Level Rise Scenarios for Climate Change Assessments of the Mekong Delta, Vietnam."
[77] Erban, Gorelick, and Zebker, "Groundwater Extraction, Land Subsidence, and Sea-Level Rise in the Mekong Delta, Vietnam."

Responses to the Problem

In wake of the threats facing both the MDR and greater Mekong Basin, many governments, researchers, and NGOs have taken measures to repair damages to the land, avoid inflicting more, and mitigate some of the inevitable impacts of climate change on economies, food systems, and wildlife. These movements are perhaps most notably rooted in the introduction of the Đổi Mới in 1986, a set of economic reforms which shifted Vietnam from a Communist system to what has been termed a Socialist-oriented market economy, where the state plays a decisive role in macroeconomics while leaving control of commodity production to private enterprise and cooperatives. Đổi Mới was seen as a top-down policy with bottom-up returns, as it freed farmers and fishers from the poverty of having to contribute to food collectives, allowing them to focus their energy on their own fields and livelihood. It also opened Vietnam up to greater coordination efforts with the ASEAN countries, developing trade partnerships and environmental policy.

The establishment of the Mekong River Commission (MRC) in 1995 was a landmark moment for transboundary collaboration in the region. Though efforts had been made to have political partnerships across the watershed since the mid 1950s, it was the MRC that laid a tangible framework for action. The MRC's mission is to ensure "the efficient and mutually beneficial development of the Mekong River while minimizing the potentially harmful effects on the people and the environment in the Lower Mekong Basin."[78] According to the Commission, it is "the only inter-governmental organization that works directly with the governments of Cambodia, Lao PDR, Thailand and Viet Nam to jointly manage the shared water resources and the sustainable development of the Mekong River."[79] Since its establishment, the MRC has been able to jumpstart numerous initiatives, including environmental assessments, providing geospatial data, installation of real-time water quality monitoring, and community forums for knowledge sharing, all of which can be found on their public website. The MRC has also partnered with non-profit organizations, international development entities, and humanitarian aid organizations such as WWF, Australian Aid, USAID, and the World Bank, all of which are committed to the sustainability of the basin. These partnerships have produced promising projects, such as UN-REDD (reducing emissions from deforestation and forest degradation) pilot programs for afforestation, Australia's ASEAN and Mekong program, or the Greater Mekong Programme, all of which have made incremental but measurable progress in improving livelihoods. [80] [81] [82] Much attention has been paid to the MDR in recent years, including several comprehensive plans prepared by water experts from the Dutch government in conjunction with local partners in the Delta.[83] These plans include visionary large-scale implementations of adaptive land use plans, new agriculture, and hydrological engineering projects to help the Delta proactively adapt for the future.

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[78] Mekong River Commission, "About MRC: Mekong River Commission."
[79] Mekong River Commission.
[80] "UN-REDD Programme (Vietnam): The REDD Desk."
[81] "Home | WWF."
[82] Australian Government, "Overview of Australia's ASEAN and Mekong Program."
[83] Strategic Partnership of the Socialist Republic of Vietnam and the Kingdom of the Netherlands, "Mekong Delta Plan."

The World Bank has certainly been one of the most active players in the Mekong. Understanding that the degradation of the Delta would have far-reaching socioeconomic implications for both Vietnam and the Indochinese Peninsula, they have responded to the situation by implementing initiatives for climate-smart planning tools and improved water management practices throughout the lower Mekong basin. In its Strategic Country Diagnostic (SCD) for Vietnam, the Bank included amongst its priorities steps to modernize agriculture and use of natural assets, to enhance climate change resilience, and to strengthen institutional foundations. It is thus supporting the region through projects that fit those priorities, one of the more notable being the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project, which seeks "to enhance tools for climate-smart planning and improve climate resilience of land and water management practices in selected provinces of the Mekong delta in Vietnam."[84] A sizable number of reports, consultancies, non-profit initiatives, and government interventions have been delivered in response, proposing vast feats of coastal engineering, new commissions for implementation, and regional scale adaptation measures for infrastructure. It is within the framework of the Integrated Climate Resilience and Sustainable Livelihoods Project that this thesis and the consultancy it partly serves finds context. While their models are rigorous and their plans encompassing, nearly every report has expressed the need for strategies at the most local levels of governance (i.e. district, commune, household). As such the Bank is now searching for more grassroots or bottom-up solutions to add to the resilience toolkit. Solutions that would help bring the grandiose plans of development partnerships to an approachable, human scale.

The Missing Piece and the Impetus for Tangible Landscape

The World Bank is not alone in neither this observation or this quest. Nearly every entity that has been involved in the MDR over the past 20 years has noted in some way or another that there is a need to develop more site-scale strategies for climate resilience that can easily be implemented by a district, ward, commune, or individual household using local resources; to facilitate a decentralization of communication and collaboration across the watershed while at the same time being able to recentralize and disseminate the knowledge gained; and to find ways of making the climate adaptation process more participatory in nature. This might include methods such as community charrettes, co-modeling, engaged action research, the Sci-TEK or geodesign approaches, or in the case of this thesis, tangible modeling.

[84] The World Bank, "Projects: Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project."

CHAPTER 3. Tactical Ruralism: Promoting Resilience through Localized Landscape Interventions

Urbanization or Urbanized Ruralism?

In 2006 and 2016, Thanh et. al conducted studies of three settlements in the Mekong Delta to measure the nature of urbanization in the region. The 2006 study revealed that despite its rapid urbanization, Vietnam retains a quintessentially rural character with the Mekong Delta holding the larger share of its rural population. It also revealed the beginnings of a very unique type of settlement pattern where there were "profound social and economic transformations in three rural settlements in the area," and that "livelihoods and the nature of the local economic base, including farming, had changed radically."[85] Of particular interest was the virtual disappearance of rice production in order to make room for fruit orchards—and fruit "acted as the key driver of diversification of the economic base of the study settlements." The authors note that "rising urban (and rural) demand for fresh fruit and vegetables was supported by increased average incomes, reflecting Vietnam's success in reducing poverty," in the study settlements.[86] They also found that "employment in the growing industrial and services sectors absorbed large numbers of increasingly mobile rural residents, especially but not exclusively the young, contributing substantially to rural incomes and to rural households' capacity to invest in high value agricultural production." This expansion of nonfarm activities related to fruit (processing and trade) also "opened up opportunities for wealthier and poorer groups alike," within the settlements.[87] The 2006 findings identified an important trend in the MDR where the "complementary links between different sectors (agriculture, trade and services) not only become stronger but also take place within the same space," blurring the lines of distinction between 'rural' and 'urban'. This hybridized settlement space, at least in the study areas, "contributed to local economic growth and poverty reduction, albeit with widening income inequality."[88]

In a 2016 follow-up study, Thanh et al. revisited the settlements and sought to explore how changes between 2006 and 2015 might reveal some of the greater nuances of urbanization, migration, and urban-rural economies in the region. Though there was a good deal of variation between the settlements, they found that they were on similar trajectories in regards to industrialization, migration, and food security. They also synthesized their findings with population growth and internal migration trends (see Figure 8) to better contextualize the complex web of rural-urban relationships (see *Figure 9*) that are affected by events like climate change, natural disaster, and global financial crises. They state:

"The linkages between rural and urban locations (large cities, small towns and industrial zones) and also between rural locations are very tight, but they are also flexible in responding to changes in the natural, economic–social environment…several factors affect migration and the nature and intensity of the linkages between rural and urban areas. Population growth and urbanization are clearly important ones; access to natural resources, especially land and water, is also extremely important, and increasingly under threat from natural disasters linked to climate change; and

[85] Thanh et al., *Urbanisation and Rural Development in Vietnam's Mekong Delta, 4.*
[86] Thanh et al.
[87] Thanh et al.
[88] Thanh et al.

finally, global factors such as price volatility and financial crises can have a considerable impact on production and employment opportunities as well as on demand, which is affected by higher costs of living."[89]

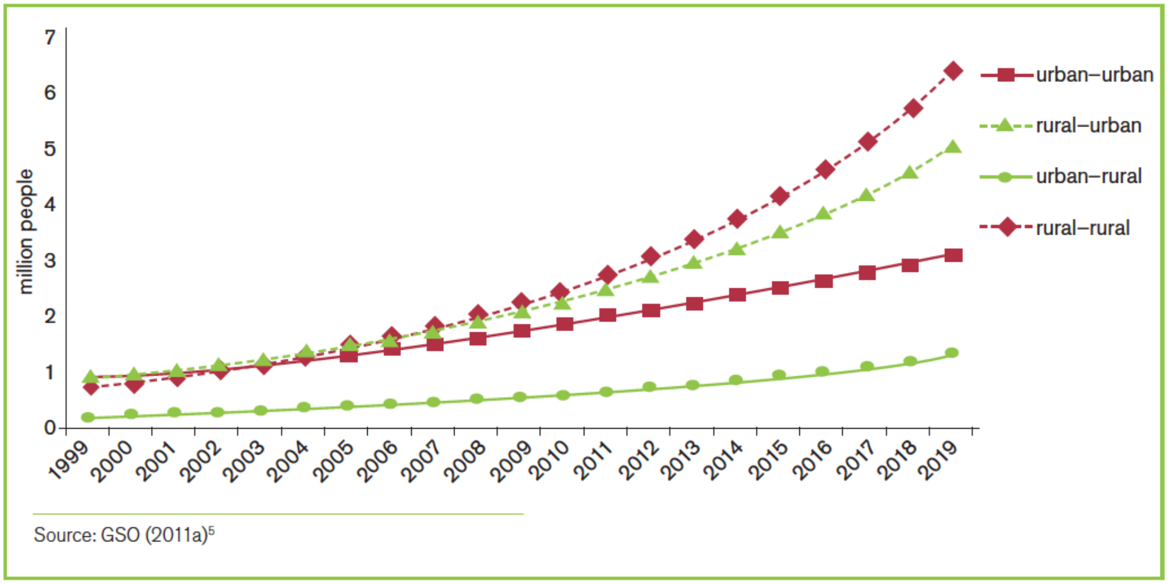

Figure 8. Urban-rural migration from 1999-2009 with projections to 2019 (from Thanh et al.)

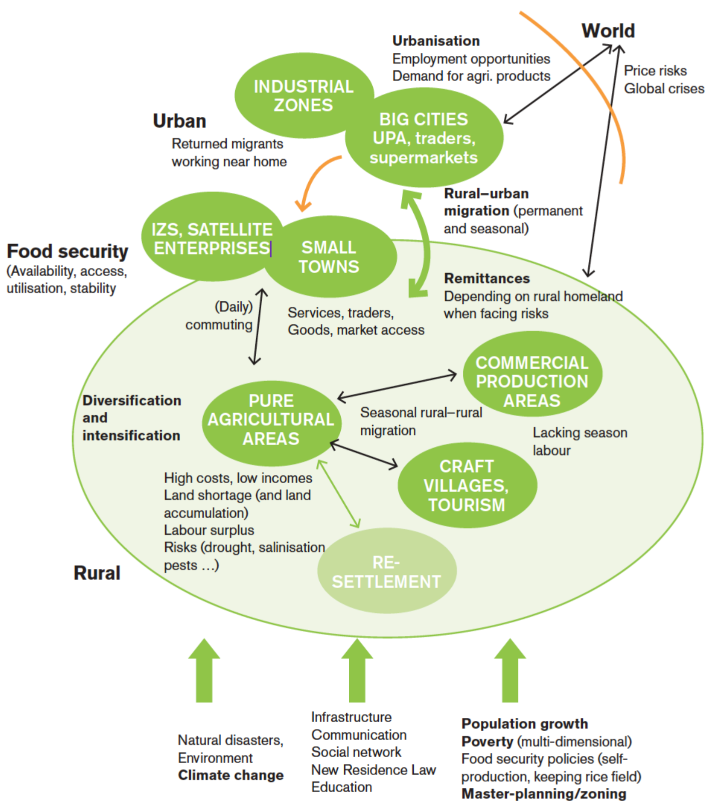

Figure 9. Rural-rural, rural-urban linkages and food security (from Thanh et al.)

[89] Thanh et al.

The complexity of this emerging system of rural and urban spaces is illustrated in the figure above and is shown in migration data, which, according to the authors, "suggest that urbanisation in Vietnam is not simply a shift of population from the countryside to the (large) cities, but is part of a broader transformation involving population movements from rural to urban areas, and also between urban areas themselves and within the rural space."[90] With Thanh et al.'s findings in mind, it becomes vital to this project to challenge the notion that *urbanization* is as simple as farmers giving up their crops for a service industry job and an apartment in Saigon or Can Tho; the case of the Mekong Delta is much more fluid—a rural space which has urbanized rather than an urban space where rural livelihoods have been left behind—and any attempt to address climate resilience issues in the region must understand its endemic patterns of human settlement to implement anything truly effective. In other words, if a farmer or a fisher cannot implement a strategy of their own accord using their own resources, it is not very likely an 'urban' resident will buy into it either because, to them, they occupy the same 'space'.

What is Tactical Ruralism?

Apart from a talk given by a landscape architect at a California winery, the term "tactical ruralism" has yet to be defined or used regularly in practice. Given the understanding gained from the previous section, an attempt at doing so seems appropriate. *Tactical Ruralism* is essentially a remix of the term "tactical urbanism", which is often used to refer to "low-cost, temporary interventions that improve local neighbourhoods." The term "tactical urbanism" came into common use in 2010-2011 when a group of young urbanists created the publication *Tactical Urbanism: Short-term Action, Long-term Change*, which showcased temporary public space improvement projects from across North America. *The Planner's Guide to Tactical Urbanism* authored by Laura Pfeifer defines the practice as "small-scale, short-term interventions meant to inspire long-term change," adding that, as a city-building approach, it features five characteristics:

- A deliberate, phased approach to instigating change;
- An offering of local ideas for local planning challenges;
- Short-term commitment and realistic expectations;
- Low-risks, with possibly a high reward; and
- The development of social capital between citizens, and the building of organizational capacity between public/private institutions, non-profit/ NGOs, and their constituents.

Pfeifer's definition is concise, comprehensive, and provides an apt framework for my definition of tactical ruralism. There are a few tweaks to be made so as to better adapt Pfeifer's 'tactics' to the rural context. One is to clarify that tactical ruralism will not always occur on public lands or public right of way, as tactical urbanism tends to (at least most of the time). Another is to change the word "small-scale" to "scalable," understanding that some tactical ruralist interventions will be small-scale while others might start in a single field but evolve to cover an entire ecoregion. The phrases "short-term intervention" and "short-term commitment" also require more flexibility in the tactical ruralist context, as some of the strategies involve plantings that will grow

[90] Thanh et al.

and (hopefully) establish for the long term. A good example of this might be patchwork plantings for the sake of forest restoration. The initial planting may be a short-term activity, but it will require monitoring to be retained and has a long-term effect without technically needing to change out the original intervention. Thus, I will choose to define tactical ruralism as:

> Scalable, short-term interventions meant to inspire long-term change in the management of the rural landscape. Features include: a deliberate, phased approach to instigating change; a practice of knowledge sharing for informing local planning challenges; low-risks, with realistic expectations and possibly a high reward; and the development of social capital between citizens, public/private institutions, non-profit/ NGOs, and their constituents.

Tactical ruralism shares many characteristics with the framework for a New Ruralism, which is a retooling of New Urbanism by the NPO Sustainable Agriculture Education (SAGE). It is focused on "the preservation and enhancement of urban edge rural areas as places that are indispensable to the economic, environmental, and cultural vitality of cities and metropolitan regions."[91] While there are shared ideals, tactical ruralism differs from the new ruralism just as tactical urbanism differs from the new urbanism—the key reason being that in practice tactical ruralism starts and emanates from site-scale, built interventions in the landscape while the new ruralism is in practice a planning initiative starting at the regional scale.

Case Studies in Tactical Ruralism: Some Plants, Some Plastic, and Some Plants with some Plastic

In keeping with the spirit of the attempt to define tactical ruralism, it is important to establish why defining a seemingly frivolous term like tactical ruralism has any meaning for climate resilience in the Mekong Delta and to give examples of tactical ruralist interventions that are viable and regionally relevant to the MDR. To do so, I will review three case studies: one that involves a survey of agroecological adaptations of croplands to restore habitat, one that involves recycled plastics for rainwater harvesting, filtration, and infiltration, and one which involves a hybrid of plantings and plastics for streambank stabilization.

Some Plants

The self-inflicted damages to MDR waterways mentioned by Campbell hinge almost entirely on the improper use of plants. As has been mentioned, nutrient levels are high and increasing, "presumably through runoff of fertilizers used in agriculture, as well as the food and waste materials derived from instream aquaculture activities," that then accumulate with urban sewage, creating a cesspool of microbial risk to the community when floods occur.[92] [93] A combination of higher dyke systems to sustain rice monocultures through multiple seasons (see Figure 10), overuse of pesticides, and habitat clearing for larger, short-term cash cropping and aquaculture degrades

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[91] "A Call for New Ruralism."

[92] Nguyen et al., "Microbial Risk Assessment of Tidal-Induced Urban Flooding in Can Tho City (Mekong Delta, Vietnam)."

[93] Campbell, "Biodiversity of the Mekong Delta."

the land and depletes the natural systems that once provided abundance by cutting their lifecycles short.[94] [95] [96] Furthermore, the current practices will themselves become obsolete and unprofitable when sea level rise, saltwater intrusion, subsidence, and flooding take their toll on the fields and fisheries. More sustainable practices are needed; more restorative practices are needed. As Tong puts it, "instead of focusing on increasing rice output to achieve rapid economic development based on exports, the government should incorporate a greater appreciation of the Mekong Delta as an environmental system which provides multiple highly-valued ecosystem services." [97]

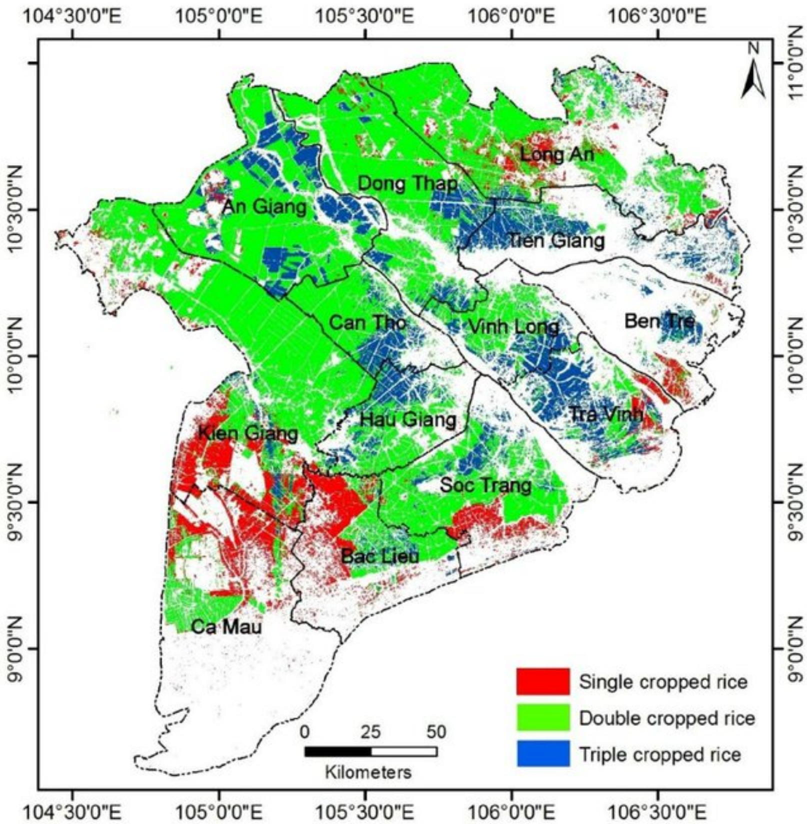

Figure 10. Rice crop map for the Mekong Delta (from Nguyen et al.)

The call for a return to mixing agricultural and ecological systems is not a new one. Since the environmental movements of the 20th century, there have been many strong advocates for concepts like agroforestry, agroecology, silviculture, or permaculture. Until recent years, however, practitioners focused on mostly temperate or Mediterranean forest systems. Though there were existed applications in tropical and subtropical regions, comprehensive literature on applications in rice growing contexts was lacking. This changed in 2017 with the publishing of FAO's *Agroforestry in rice-production landscapes in Southeast Asia*. The manual provides a sweeping set of

[94] Vo et al., "Methane Emission from Rice Cultivation in Different Agro-Ecological Zones of the Mekong River Delta: Seasonal Patterns and Emission Factors for Baseline Water Management."
[95] Tong, "Rice Intensive Cropping and Balanced Cropping in the Mekong Delta, Vietnam — Economic and Ecological Considerations."
[96] Nguyen et al., "Mapping Rice Seasonality in the Mekong Delta with Multi-Year Envisat ASAR WSM Data."
[97] Tong, "Rice Intensive Cropping and Balanced Cropping in the Mekong Delta, Vietnam — Economic and Ecological Considerations."

design, planning, and maintenance guidelines for applying sustainable agroforestry to rice landscapes. There are several types of agroforestry described:

> "There are many different agroforestry practices that farmers use to fulfil different functions. The most common way to classify agroforestry is according to use of the main components involved: the trees, crops or livestock. Different types of agroforestry practices may be integrated within a farming or livelihood systems. For example, on the same farm, fodder shrub/tree hedgerows are grown along the contour lines of the slope with annual crops such as rice on the terraces, timber trees are planted on the field boundaries and trees and shrubs are growing on the grazing land. Agroforestry can also be categorized into either simultaneous or sequential systems or practices. In simultaneous agroforestry, trees and crops are grown at the same time. The arrangement of the components influences the types of interactions. Trees can be intermixed throughout the system, such as in homegardens, understorey crops, and silvopastoral systems. Trees can also be planted in zones partially separated from rice or livestock, such as in alley cropping."[98]

With such a diverse palette of options[99] (see Figure 11 and Figure 12) farmers are afforded a great deal of autonomy and artistic liberty in implementing agroforestry practices; herein lies the case for patchwork agroforestry as an example of tactical ruralism—scalable, realistic according to needs, deliberate, and phased. It can also bring benefits to farmers' bottom line in the long-term (see Figure 13). FAO notes that "farms that grow only rice are vulnerable to both climate and market shocks. Diversification through adding trees help spreads the risk. Trees are stronger and more resilient to storms, floods and droughts. They can continue to produce both food and income even immediately after a storm or flood that has destroyed a rice crop."[100] Trees can also endure long droughts much "better than even irrigated rice if the source of irrigation water is depleted," an occurrence that is projected to become even more frequent in the MDR with climate change and forthcoming hydropower projects.

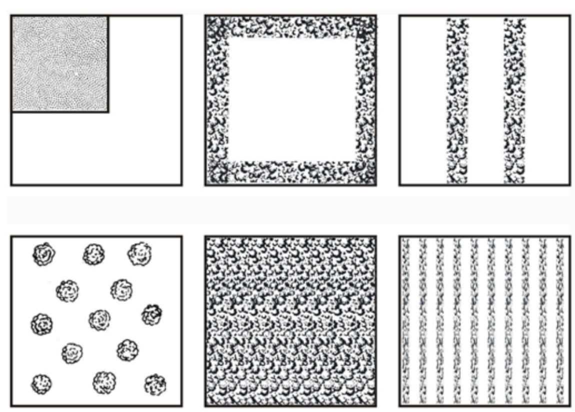

Figure 11. Patterns for integration of trees on farms (from Xu et al.)

[98] Food and Agriculture Organization of the United Nations, *Agroforestry in Rice-Production Landscapes in Southeast Asia*.
[99] Xu et al., *An Agroforestry Guide for Field Practitioners*.
[100] Food and Agriculture Organization of the United Nations, *Agroforestry in Rice-Production Landscapes in Southeast Asia*.

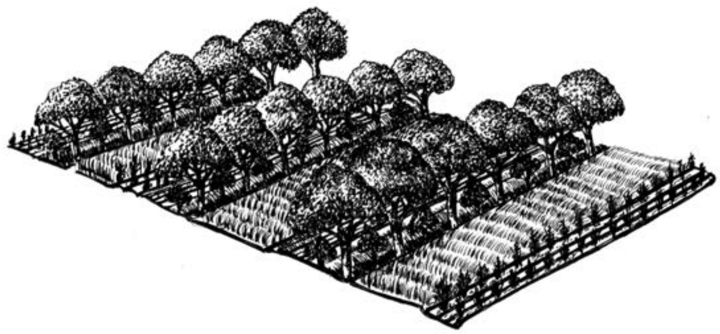

Figure 12. Alley cropping, a familiar form of agroforestry (from Xu et al.)

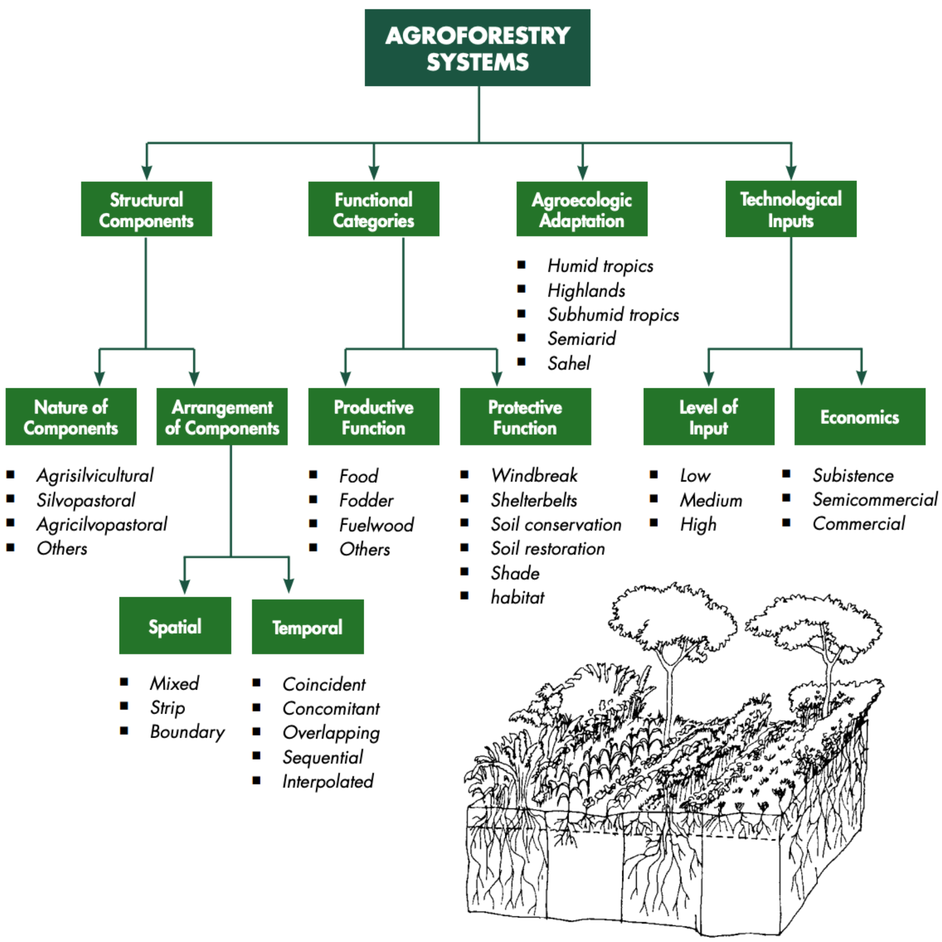

Figure 13. Classification of agroforestry systems (from Xu et al.)

Figure 14. Alley cropping, Indonesia (from FAO)

Figure 15. Perimeter trees on rice landscape in Philippines (from FAO)

Figure 16. Dispersed trees on rice field in Lao PDR

Figure 17. Trees and rainfed rice in Thailand

The authors of the manual have reviewed numerous case studies and found "farmers in Viet Nam, Indonesia, the Philippines, Myanmar, Lao PDR, Thailand and other countries in Southeast Asia have been able to lessen these risks if they have a mix of trees and rice on their farms rather than just rice alone," (see *Figure 14*, *Figure 15*, *Figure 16*, and *Figure 17*) further strengthening the case to strive for a more widespread agroecological regionalism.[101]

[101] Prasit Wangpakapattanawong et al., *Agroforestry in Rice-Production Landscapes in Southeast Asia*.

Some Plastic

Since scientists began observing litter input to the world's waterways in 1975, the production of plastic resin has skyrocketed—a whopping 620% increase in just 50 years.[102] Where improperly managed, such an exponential spike in production has led to increased incidences of pollution. The effects of plastic pollution on water quality and marine habitat are well documented[103] and widely manifest in Southeast Asia. China and Vietnam, the countries sitting at the Mekong River's headwaters and mouth, respectively, are responsible for over 24% of all plastic waste generated globally.[104] A recent study by Schmidt, Krauth, and Wagner hones in on specific river catchments and estimates that the Mekong is one of ten rivers—and it should be noted that eight out of the ten are in Asia—contributing over 93% of plastic debris in the oceans.[105] [106]

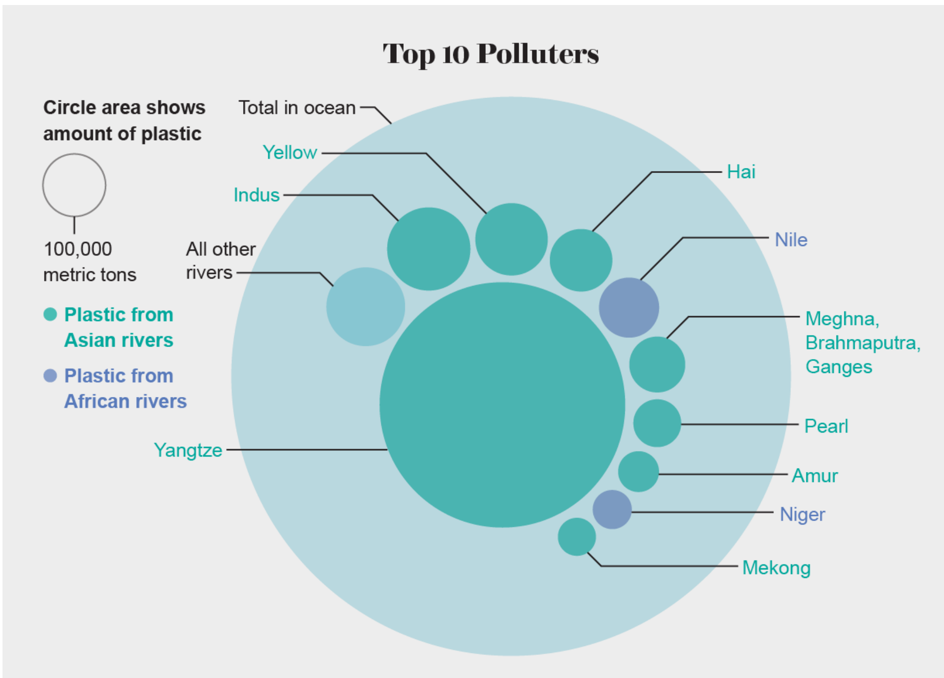

Figure 18. Top ten plastic polluting rivers in the world (from Schmidt et al.)

These observations have rightfully caused much concern over how to better coordinate and regulate plastic waste management in the region. Many government, humanitarian, and non-profit organizations have responded by funding initiatives to curb production of single-use plastics, clean up polluted waterways and institute more effective recycling programs. USAID has sponsored WWF in Vietnam with one of their more recent Municipal Waste Recycling Program grants to reduce plastic pollution on tourism-oriented Phu Quoc Island in southern Vietnam. The activity will "work with hotels, tour operators, and fishing boats to manage and reduce their plastic waste and educate their clientele." It will also "work with the local government to develop

[102] Jambeck et al., "Plastic Waste Inputs from Land into the Ocean."
[103] Law, "Plastics in the Marine Environment."
[104] Jambeck et al., "Plastic Waste Inputs from Land into the Ocean."
[105] Patel, "Rivers of Plastic."
[106] Schmidt, Krauth, and Wagner, "Export of Plastic Debris by Rivers into the Sea."

regulations on plastic management." USAID mentions that with this award there are now "five active grants in Vietnam, each working in a different location to pilot solutions to plastic pollution."[107]

Figure 19. PET bottle greenhouse in Vietnam (from Inhabitat.com)

Figure 20. PET bottle farming shelter in Vietnam (from Inhabitat.com)

[107] U.S. Agency for International Development, "USAID Awards a New Grant to Reduce Plastic Pollution in Vietnam."

While these programs show promise for addressing the problem at the municipal level, there is also potential for rural communes and households to clean up and reuse plastics as part of their personal climate adaptation efforts. This may include financial strategies such as establishing recycling centers that incentivize the collection of waste for money exchange, Plastic Bank is a more notable example of this model;[108] household reuse strategies such as fashioning plastic bottles to make greenhouses and shelters (see *Figure 19* and *Figure 20*);[109] [110] [111] or scalable repurposing strategies such as creating PET bottle modules to implement in greywater filtration systems of any size, so long as supplies are plentiful (see *Figure 21*).[112]

Figure 21. PET bottle greywater system in Kibera, Nairobi (from Huffington Post)

The idea of building a flexible, scalable module using cut and crushed plastic bottles has been particularly successful for an entrepreneurial pair of engineers out of Richmond, California as they have developed a product called "plavel" (plastic + gravel) and implemented it in a variety of settings, including a neighborhood in Kenya, an island in Fiji, and various residential projects throughout California. They find that PET bottles "when properly prepared, can be used as a substitute for gravel and other commercially manufactured plastic products used in various types of drainage, water storage and water filtration applications."[113] These potential uses include: (a) foundation drains and French drains; (b) sanitary drainfields (i.e., leachfields, soak trenches); (c) stormwater detention and bio-retention systems; (d) rainwater harvesting; and (e) a variety of water and wastewater filtration uses such as trickling filters, septic tank effluent filters, greywater treatment, constructed wetlands, and water filtration for aquaculture, koi ponds and other

108 SC Johnson, "SC Johnson and Plastic Bank Team Up to Address the Global Ocean Plastic Crisis."
109 Hooper, "Unique Greenhouse Teaches Students on Many Different Levels."
110 Irel et al., "Did You Say RECYCLED PLASTIC BOTTLE GREENHOUSE?"
111 "How to Build a Greenhouse Using Plastic Bottles."
112 Hantzsche and Woll, "Repurposing Used Plastic Water Bottles for Drainage and Water Treatment Applications."
113 Hantzsche and Woll.

landscape water features (see Table 2). The inventors of plavel have explicitly stated in interviews that the module is meant to be low cost and relatively easy to assemble with community labor (see Figure 22). They describe the production method thus:

> "Plavel can be formed from common PET bottles (0.5 to 2.0 liters) by: (1) twisting or otherwise deforming the bottle into a rope-like shape; and then (2) cutting the deformed bottle into gravel or small cobble-sized pieces or chunks (ideally 1 to 4 inches across), using a knife, paper cutter, or similar cutting tool. The plavel pieces are then tightly packed into a durable (polypropylene or polyethylene) plastic mesh bag or netting for use in various drainage, water storage or treatment application."[114]

Given the success of precedents in other developing countries with similar socioeconomic struggles to the rural poor of the MDR, the (sadly) abundant access to plastics in MDR waterways, and the relatively low cost of preparation, plavel is a quintessentially tactical ruralist material, with potential for its applications to make great impacts on household and commune water systems while at the same time contributing to poverty alleviation. Though, as the authors of the case studies state, "the method is labor intensive," it also "relatively simple and especially well-suited to areas where a large labor force is available or can be mobilized through community engagement,"[115] a very achievable goal given the already established infrastructure for engagement through MRC, WWF, and USAID.

Table 2. Repurposing applications and water bottle estimates (from Hantzsche and Woll)

Applications	**Assumptions**	**# of Water Bottles (0.5 liter)**
Building Foundation Drain	1,500 ft2 house; 150 lf of 9" dia. drain unit	5,000
French Drain	Residential yard; 100 lf of 9"dia. drain unit	3,000
Stormwater Bio-retention	0.6-ac commercial site, 7,500 gal stormwater retention/storage	90,000
Rainwater Storage	1,000 gal below ground storage, 12"dia. *plave*l drainage units w/liner	12,000
Greywater Treatment	Residence, upflow mixed media filter, 55-gal drum, 12" *plavel* layer	250
Sub-irrigation, Residential	100 gal/wk greywater, 6 raised beds, 3'x7', 12" *plavel* reservoir	11,000
Sub-irrigation, Community	Community garden, 50 raised beds, 3'x7', 12" *plavel* reservoir	94,000
Sanitary Drainfield, Residence	150 lf, standard gravity, ave soils, 1.3 ft3 *plavel* per lf	15,000
Constructed Wetland*	Fijian village community greywater system	2,000
Recycled Water System*	HNP Kibera, 10,000 gpd, upflow, horizontal & trickling filters	150,000

*Actual quantities for constructed projects

[114] Hantzsche and Woll.
[115] Hantzsche and Woll.

Figure 22. Plavel modules of various shapes and sizes (from Hantzsche and Woll)

Some Plants with Some Plastic

The third case study is really a combination of two case studies with the use of plavel to propose a hybrid application of plants and plastics that can be conceivably implemented at the farm, commune, or district scale. The first is an effort entitled Building with Nature in Indonesia. The Indonesian Ministry of Marine Affairs (MMA) partnered with a number of Dutch engineering and development firms in 2015 to restore a 2 km section of mangrove belts in Demak, Northern Java. The project was a response to the extensive shoreline erosion that had taken place as a result of mangrove conversion for shrimp farming.[116] Through coordination with local stakeholders, the team implemented a series of permeable dams made from an array of bamboo poles filled with brushwood (see *Figure 23*). Instead of simply planting mangroves, a measure that has shown mixed results in some projects, the structures were meant to capture sediment and create conditions that support natural propagation of stands. In the year following installation, monitoring showed up to 50 cm of sedimentation behind the structures with mangrove seedlings emerging. If the

[116] "Building with Nature Indonesia."

structures hold, a small forest can establish within a few years to act as breakwaters and retain sediment in place.[117]

Sediment fencing has proven successful in a variety of hydrological settings, and it shows promise for applications in the Mekong Delta. Structures can be adapted to suit the ideal conditions for each ecoregion of the delta—such as bamboo/brushwood fencing for mangrove propagation along the coast and melaleuca structures for bank stabilization in the Plain of Reeds—and could even be made into a partially living structure, doubling as habitat.[118] There is great precedent for living structures throughout the UK, Europe, and United States. A number of publications have detailed out the contents and building instructions for bioengineering methods such as living stakes from coppiced cuttings, live fascines, terraced live willow spiling, and brush mattress revetments (see *Figure 24* and *Figure 25*).[119] [120] [121]

Figure 23. Sediment fences made from bamboo and brushwood help promote natural mangrove regeneration (from Build with Nature Indonesia)

[117] "Building with Nature Indonesia."
[118] Van Cuong et al., "Using Melaleuca Fences as Soft Coastal Engineering for Mangrove Restoration in Kien Giang, Vietnam."
[119] Bentrup, Gary and Hoag, J. Chris, "The Practical Streambank Bioengineering Guide."
[120] Georgia Environmental Protection Division, "Streambank and Shoreline Stabilization: Techniques to Control Erosion and Protect Property."
[121] "Living Willow / RHS Gardening."

Figure 24. Live stakes planting in Dakota County, MN (from 7 Mile Creek)

Figure 25. Live willow spiling in UK (from salixrw.com)

The flexibility of scale and wide range of possible materials in both the Building with Nature and living bank and shoreline structure strategies make them not only solid examples of tactical ruralism but also highly adaptable and mixable with other complementary strategies. For example, an array of plavel modules can be used by a farmer to build a rainwater capture system which then flows into a constructed wetland greywater system along his homestead, and falls into a hybridized infiltration trench laden with plavel and living stakes from coppiced alley crops, which make up the upper part of an embankment stabilized by a living spiled terrace garden. If every measure were implemented, you would have a single farmer who is able to mitigate erosion, harvest rainwater, diversify crops, restore habitat, and recharge groundwater all on the same site. Yet the greatest advantage lies in the fact that each of these strategies is independent from the others. The farmer need only implement what is fiscally or environmentally feasible on their site.

In addition to the ecological and economical benefits of strategies like the ones I have introduced, it is important to consider the cultural and aesthetic dimensions of tactical ruralism in the Mekong Delta. Because all of the strategies focus on locally sourced media and materials (plastic from waterways and plants from wild or locally grown seedlings) they evoke a rich and living vernacular characteristic of the time and place which MDR residents find themselves. It may not be what many consider to be 'high design', but is nonetheless significant.

An Ecoregional Matrix of Expedience

In his *Framework for Geodesign*, Steinitz professes "The referential link between the entity being designed and its geographic context provides the tangible basis for doing both science-based and value-based design."[122] It is thus important to contextualize the proposed tactical ruralism interventions. There are number of ways to organize these strategies, whether it be by material, cost, type, or number of benefits, to name a few. I have chosen to utilize a matrix that sorts strategies according to expedience, lifespan, and ecoregion. Those categories are:

- *Retract and Stabilize* – these are strategies that are imperative to meeting human needs in the present. The "drop everything and do this now" projects that will have more immediate efficacy the sooner they are implemented and just as immediate repercussions if ignored. They often include ceasing an unsustainable or damaging practice immediately (e.g. over extraction of groundwater using tube wells) and taking measures to mitigate that damage while still sustaining livelihoods (e.g. transitioning to rainwater harvesting and storage using plavel modules). These measures are usually best seen as transitional methods that will eventually be phased out once the household is stable and well off enough to implement more long-term interventions; thus, the phrasing 'Retract and Stabilize'.

- *Restore* – restoration strategies are of a similar expedience to Retract and Stabilize strategies as they apply to repairing tried and true ecological and cultural systems that are at risk of being permanently lost (e.g. Tonle Sap Peat Swamp Forest, sustainable smallholder farming methods, etc.) if no action is immediately taken.

[122] Steinitz, *A Framework for Geodesign: Changing Geography by Design.*

- *Adapt* – adaptation strategies fall in the mid-range of expedience and lifespan, mostly due to the fact that they require some nimble experimentation. While they can easily be implemented right away, they may have to be adjusted as trial and error teach us more about their long-term effectiveness. Examples include adaptive crop systems, living structures, or integrated agriculture-aquaculture systems.

- *Sustain* – strategies that have a high likelihood of long-range success in sustaining ecologies, livelihoods, and social structures. They tend to function simultaneously at the household and regional (even global) scale, which is part of what makes them so sustainable. Truly impactful solutions for climate change adaptation must have both a worldwide and a local functionality that are mutually accessible.

CHAPTER 4. Disruptive Đổi Mới: Introducing Tangible Landscape to the Mekong Delta

The World Bank team in Southeast Asia sees the potential of using a methodology known as Tangible Landscape as a participatory planning tool for climate change resilience planning, and has in turn hired Louisiana State University professor and Tangible Landscape developer Brendan Harmon, along with a team of consultants (myself included) to develop an application of the method tailored to the Mekong Delta to illustrate key issues and scenarios through a series of stakeholder workshops. In the ensuing chapter I will define Tangible Landscape as a method, conceptualize a transect of the Delta from which to base a Tangible Landscape model, explore several sustainable design interventions that we could potentially model using Tangible Landscape, and present a suitability analysis to identify potential sites for applying those interventions.

What is Tangible Landscape?

Before delving into the details about my approach to assembling a tangible model application for the Mekong Delta, it is important to define what a tangible user interface (TUI) is and to establish where Tangible Landscape falls under its broad umbrella. The idea of a TUI evolved from works such as Bishop's Marble Answering Machine or Fitzmaurice et al.'s Graspable User Interface into a proposal by Ishii and Ullmer for a new type of human-computer interaction wherein an interface could "make computing more natural and intuitive by coupling digital bits with physical objects as Tangible Bits." The goal was to bridge the digital and the physical, giving more "manual dexterity and kinesthetic intelligence and situating computing in physical space and social context." [123] As Petrasova et al. put it, "understanding and manipulating 3D data using a GUI [graphical user interface] on a 2D display can be highly unintuitive, constraining how we think and act. Being able to interact more naturally with digital space enhances our spatial thinking, encouraging creativity, analytical exploration, and learning."[124]

There are various types of TUIs in use such as shape changing interfaces like inFORM, augmented architectural interfaces like Urp, or augmented clay interfaces like Illuminating Clay.[125] Tangible Landscape is considered an augmented sandbox interface, a TUI which "couples a sandbox with a digital terrain model through a cycle of sculpting, 3D scanning, computation, and projection" (see *Figure 26*). The developers of Tangible Landscape describe its concept and application thus:

> "Tangible Landscape couples a physical model with a digital model in a real-time feedback cycle of 3D scanning, geospatial modeling and simulation, and projection and 3D rendering. For example, by sculpting the terrain of the physical model, we can see how the changes affect processes like the flow of water, flooding, erosion, and solar irradiation. Thus we can easily and rapidly test ideas while being guided by scientific feedback, exploring a much a larger solution space and make more creative and informed decisions."[126]

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[123] Petrasova, Anna et al., *Tangible Modeling with Open Source Gis*.
[124] Petrasova, Anna et al.
[125] Petrasova, Anna et al.
[126] Petrasova, Anna et al.

Figure 26. Example of a Tangible Landscape model (from Petrasova et al.)

Tangible Landscape has been used for applications ranging from grading and analyzing landforms to modeling water flow and soil erosion, to landscape design. It utilizes open source GIS and rendering software and is relatively low cost—requiring only a physical model, 3D scanner, projector, and a computer installed with GRASS GIS and necessary software for connecting the components. Furthermore, since many users can interact with the physical model at once, Tangible Landscape "encourages collaboration and interdisciplinary exchange," with the qualitative and quantitative precision needed for real-world design applications.[127]

Modeling a Livelihoods Transect

Since the consultant team will not be able to visit a site to collect data before the initial workshop, it is incumbent upon us to do our due diligence using available documents and data and to create an abstract but relevant concept model to demo during the World Bank's Mekong Delta Forum. For my part, I have decided to analyze a transect of the Delta from the provincial city of Can Tho using aerial imagery and available data from the Mekong River Commission

[127] Petrasova, Anna et al.

and create a cross sectional model focused on typical MDR livelihoods (farming, fishing, crafts) and their relationship to waterways (see

Figure 27*)*.

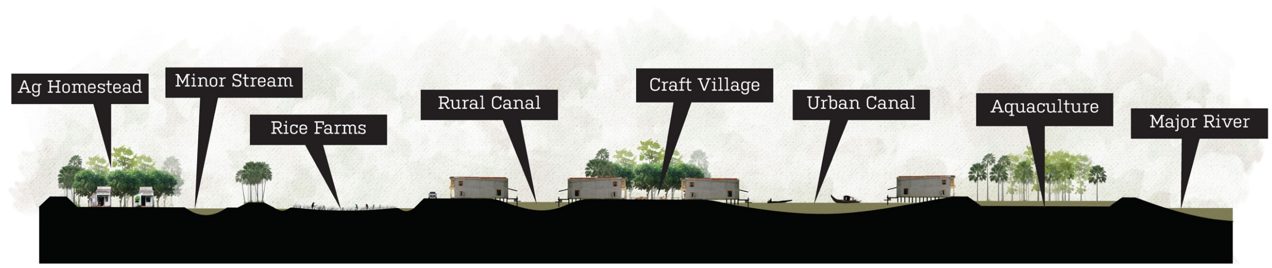

Figure 27. Conceptual transect of Mekong Delta livelihoods

The transect is broken down into the following sections:

- Tree Farm Homestead – A recent development in diversifying MDR crop systems. Normally includes row cropping of fruit or fuel trees and can often be part of a larger farm that includes rice fields.

- Minor Stream – A natural water body that often meanders through or adjacent to homesteads. Act as small riparian corridors. Generally between 4 – 7 meters wide.

- Rice Farms – The most commonly occurring land use in the Delta. Can include rain fed or irrigated rice paddies (though the latter is increasingly more common). Depending on the water delivery system, fields range from single to triple cropped rice.

- Rural Canal – The principal distributaries feeding the rice fields. Normally sit channelized at a higher elevation than the paddies with dykes and roads separating them. A number of village residents may be living along these water bodies. Between 6 – 10 meters wide.

- Craft Village – A small village dedicated to traditional Vietnamese crafts such as woven sedge mats, hats, fishing nets, etc. The Can Tho area has instituted initiatives to help practitioners in establishing their production homesteads as eco-tourism sites showcasing the beauty and sustainability of traditional making.

- Urban Canal – Most densely populated distributaries. Normally includes various housing types[128] from which an occupant can easily access the water. Some of the most susceptible to flooding and streambank erosion in Can Tho. Generally 30 – 70 meters wide.
- Aquaculture or shrimp farm – Ponds for fish or shrimp farming. Normally walled in by dykes and include floodgates which operators can open to set water levels. Many lie along the edges of major waterways and are highly susceptible to subsidence and erosion. Sizes vary depending on site.

- Major River – In the case of this transect, the Song Hau River, which varies between 170 and 200 meters wide. Includes a variety of edge conditions from natural to aquaculture, to stilt houses to river gardens.

How to Construct the Model

Utilizing the above cross section as a guide, I have used the software program Rhinoceros to build a digital model (see *Figure 29*) that reflects the average amount of space each typology would occupy and cropped the surface into a 250m x 125m area (31,250 m^2). The surface is then scaled down to a size appropriate for a Tangible Landscape demonstration (roughly 60cm x 30cm with slight vertical exaggeration makes for an approachable model) and prepared for 3D printing and/or CNC milling. The fabricated mold can then be packed with kinetic sand to form a topographical model which represents typical existing conditions for each landscape typology. This model is then projected onto and calibrated using GRASS GIS, after which the user can begin sculpting and placing interventions on the landscape while receiving real-time feedback of the effect their interventions would have on things like flooding, erosion, viewsheds, etc. (see *Figure 28*).

[128] Thi Hong Hanh and Duong, "Morphology of Water-Based Housing in Mekong Delta, Vietnam."

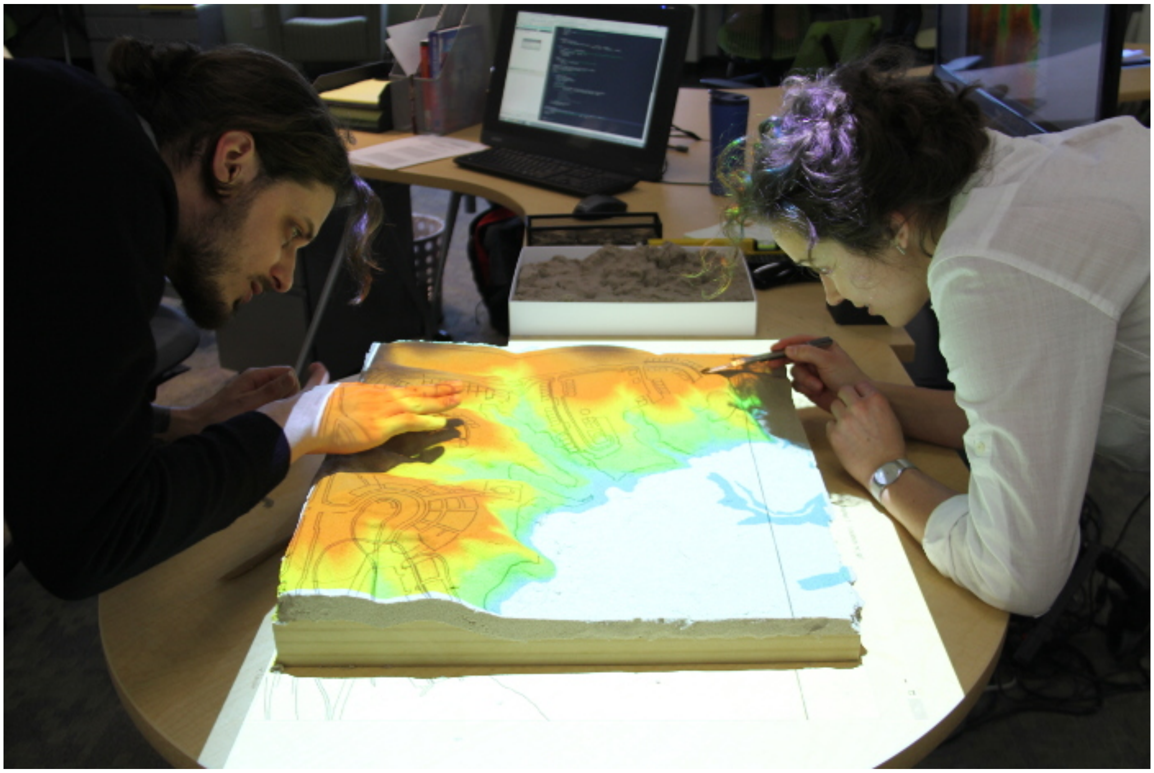

Figure 28. Tangible Landscape users sculpting topography and receiving real-time feedback (from Petrasova et al.)

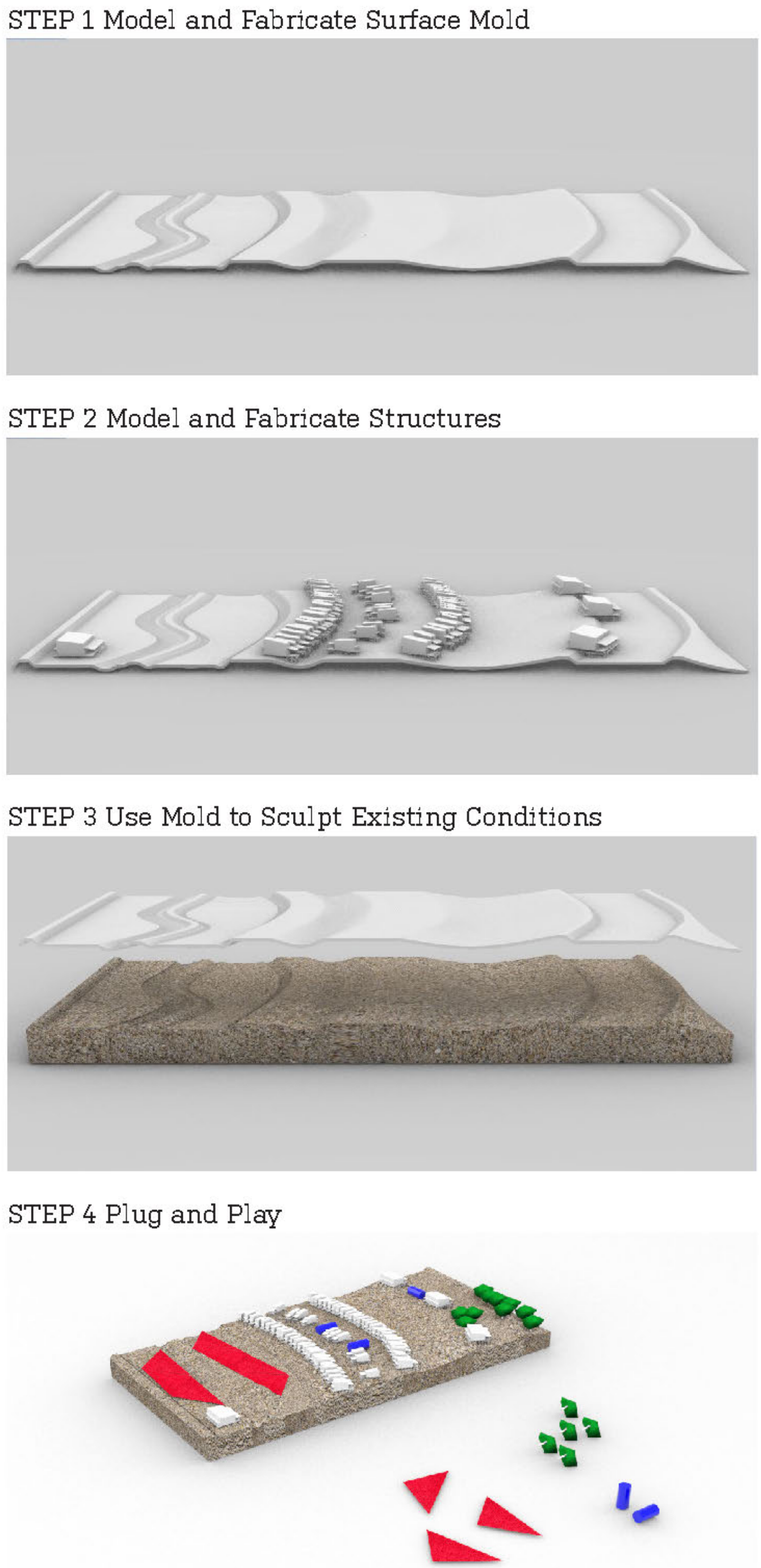

Figure 29. Steps for preparing a Tangible Landscape model

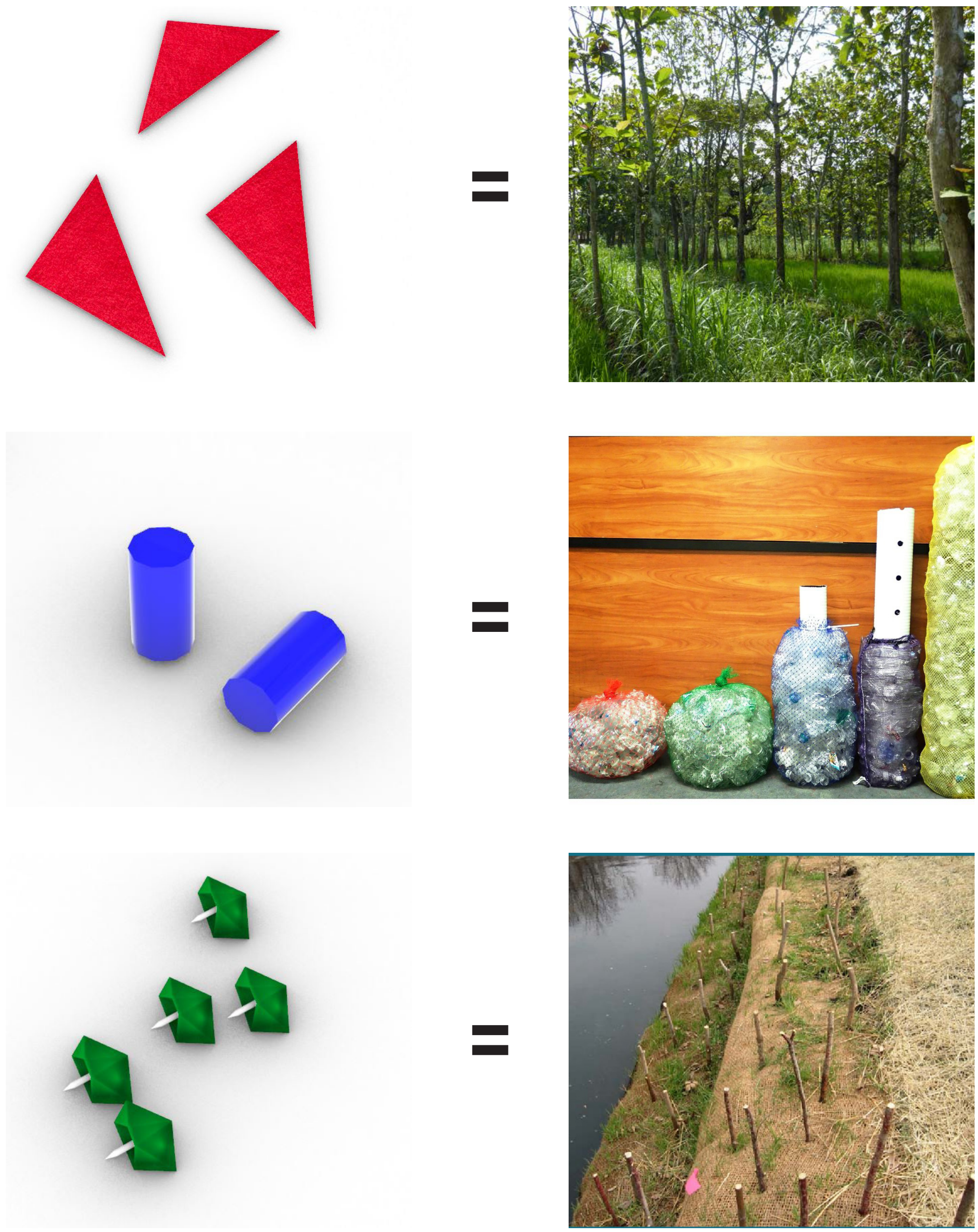

Figure 30. Distinct materials can be recognized by the scanner as specifically defined design strategies while modeling

How to Represent Strategies

To inform our Tangible Landscape scenarios, I will extract from the tactical ruralism case studies three strategies to be represented on the model—one for agroforestry plantings, one plavel rainwater filtration system, and one hybrid living structure for streambank stabilization. The strategies can be physically represented in two ways: either using a single material with three distinct colors (such as triangular felt pieces with each of the primary colors representing a strategy e.g. red for plantings, blue for plavel, yellow for living streambank structure) or using three distinct objects with different colors and textures (such as red felt for plantings, tiny bags of clear plastic beads for plavel modules, and green rubber cylinders for streambank structures). Either option is feasible so long as the chosen materials can be distinguished by the scanner (see *Figure 30*). Depending on what part of the Delta Region we choose to represent, we can calibrate the assumption that the interventions are reflective of the ecoregion in which they are being implemented. For example, a living streambank structure placed in the Tonle Sap Freshwater Swamp region can include live stake cuttings of *Barringtonia acutangula* while it might be bamboo and *Sonneratia pagatpat* in another; an agroforestry planting in the Plain of Reeds can be an alley cropped mosaic of fruit trees, rice paddies, and *Melaleuca cajuputi* while the same strategy on the coast will be shrimp-mangrove systems. Tangible Landscape allows for this flexibility while still re-projecting relatively precise and site-specific results back to the user.

Tangible Landscape as a Participatory Planning Tool

Perhaps one of the greatest challenges for designers, scientists, planners, and geographers when trying to engage stakeholders is the often unrelatable process of mapping. Spatial thinking is "used pervasively in everyday tasks such as recognizing things, manipulating things, interacting with others, and way-finding." We are all spatial experts of our everyday lives without really needing to study it. Yet expressing sharing that expertise in a 2D representations can be cumbersome, especially in cultures that do not customarily rely on traditional western forms of mapping. Tangible Landscape offers a way to overcome this barrier, as its 3D interface allows users to "cognitively grasp and absorb it, thinking with it rather than about it."[129] [130] As Petrasova et al. state, "embodied interaction should be highly intuitive—drawing on existing motor schemas and seamlessly connecting intention, action, and feedback. It should reduce users' cognitive load by enabling them to physically simulate processes and offload tasks like spatial perception and manipulation onto the body."[131] Tangible Landscape can therefore enable users to "subconsciously, kinesthetically judge and manipulate spatial distances, relationships, patterns, 3D forms, and volumes offloading these challenging cognitive tasks onto their bodies."[132] [133] Thus, in overcoming the cognitive barriers to receiving spatial expertise, Tangible Landscape model can substantially progress the World Bank's goal for the Mekong Delta initiatives "to

[129] Petrasova, Anna et al., *Tangible Modeling with Open Source Gis*.
[130] David Kirsh, "Embodied Cognition and the Magical Future of Interaction Design."
[131] Petrasova, Anna et al., *Tangible Modeling with Open Source Gis*.
[132] Petrasova, Anna et al.
[133] Jeannerod, *The Cognitive Neuroscience of Action*.

support knowledge sharing, policy development and strengthening of sector investment programs…to inform relevant downstream operations either in form of investment projects or policy operations."[134]

[134] Nagaraja Rao, Harshadeep and Acharya, Anjali, "Terms of Reference for Consultancy Service: Bringing Disruptive Technology to the Mekong Delta: Tangible Landscape."

CHAPTER 5. The Need for a Living Vernacular

Discussion

In developing a conceptual Tangible Landscape model for the Mekong Delta, it has become clear that while the benefits of Tangible Landscape to the World Bank project are numerous and the strategies included in the model sound, viable, and regionally relevant, they are nothing without interaction. The consultancy team can tinker around with the model for hours on end and most likely produce some interesting design solutions, but it is only when the interface is used by the actual farmers, fishers, and makers living on the Delta can it become an effective tool for communicating needs and recommendations to the World Bank, MRC, and their partners. As a remote maker of the model, I have the disadvantage of being divorced from a spatial understanding of the fields, rivers, and ponds that Delta residents live and work in every day. As a consultant, I can offer them certain knowledge, ideas, and methods, upon which they can apply their wisdom of a place and to improve the methods and ideas to better fit the needs of that place. My strategies might be good on paper, but their wisdom will make them good in practice. Local stakeholders can also provide the Bank and colleagues with new ideas for strategies that would not otherwise have been thought of without experiences endemic to a certain locale being applied to a tangible modeling scenario.

Perhaps the most important insight gained from this process is the overwhelming need for a greater framework into which Tangible Landscape can fit into. Neither Tangible Landscape nor the proposed theory and strategies of tactical ruralism can profess to be silver bullet solutions for the multi-faceted environmental issues of the Mekong River Basin. They can however be invaluable tools for knowledge sharing, ideating, and collaboration when embedded within the proper infrastructure. While it is not the purpose of this thesis to pinpoint or propose this framework, it is sufficient to say that one is needed. It may take many forms, whether it be an online platform that retools the existing website for the Mekong River Commission and makes the community forum aspect a more robust knowledge center, a smartphone app (nearly all of Vietnam now owns or uses the technology)135, or a completely new entity which acts independently of the MRC with both an online, print, and brick and mortar presence in the Delta. Mekong Delta residents need a framework within which they can sustain a living vernacular—one which has a universally intelligible yet constantly evolving culture, language, aesthetic, and ecological knowledge base that is enhanced by tools like Tangible Landscape.

Conclusion

The main goal of this thesis was to inform an impending consultancy with the World Bank by answering two questions: What are the most pressing issues affecting the livelihood of the Mekong Delta Region? And what is the role of Tangible Landscape in addressing those issues? I can conclude with confidence that both of those questions have been answered, though in the process we have garnered more additional questions that we simply cannot address in this venue.

The Mekong Delta Region is the breadbasket of southeast Asia, fed by a river basin with an incredibly varying morphology that supports rich biodiversity. Because the basin cuts through

[135] "Smartphone Users Cover 84% of VN Population."

six countries, coordination and compromise over the use of resources can be fraught and difficult, especially in the current geopolitical context. To that end, the Mekong Delta Region essentially finds itself stranded on an island of uncertainty where hydropower activities, broad deforestation, and habitat destruction contribute to more volatile hydrodynamics from upstream while climate change creates severe weather patterns and sea level rise creeps in from the coast. Further exacerbating the problem is the widespread ecological degradation over the last half century coupled with unsustainable agricultural practices which cause subsidence and compromise water quality.

Many entities, both governmental and non-governmental have taken note of these challenges and sought to address them at the broadest scale possible. While improvements have certainly been made, there is great opportunity for MDR residents to address these issues at the more feasible yet effective scales of governance—household, commune, ward, and district—by introducing principles of *tactical ruralism*, scalable, short-term, and low-cost interventions in the landscape which are meant to catalyze long-term change.

Tangible Landscape offers an ideal platform for testing tactical ruralist interventions, as it provides farmers, fishers, and makers with a more intuitive way of ideating on their land and facilitates knowledge sharing in a less contrived manner than traditional 2D mapping. It also has the potential for greater buy-in from stakeholders as they take a more active and literal role in designing (and hopefully implementing) solutions for adapting their land to climate change.

Despite the apparent usefulness of a Tangible Landscape model driven by the theory and strategies of tactical ruralism, it is only as effective as the audience it reaches; thus, it is vital that it be used by the actual residents of the MDR and not just the consultants before it is considered a source from which to draw policy recommendations for the World Bank team. It is also not an overarching solution for promoting climate resilience nor is it meant to be. Its principal role should be that of a tool integrated into a greater framework for knowledge sharing and collaboration across the basin. Every regional phenomenon is an amalgamation of individual decisions made in specific locales. Thus, any strategy to address climate resilience does not become truly 'sustainable' until its effects are understood and accepted by everyone in the watershed. That requires both individual and collective communication across the basin at a level more meaningful than simply getting on a social media forum and posting "Hello, please don't build a dam." The effects of climate change do not respect the traditional 'boundaries' of academic expertise and must therefore be addressed by working across disciplines. The need has perhaps never been greater for a framework which helps designers and citizens alike to more easily comprehend what it means to intervene in the landscape at different scales, what the sociopolitical and environmental implications of each intervention are at each respective scale, and what areas there is opportunity (or necessity) for interdisciplinary coordination in the quest for climate resilience.

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VITA

Phillip Fernberg is a Master of Landscape Architecture Candidate in the Robert Reich School of Landscape Architecture at Louisiana State University. He is also a husband, father, linguist, philomath, musician, surfer, and travel junkie. While traveling the world as a performer, Phillip became fascinated with the phenomena of public open spaces and how dramatically they can be influenced by design decisions. This passion led him through years of eccentric major-shopping and job-hopping before finally finding a dream discipline in landscape architecture. Growing up on the pristine coastlines of Southern California imbued Phillip with a love for living systems, and subsequently a passion for using landscape architecture as a tool to reveal their stories. After graduation, he plans to continue honing his skills as a designer, researcher, and mixed-media storyteller to develop a process for managing vernacular landscapes in a changing world—including built-work, planning, and knowledge sharing strategies. He looks forward to building a career as a design generalist, in whatever capacity that may be.