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Preservation and Use of Natural Resources in the Developing World:

A case study of the Can Gio Biosphere Reserve,
Ho Chi Minh City, Vietnam.

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Preservation and Use of Natural Resources in the Developing World

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Introduction

Developing nations often overlook the environmental effects of industrialization. However, these nations need healthy, sustainable resources in order to become prosperous and stable countries. Additionally, developed nations depend upon the natural resources of developing nations as raw materials. Loss of natural resources in developing nations therefore has effects at both national and global levels. A key challenge across the globe is balancing the human need for development with the necessity of the sustainable use and protection of natural resources. In the process of finding this balance, developing nations are revising both their national definition of conservation as well as the global definition.

The purpose of my study is to use the Can Gio Mangrove Biosphere Reserve in Ho Chi Minh City, Vietnam, as a microcosm of the global relationship between natural resource use for development and natural resource preservation. Can Gio is also a unique space in which to analyze the evolving concepts of environment and conservation in Vietnam. The site spans gradients that are both natural and cultural: from the marine ecosystem to the terrestrial ecosystem, from urban space to rural space, and from local to global conservation efforts. The history of Can Gio has been shaped by war, by the demands of economic development, and by modern ideas about environmental conservation. The efforts to balance development while maintaining a productive environment in Can Gio are a reflection of the worldwide efforts to conserve natural resources and foster development. I will begin with a general discussion of the recent changes in conservation management from an exclusionary protected model to one rooted in community-based conservation, and follow this with a short discussion of the goals

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of the Biosphere Reserve Program and the conservation approach the program promotes. I will then provide an introduction to mangrove ecology, including the adaptations that allow mangroves to persist in high stress environments as well as the ecological services that mangrove forests provide to organisms and to surrounding environments. Next I will discuss the history of what is now the Can Gio Mangrove Biosphere, from the time of the Vietnam-American War to the creation of the biosphere in 2000. Finally, I will review the current state of the biosphere, describing the tensions that arise in a space that is at the same time a threatened environment, the source of economic stability for hundreds of people, an attractive tourist site, and a part of a global network committed to conservation.

Overview of Modern Conservation Strategies

The motivations behind conservation vary from individual to individual. Some arguments are based upon a utilitarian worldview: resources are finite, so efforts must be made to conserve the natural space that supports resources we value. Other arguments are aesthetic: green space and natural vistas are beautiful and should be conserved for human enjoyment. Spiritual arguments question the morality of driving other species to extinction. Throughout the history of the conservation movement, different arguments have held prominence at different times and have shaped contemporary conservation models and philosophy.

The dominant environmental conservation paradigm up until the 1980's was the exclusionary protected areas model. This model originated in the 1800's, with the development of the national parks program in the United States and grew with the creation of additional protected areas such as wilderness areas. The exclusionary paradigm conceives of nature and culture as separate entities.¹ A classic example of this position is found in the 1964 US Congressional Act establishing the Wilderness Preservation System. In this document, wilderness is defined as "an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain".² These two spheres, man and nature, are clearly defined as separate, ideally non-overlapping entities. In this paradigm, man has a negative impact

¹Fikret Berkes, "Rethinking Community-Based Conservation," *Conservation Biology* 18, no. 3 (2004): 621

²"Wilderness Act of 1964," *Wilderness.net*. Accessed April 3, 2011, <http://www.wilderness.net/index.cfm?fuse=NWPS&sec=legisAc>

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on wilderness and therefore natural space must be protected from human influence. Consequently, establishment of exclusionary protected areas almost always involves the forced removal of local populations and a management philosophy that is built around limiting human activities within protected areas.³

Exclusionary management developed in the United States; a country with an environmental and social history that is very different from the majority of the world's nations. When the United States began establishing protected areas, the country still had vast tracts of unsettled or sparsely settled land which could be set aside without displacing a large population or restricting future population growth. The United States was, and has remained, an affluent nation and can afford to leave resources unutilized and enforce laws protecting natural sites.⁴ Finally, the United States has a unique cultural conception of natural space and "wilderness" that stems from the experiences of European colonialists and their descendants with the relatively untouched natural resources of North America.⁵ In contrast, many nations, particularly developing nations, lack the luxury of unutilized space, affluence, or both, as well as a cultural worldview that separates people from the environment. As a result of these differences, exclusionary management has had mixed results across the globe. The challenges and failures of exclusionary management in the developing world over the last thirty years have led to the development of a new model called Community-Based Conservation (CBC).

CBC (also known as participatory management) emerged in the mid-1990's in response to a number of critiques of exclusionary management.⁶ The first had to do with the ethical consideration of forcibly removing inhabitants from protected sites. Second was the restriction of local use of a site, particularly of poor communities who could benefit from a site's resources. Third, some human activities, such as controlled burning, do have positive effects on environments, and in some cases restricting humans from a site has contributed to a decline in biodiversity.⁷ CBC seeks to foster biodiversity conservation through

³Sharachchandra Lele, Peter Wilshusen, Dan Brockington, Reinmar Seidler, and Kamaljit Bawa, "Beyond exclusion: alternative approaches to biodiversity conservation in the developing tropics," *Current opinion in environmental sustainability* 2, iss.1-2, 94 (2010): 2. DOI 10.1016/j.cosust.2010.03.006

⁴Roderick Nash, "The American Invention of National Parks," *American Quarterly* 22, no.3 (1970): 733.

⁵Nash, "The American Invention," 728.

⁶Lele, "Beyond Exclusion," 1.

⁷Lele, "Beyond Exclusion," 1.

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community involvement and emphasizes a decentralized, bottom-up approach to management.⁸ The guiding philosophy behind CBC states that by giving communities a stake in a site—through economic rewards, social development, or by simply providing a place for community input in site management—sites will be better protected.

CBC is a developing model. Some projects have been successful in protecting biodiversity and encouraging community growth, while other projects have failed. Opinion is divided as to why CBC has not succeeded universally. Some experts contend that by linking conservation to development, both efforts are undermined, while others say that failures are due to improper implementation and community involvement.⁹ However there is a general acknowledgement among many organizations and individuals involved in conservation that in an increasingly human dominated world and given the needs of developing nations, exclusion of people from natural preserves is not a viable model. Community-Based Conservation will therefore remain a relevant conservation model in the coming decades.

The ideas that produced CBC have their roots in the 1970's, when the environmental movement expanded beyond the national level to become a global movement. It was during this time that the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere Program (MAB) was founded. The MAB program strives to address "the economic, educational, scientific, cultural, and recreational needs of humankind."¹⁰ An integral part of this program is the biosphere reserves, which act as 'living laboratories' for research and education. The goals of biosphere reserves are to conserve ecological and genetic biodiversity, foster socio-ecologically sustainable development, and support research, education, and information exchange relating to local, national, and global issues of conservation and development.¹¹ While the MAB program does not require biosphere reserves to follow a specific management strategy, it does encourage them to consider what is known as the ecosystem approach when developing

⁸Lele, "Beyond Exclusion," 4.

⁹Berkes, "Rethinking CBC," 625

¹⁰The MAB program United States of America, "Background – MAB United States of America." Accessed October 11, 2010. <http://www.rmrs.nau.edu/usamab/What%20is%20MAB.htm>

¹¹UNESCO, "Man and Biosphere Programme FAQs: Frequently asked Questions on Biosphere reserves." Accessed October 11, 2010. <http://www.gov.mb.ca/conservation/wno/status-report/fa-8.19.pdf>

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their individual management strategies. This approach calls for decentralization of management, consideration of ecosystems within an economic context, and the involvement of scientists, businesses, organizations, and communities in flexible long-term planning.¹²

The MAB Reserve Program and community-based conservation are part of a wider paradigm shift in ecology and conservation towards a systems view of the world. As the human population continues to grow, greater demand is placed on natural resources, and old models and answers become less relevant. This is particularly true in developing countries like Vietnam, where environmental protection laws are weakest and where impoverished communities need the natural resources found in preserves like the mangrove forests of Can Gio. To understand the value of the natural wealth that is Can Gio requires a discussion of mangrove ecology, its relationship to marine and terrestrial ecosystems, and the benefits mangrove forests provide to humans.

Mangrove Ecology

'Mangrove' refers to an evolutionarily diverse group of trees that share similar physiological adaptations as a result of living in areas with similar environmental conditions, rather than sharing a common ancestor.¹³ To define a mangrove therefore is to define the environment in which mangroves are found and the adaptive traits that allow them to thrive. Mangroves grow in sheltered coastal intertidal areas in the tropics and sub-tropics, in the transition zone between the marine and terrestrial ecosystems.¹⁴ This is a high stress, dynamic environment, with widely varying conditions. Salinity ranges from that of saltwater during high tide to almost freshwater during heavy rain. Daily tides submerge roots and trunks while wave action buffets trees. Soil in these areas is generally low in dissolved oxygen, high in salts, and acidic.¹⁵ Despite all these challenges, mangroves persist and survive in an environment most plants find uninhabitable. The key to mangrove survival is their adaptations.

Mangroves face four major challenges living in the intertidal environment: high soil salinity, water loss, soil instability, and low levels of dissolved oxygen in the soil. High soil salinity poses two main threats

¹²UNESCO, "Solving the Puzzle: The Ecosystem Approach and Biosphere Reserves," Unesco, Paris (2000): 4.

¹³William J. Mitsch and James G. Gosselink, *Mangroves*, (New York: Van Nostrand Reinhold, 1986), 231.

¹⁴Mitsch, *Mangroves*, 232.

¹⁵Mitsch, *Mangroves*, 238-240

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to mangroves: high external salt concentration draws water from the plant roots into the soil, thereby desiccating the plant, while a high internal salt concentration will eventually poison the plant. Mangroves therefore actively regulate the amount of salt in their system by either excluding salt at their roots, excreting excess salt from specialized glands in their leaves, or storing salt in leaves before the leaves fall.¹⁶ The high salinity of the environment coupled with the warm temperatures makes it difficult for mangroves to acquire and retain fresh water. Because of this, mangroves have many adaptations similar to those of desert plants that allow them to conserve water, including hairy or waxy leaves that reduce evaporation, fleshy leaves in which to store water, and thorns or toxins to discourage herbivory.¹⁷

Dessication:

The harmful removal of moisture from a plant

The soil of mangrove swamps is often more water than earth. This, coupled with the tidal waves that inundate forests, makes it difficult for a tree to remain stable. To stay upright, some species like the black mangrove, *Avicennia*, use a wide, shallow root system to anchor themselves, while others such as the red mangrove, *Rhizophora*, grow above-ground prop roots from their trunks and branches that provide extra stability. Root adaptations play an additional role in mangrove survival by combating the problem of low dissolved oxygen in the soil. Plants require oxygen for respiration, the process by which sugars are broken down to release energy. While oxygen is always plentiful in the air, the soil in intertidal zones is low in dissolved oxygen. Mangroves use above-ground roots to supply oxygen to the below-ground root system. The prop roots of *Rhizophora* are covered in small pores called lenticels which absorb oxygen, while *Avicennia* sends up pneumatophores, small hollow roots, which function like a diver's snorkel to take in oxygen.¹⁸ The absorbed oxygen is released into the soil and creates an aerobic layer around the entire root system.

These adaptations—prop roots, salt glands, etc.—increase the mangroves' chances of survival in the intertidal zone and of successful reproduction. Mangrove reproduction is another defining adaptation of

¹⁶Mitsch, *Mangroves*, 243-245

¹⁷Mitsch, *Mangroves*, 243-245

¹⁸ Mitch, *Mangroves*, 243-245

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this group. Mangroves are part of a non-phylogenetically related group of viviparous plants. The offspring of viviparous organisms develop on or in the parent, as opposed to emerging from eggs or seeds after leaving the parent. In the case of mangroves, the seed germinates while still on the parent plant, which will often provide its offspring with nutrients while it grows.¹⁹ Eventually, the seedling or fruit drops off the tree and floats in the water until it finds a site, sometimes traveling in ocean currents for hundreds of miles. Some mangrove seedlings can survive at sea for up to a year, while others can sprout and grow underwater, relying on embryonic food stores until they break the water's surface.²⁰ Vivipary allows mangroves to increase their offspring's chance at surviving in this harsh environment, as well as colonize sites many miles away.

The presence of mangroves along the shoreline enhances the ecology of the intertidal zone and the surrounding ecosystems. Like other *ecotones*, mangrove forests act as a buffer for surrounding ecosystems. The roots of mangroves trap and hold soil, thereby preventing coastal erosion, as well as filtering sediments from water flowing into the ocean. Mangrove forests provide food and habitat for many marine and terrestrial species, including juvenile fish, amphibians, and birds. They also protect inland regions from tidal surges and tsunamis. A study published in 2009 found that a mangrove forest with a density of 0.2 trees per square meter could reduce tsunami inundation depth by 30%. Another study in 2005 reported a significant correlation between the increased presence of coastal mangroves and decreased storm damage during the 2004 tsunami in Thailand.^{21,22} In addition to benefiting from these ecological services, Humans also use mangrove forests as sources of timber, charcoal, and medicine. Mangrove forests therefore enhance both the health of surrounding ecosystems and the quality of life for humans living in and around these forests. So far I have discussed the general background knowledge that shapes the Can Gio Mangrove Biosphere Reserve: the

Ecotones: A transition zone between two major ecological communities

¹⁹Ria Tan, "Mangrove Trees," Accessed October 27, 2010. http://www.naturia.per.sg/buloh/plants/mangrove_trees.htm

²⁰Ria Tan, "Mangrove Trees," Accessed October 27, 2010. http://www.naturia.per.sg/buloh/plants/mangrove_trees.htm

²¹Hideaki Yanagisawa et al., "The reduction effects of mangrove forest on a tsunami based on field surveys at Pakarang Cape, Thailand and numerical analysis," *Estuarine, Coastal, and Shelf Science* 81, iss. 1 (2009): 32.

²²T. J. Oyana, W. Sun, and P. Sirikulchayanon, "Buffering functions of mangroves in the 2004 tsunami," *International Journal of Digital Earth* 2, no. 3 (2009): 270.

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shifting relationship between man and nature and the complexities of mangrove ecology. I now turn to the specific case of Can Gio: its history, the emergence of a CBC management model, and the relationship—both negative and positive—between the Vietnamese and the mangrove ecosystem.

History of Can Gio

The Can Gio mangrove forest is situated about 65 km southeast of downtown Ho Chi Minh City (formerly Saigon), on soil deposition from the Saigon-Dong Nai River system. During the Vietnam-American War, the forest, then called Rung Sat, was the home of a North Vietnamese base. From this base the North Vietnamese soldiers would attack ships carrying supplies and troops up and down the Saigon River to Saigon. Early in the war this was a 'safe zone' for the North Vietnamese. They were protected by the mangrove forest, which was, in the words of a 1962 army report, "practically impenetrable and therefore not feasible for ground operations."²³ The mangrove forest was a tactical nightmare for American troops; soldiers and vehicles sank as much as three feet into the soft mud, movement was hampered by prop roots, and troops traveling in mangrove forests risked finding themselves flooded at high tide.

The solution to the tactical problem of Rung Sat came in 1962, when the United States began using herbicides such as Agent Orange and Agent Blue to destroy plant cover and agricultural crops in Vietnam.²⁴ The goal of this deforestation campaign was to deprive the enemy of forest cover, food, and a peasant support base.²⁵ From 1965-1970 approximately 300 herbicide missions were flown in Rung Sat, dispersing around 900,000 gallons of herbicides; 35% of the total amount sprayed on all of South Vietnam's mangrove forests.²⁶ Estimates of the extent of defoliation range from 50-70% of the forest area.²⁷ These dead and dying trees were collected by local Vietnamese for fire-wood, further contributing to the deforestation and leaving behind barren ground.²⁸

²³"Rung Sat Special Zone Intelligence Study." Accessed November 11, 2010. <http://www.mrfa.org/rungsat.htm>

²⁴Phan Nguyen Hong, "The Severe Impact of Herbicides on Mangroves in the Vietnam War and the Ecological Effects of Restoration," in *Ecological Destruction, Health, and Development: Advancing Asian Paradigms*, ed. Hisao Furukawa (Japan: Kyoto University Press and Trans Pacific Press, 2004): 177.

²⁵Maj. A. Buckingham Jr., "Operation Ranch Hand: Herbicides in Southeast Asia." Accessed October 23, 2010. <http://www.airpower.maxwell.af.mil/airchronicles/aureview/1983/Jul-Aug/buckingham.html>

²⁶Hong, "The Severe Impact," 179

²⁷IMABE Project, "Cangio Mangrove." Accessed October 17, 2010. <http://www.donimabe.org.vn/index.php?mod=content&id=77>

²⁸Le Duc Tuan et al., *Can Gio Mangrove Biosphere Reserve* (Oxfam, 2002), 21

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After the war ended in 1975, the People's Committee of Ho Chi Minh City issued a reforestation policy to rehabilitate the defoliated areas of Can Gio, in part of a larger effort to restore the greenbelt around the city.²⁹ The reforestation was primarily done by volunteer and re-educated youths, who had little training and poor technique. As a result seedling survival was low, but eventually approximately 60% of the defoliated areas in Can Gio were replanted.³⁰ Initially, the forest was classified as a productive forest and put under the management of Duyen Hai Forestry Enterprise.³¹ Duyen Hai management was based on what we would now call exclusionary management and was focused on supplying food and forest products to Ho Chi Minh City.³² However, this management model proved to be unsustainable and unproductive. The soils were too acidic and salty to support high crop yields and transportation to and from the city was difficult. Additionally, the poor inhabitants in and around the forest harvested mangroves illegally for fuel and to build shrimp ponds, contributing to deforestation and bringing the local people into conflict with Duyen Hai and the People's Committee.³³

This was a problem across Vietnam, as unsustainable forestry practices coupled with illegal forest harvest by disenfranchised citizens devastated all types of forests. In response, Committees turned to a new management model based on community-based conservation, which had started to emerge by this time. The goals of the community-based conservation in Vietnam are to "[empower] impoverished local people...to manage forest areas...[capitalize] on traditional knowledge...[and provide] a transparent means of support through the state-funded Management Board."³⁴ This new model was instituted in 1991 in Can Gio, when the People's Committee re-designated the forest as a productive forest and Duyen Hai Forestry Enterprise became the management board of the new park.³⁵ Under this management strategy, areas within the forest (an average of 100 ha) are allocated to a household for

²⁹ Tuan, Can Gio, 25

³⁰ Tuan, Can Gio, 25

³¹ Tuan, Can Gio, 25.

³² Ngoc Nam, "The role of households in mangrove management at Can Gio District, Ho Chi Minh City, Vietnam," in *Community Participation in Conservation, Sustainable use and rehabilitation of mangroves in Southeast Asia* (UNESCO 1996): 105.

³³ Vien, "The role of households," 105.

³⁴ Phan Nguyen Hong, "Can Gio: Turning Mangroves into Riches," in *In Search of Excellence: Exemplary Forest Management in Asian and the Pacific*, ed. Patrick B. Durst, Chris Brown, Henrylito D. Tacio, and Miyuki Ishikawa

³⁵ Tuan, Can Gio, 33.

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a minimum of 30 years.³⁶ Each household receives a monthly stipend of \$20 per hectare (USD) for protecting the forest by patrolling their plot, noting any disturbances or illegal activities, and then informing the park

management.³⁷ The households are allowed to supplement their income through approved activities such as thinning and aquaculture.³⁸

Today, the average farmer living in Can Gio earns 60 million Vietnamese Dong (approximately \$280 USD) each year from these activities, in addition to the protection stipend.

One **hectare(ha)** is equal to **10.000 square meters**.

100 ha is 1 square kilometer.

The results of the adoption of community-based conservation were positive; deforestation was dramatically reduced and many deforested areas were successfully replanted.³⁹ The healthy forest provided ecological benefits to Ho Chi Minh City and the surrounding area by preventing coastal erosion, filtering water flowing from the densely-populated and industrial Saigon-Dong Nai watershed, and protecting inland areas from storms and waves. Additionally, the monthly stipend stabilized the living standards of households involved in the new management model. This was an important development in a region that is still one of the poorest and least developed districts in Ho Chi Minh City.⁴⁰

The third and final re-definition of Can Gio came in 2000, when UNESCO's Man and the Biosphere Program designated Can Gio as Vietnam's first biosphere reserve.⁴¹ As a biosphere, Can Gio represents a unique and ecologically important landscape, with a management model that incorporates the participation of the local community. It contains a continuum of habitat from sea to forest to urban space that provides opportunities for research and education. Additionally, the biosphere designation strengthens the commitment of the national government to support and preserve this area and provides opportunity for the growth of environmental education in Ho Chi Minh City. Finally, the biosphere designation raises the international profile of Can Gio and connects it to

³⁶Tuan, Can Gio, 35.

³⁷Hong, "Can Gio: Turning Mangroves," 54.

³⁸Tuan, Can Gio, 35.

³⁹Phan Nguyen Hong, "Reforestation of mangroves after severe impacts of herbicides during the Viet Nam War: the case of Can Gio," Accessed November 12, 2010. <http://www.fao.org/docrep/004/y2795e/y2795e11.htm>.

⁴⁰Thoa Kim Le, "Final Report: Economic distribution and institutions in the recreation and tourism of mangrove biosphere reserve: case study of Can Gio Mangrove Biosphere Reserve, Vietnam." MAB Young Scientist Award Program. (2010): 8

⁴¹The MAB Program, "Biosphere Reserve Information: Can Gio." Accessed October 11, 2010. <http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=all&code=VIE+01>

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a global network of reserves.

The Current State of Can Gio

Currently, the Can Gio Mangrove Biosphere reserve covers 75,740 ha.⁴² Of that, 15.39% is made up of natural mangrove forest, 26.75% is plantation forest, and 30.9% is covered by water.⁴³ The remaining space is used for human activities. The forest that grows on the site today is much more diverse than the pre-war forest. The goal of restoration was never to recreate the forest as it was before the war. Managers planted a variety of indigenous mangrove species in order to preserve mangrove diversity and retain the ecological benefits of a mangrove forest.⁴⁴ Like other biosphere reserves, Can Gio is divided into three zones: a core area, a buffer zone, and a transition zone. Land within the core and buffer areas is owned by the government and used for conservation and low impact activities such as research, sustainable aquaculture, and ecotourism. The government also owns the transition zone, but leases the land to private users. The transition area of Can Gio is therefore the most developed and it is here that much of the economic activity that sustains the district occurs. The economy of Can Gio District is closely aligned with the health of the mangrove forest and its status as a biosphere reserve. The primary industries in the district are tourism, forestry products, salt-making, and aquaculture and fisheries activities. Of these, tourism and shrimp farming have the greatest impact on the mangrove forest.

Tourism began in Can Gio in the 1980's, when residents of other districts of Ho Chi Minh City began making day trips to the site. There are three main tourist sites in Can Gio. Within the forest are Forest Park and Vam Sat Nature Park. Forest Park features a historical museum, a restored model of the Rung Sat army base, and a monkey troupe.⁴⁵ Vam Sat Nature Park, established in 1998, contains a crocodile pool, a bat and bird reserve, and saltwater baths.⁴⁶ To the south, the April 30th Beach offers tourists beaches, restaurants, hotels, shops, and seafood.⁴⁷ There are also plans to add additional tourist sites to attract more

⁴²The MAB Programme, "Biosphere Reserve Information: Can Gio." Accessed October 11, 2010. <http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=all&code=VIE+01>

⁴³IMABE Project. "Cangio Mangrove." Accessed October 17, 2010. <http://www.donimabe.org.vn/index.php?mod=content&id=77>

⁴⁴Le Duc Tuan. Personal Interview. December 17, 2010.

⁴⁵Le, "Final Report," 9.

⁴⁶VNA, "Can Gio – attractive tourist destination," Accessed November 17, 2010. <http://english.vietnamnet.vn/travel/2007/02/665889/>

⁴⁷Le, "Final Report," 11.

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tourists, particularly sites that will be attractive to international visitors.⁴⁸

Today, Visitors from Ho Chi Minh City account for over 70% of all the tourists who visit Can Gio, while international tourists make up only 1%.⁴⁹ The focus of the government and managers of Can Gio is currently on attracting more international tourists to Can Gio, primarily through the development of green tourism. This is part of a country-wide effort to re-brand Vietnam as an ecotourism vacation site.⁵⁰ Tourism is the economic sector with the most potential to grow in Can Gio, and also the sector that can be the least disruptive to the mangrove forest, provided that the management board builds consideration for the health of the ecosystem into their development plans.⁵¹

In contrast to tourism, shrimp farming in Can Gio is primarily a destructive economic activity, though no less important to Vietnam's economy. In 2001, fisheries and shrimp products were the country's third largest export, earning approximately \$1.76 billion (US).⁵² Conditions in Can Gio support shrimp farming; the soft soils permeated by water are ideal for shrimp ponds. In 2005 approximately 5,264 ha of Can Gio was devoted to shrimp farming operations.⁵³ The reserve regulations restrict most shrimp farming activities to the transition zone, aside from the non-disruptive organic shrimp farming practiced by locals involved in community-based conservation. Shrimp farmers therefore have a limited area in which to farm, which results in the use of intensive farming practices in order to maximize production.⁵⁴ Intensive shrimp farming is the most environmentally destructive form of shrimp aquaculture, generating massive amounts of water pollution.⁵⁵ The water in the shrimp ponds must be constantly refreshed, and the effluent, which is released directly into the rivers, has a high concentration of fecal matter, uneaten feed, bacteria, and antibiotics, and is low in dissolved oxygen.⁵⁶ These conditions kill many organisms living in the river systems and also

⁴⁸Le, "Final Report," 12.

⁴⁹Le, "Final Report," 14.

⁵⁰Phan Nguyen Hong, Quan Thi Quynh Dao, and Le Kim Thoa, "Ecotourism in Vietnam: Potential and Reality," *Kyoto Review of Southeast Asia*, October 2002, http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue1/article_167.html

⁵¹Le, "Final Report," 37-38.

⁵²Xuan Tuan Le et al., "Environmental management in mangrove areas," *Environmental Informatics Archives* 1 (2003): 46.

⁵³Van Trai Nguyen, "The Influences of Shrimp Farming and Fishing Practices on Natural Fish Conservation in Can Gio, Ho Chi Minh City, Vietnam." (PhD diss., University of Newcastle, 2008): 5

⁵⁴Pham Thi Anh et al., "Water pollution by intensive brackish shrimp farming in south-east Vietnam: Causes and options for control," *Agricultural Water Management* 97 (2010): 874.

⁵⁵Nguyen, "Influences of Shrimp Farming," 36-37.

⁵⁶Xuan, "Environmental Management," 43.

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contribute to the spread of diseases to shrimp ponds downstream. However, proper sediment and wastewater treatment costs between 4-5 million dong (300 USD) for a 5000 m² pond, which is more than the cost of losing a crop to disease.⁵⁷ Therefore, it is not immediately economically viable for farmers to treat their water, even though the long term costs of water pollution and lost shrimp yields is high.

Aside from tourism and shrimp farming, salt-making is another significant economic activity in Can Gio. To make salt, sea water is allowed to flood shallow fields which are then edged off to prevent the water from leaving. The water evaporates in the sun, leaving behind salt. In 2007, the Sub-department of Agricultural Development and the Can Gio District Agriculture and Rural Development Board introduced plastic covers to the salt making process, which prevents salt from depositing directly on the soil and produces cleaner salt. This has increased salt production revenue by 20% in the district.⁵⁸ Currently, approximately 1,500 ha are used for salt making in Can Gio. Unlike shrimp farming, salt making does not produce large amounts of environmental pollutants and is less environmentally destructive. However, construction of the salt ponds does require clearing land, including mangrove forest.

The remainder of Can Gio's economy is made up of forestry products and agriculture. Most of the forestry products generated by the district come from plantations of mangroves, eucalyptus, and nipa palm, which are used for charcoal, construction, and thatching.⁵⁹ A small amount comes from management thinning, which is used to maintain "optimum nutritional area" around trees.⁶⁰ Some rice is grown in the north of Can Gio District, but yields are very low because of the salty soils.⁶¹ As a result of reserve policy and the environmental conditions of the site, agriculture and forestry makes up only a small percentage of Can Gio's economy.

The negative effects of human economic activities do not come

⁵⁷Anh, "Water pollution by intensive shrimp," 878.

⁵⁸Viet Nam Net, "Cleaner salt gives Can Gio farmers higher earnings." Vietnam News Network June 7, 200. <http://www.vietnammarkets.com/vietnamnews.php?nid=3645>

⁵⁹IMABE Project. "Cangio Mangrove." Accessed October 17, 2010. <http://www.donimabe.org.vn/index.php?mod=content&id=77>

⁶⁰Tuan, Can Gio, 29

⁶¹IMABE Project. "Cangio Mangrove," Accessed October 17, 2010. <http://www.donimabe.org.vn/index.php?mod=content&id=77>

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exclusively from inside the district; the industrialization and urbanization of Ho Chi Minh City has an enormous impact on Can Gio. As the ecosystem model of biosphere management emphasizes, an ecosystem is affected by activities in surrounding ecosystems. In the case of Can Gio, the surrounding ecosystem is the urban/industrial area of Ho Chi Minh City. Can Gio is connected to Ho Chi Minh City through tourism, economy, and management, as well as through the watershed of the Saigon-Dong Nai Rivers. The rapid urbanization of Ho Chi Minh City has produced major environmental problems, particularly air and water pollution. These problems are partially mitigated by the presence of Can Gio, the “lungs and kidneys” of Ho Chi Minh City.

The link between plants and clean air is unambiguous—plants take in carbon dioxide, the major product of combustion, and produce oxygen. Can Gio makes up over 50% of the green space of Ho Chi Minh City and therefore is the principle offset for the carbon emissions from the city’s industries and transportation needs, the ‘lungs’ of the city. However, the levels of air pollution in Ho Chi Minh City are currently beyond the capacity of the forest. Air pollution in Ho Chi Minh City comes primarily from transportation. In 2006, there were approximately 3 million motorcycles in the city, emitting pollutants such as ozone and carbon monoxide.⁶² This increase in air pollution has contributed to a decline in the health of residents, particularly the increase of cases of respiratory diseases like asthma. The government of Ho Chi Minh City has recognized the problem of air pollution, particularly in relation to human health, and committed to reduce air pollution, primarily through better emissions control of factories and increased access to public transportation.⁶³ While air pollution does not have a large impact on the health of Can Gio, the relationship between plants and clean air ties the forest to the air quality problems of the city, and reinforces the importance of a healthy mangrove ecosystem.

Not only is Can Gio the metaphorical lungs of Ho Chi Minh City but it is also its kidneys. In 2003 Ho Chi Minh City was releasing 700,000 m³ of raw sewage and 5,000 m³ of industrial effluent per day into the Saigon River.⁶⁴ This pollution has earned the Saigon River the

⁶²Bang Quoc Ho, Alain Clappier, and Golay François, “Air pollution forecast for Ho Chi Minh City, Vietnam in 2015 and 2020,” *Air Quality, Atmosphere, and Health* (2010): 1. DOI 10.1007/s11869-010-0087-2

⁶³Bang Quoc Ho, “Air pollution,” 9.

⁶⁴Tran Dinh Thanh Lam, “Polluted River Plagues Ho Chi Minh City,” *The Irrawaddy*, January 8, 2003. http://www.irrawaddy.org/article.php?art_id=122.

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nickname “the stinking canal”.⁶⁵ Efforts to curb water pollution have been largely unsuccessful in Ho Chi Minh City, due to lack of infrastructure and the inability of government officials to enforce standards. This pollution flows with the Saigon River through and around Can Gio, where the dense mangrove roots trap and hold sediments. In this way, Can Gio filters the waste water of Ho Chi Minh City. However, much of this pollution is high in heavy metals, pesticides, and other pollutions which are incorporated into the food chain of the system, impacting the health of all the organisms that use the forest for food, including humans.

An overview of the current state of Can Gio reinforces the tension between conservation and development seen in the history of the site. Without the livelihoods provided by the shrimp industry, forestry, tourism, and the other economic activities of Can Gio, the people living in and around the site would not be able to survive. Similarly, the industries that generate the massive amounts of air and water pollution of Ho Chi Minh City support the city residents. Can Gio cannot insulate itself from the by-products of development; it is connected to these systems by air, water, and visitors. However, the presence of a biosphere reserve near Ho Chi Minh City serves as a reminder to the city of the cost of uncontrolled and unlimited development. The reserve’s conservation model also provides a model of how people can live within nature without destroying it.

Conclusion

The space humans choose to conserve and the methods employed for conservation reflect the values a society places on natural space and the relationship between humans and nature in the society. Can Gio mangrove forest is a unique ecosystem that provides many benefits to humans: prevention of coastal erosion, nursery grounds for fish, and buffering from tropical storms, to name a few. Throughout its history, these forests have been demolished by war and harvested for industry. The management of the forest has changed with the development of Vietnam. Initially an exclusionary protected area emphasizing the production of industrial raw materials, Can Gio now uses a community-based approach to incorporate species conservation and sustainable development. Its status as a biosphere reserve recognizes the

⁶⁵Tran Dinh Thanh Lam, “Polluted River Plagues Ho Chi Minh City.” *The Irrawaddy*. January 8, 2003. http://www.irrawaddy.org/article.php?art_id=122

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unique space this site fills within the history and ecology of Vietnam, and connects Can Gio to the global discussion about conservation and sustainability.

The story of Can Gio paints the picture of a resilient site, a site that “proves that the Vietnamese people—together with the government—can put tremendous energy into reforestation work for the protection of their environment.”⁶⁶ However, the future of the site and the commitment of the Vietnamese to the environment are not as certain as these optimistic words might suggest. Vietnam is a developing nation, with a young, large and energetic population eager to enjoy the economic benefits of a strong, modern economy.⁶⁷ Development and environment are closely linked: rapid, unrestricted development, experts observe, has “adverse impacts on the environment and environmental pollution...[and] may become a major obstacle for...development.”⁶⁸ The ongoing challenge of sites like Can Gio is to continue to prove that conservation and development can be incorporated into a successful management program—one that connects the people who live in Can Gio, the people who live around it, and the people who visit it.

⁶⁶Tuan, Can Gio., 3

⁶⁷Kinh, Bui Duc. Personal Interview. December 24, 2010.

⁶⁸Truyet, T. Mai, and Quang M. Nguyen. “Development and Environment in Vietnam.” Conference on Sustainable Development in Vietnam. University of Maryland. Adele H. Stamp Student Union Bldg, College Park, Maryland. November 13, 2003.

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