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Restoration of wetlands in the Tram Chim Nature Reserve (Dong Thap Province, Mekong River Delta, Vietnam)

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The Tram Chim Nature Reserve is about 9000 ha portion of the approximate 1,00,,000 ha area of lowland vegetation composing the Plain of Reeds (Kiet, 1993). The depression is located between the Vaico and Mekong Rivers in southern Vietnam and southeastern Cambodia. Due to the high temperatures and six-month rainy season characteristic of the area, the Plain of Reeds is covered with 30 cm to 1 m of water during 3-6 months of the year (Husson et al., 1993). The dynamic conditions of the Plain of Reeds enabled the system, when in its pristine state, to produce abundant natural resources. The area's exceptional productivity supported human and wild inhabitants of the region for hundreds of years before the region was degraded.

Today the Tram Chim Nature Reserve is enclosed by dikes that protect it from the intensive agriculture surrounding the reserve. Since the initial construction of the dikes in 1984, six carefully designed water gates have been added to allow water to enter the Tram Chim during the rainy season (Beilfuss and Barzen, 1994; Barzen, personal communication). Along with the normal difficulties of developing a management plan for a dynamic area, reaching an agreement of goals for the restoration has been a long and difficult struggle that is not yet complete (Barzen, personal communication). Attaining a consensus of goals has been challenging. While providing habitat for the rare *Grus antigone sharpii* (or eastern sarus crane) is important, it is also necessary that management actions boost the production of resources vital to the survival of Vietnamese people living in the region. Without local support the restoration will not be very successful.

Initial restoration of the area was initiated by Nguyen Xuan Troung, or Muoi Nhe, governor of the Dong Thap Province after the American-Vietnam War (Kuznik, 1994). Nguyen Xuan Troung had grown up in the province and could remember the plethora of wildlife and vegetation that had once flourished in the Tram Chim (Nguyen Xuan Troung, 1990; Beilfuss, 1991). Under a policy in which Vietnam determined that economic recovery and environmental rehabilitation are inseparable, projects to restore areas of *Melaleuca* floodplain forests (or rear mangrove swamp) were initiated. *Melaleuca cajiputi* is a valuable resource to local residents because it can be used for timber, firewood and fodder, and houses wild bees which are an important source of honey (Duc, 1993). The Tram Chim supported *Melaleuca cajiputi*, but dry conditions allowed fires to frequently pass through the area. To keep the area wet so that fire would not burn the *Melaleuca cajiputi*, Nguyen Xuan Troung determined that dikes should be built to retain water. By 1984, Nguyen Xuan Troung had overseen the construction of almost 32 kilometers of dikes (Rome, 1990). This was the beginning of the Tram Chim restoration.

The Study Area and Historic Conditions

The Tram Chim is located in southern Vietnam along the Mekong River Delta (11 40'N, 105 34'E). The park comprises a 9,000 ha portion of the approximate 1,000,000 ha freshwater floodplain marsh known as the Plain of Reeds (Beilfuss, 1991; Kiet, 1993). The Mekong River has been called the Plain of Reed's "lifeblood" because every summer the waters flowing south in the river and the annual monsoons combine to flood the plain and deposit essential nutrients (Kuznik, 1994).

Present understanding of the historic vegetation of the Plain of Reeds suggests that the wetlands were composed of scattered clumps of *Melaleuca cajiputi*. *Melaleuca cajiputi* was the only recorded type of forest in the plain, creating a near monotype stand of the tree species. The lowlands were composed of forested freshwater wetlands. In surrounding regions other tree species can be found, which suggest that those specific species may have also existed in Tram Chim. References to plant species as geographic

names and in regional folksongs serve as another clue to the original vegetation of the Tram Chim (Kiet, 1993). Before creating a management plan for the Tram Chim, International Crane Foundation scientists, Richard Beilfuss and Jeb Barzen gathered additional information regarding the historic composition of the area through personal interviews with long-term residents, literature reviews, examination of existing wetland remnants in the Plain of Reeds, and military aerial photos (Barzen, personal communication).

Well-preserved tree stumps buried under 20-70 cm of earth in the northeast buffer zone around the Tram Chim were found in 1991 by Mr. Ngo Quoc Thang, who was then vice director of the Tram Chim, and Le Cong Kiet. Scientists hoped that determining the age and species of these stumps would provide a clear, tangible picture of the tree species that historically occurred in the area (Kiet, 1993). Since their article was published, the stumps have been determined to be from a historical time and primarily the genus *Eugenia (*Barzen, personal communication).

Ecosystem Stressors

The Tram Chim has faced degradation from many sources over the last century. Disturbance began with the minute impacts of Vietnamese agriculturalists and migrants that sustainably harvested resources from the area. Later, the area was almost completely destroyed during French-Vietnamese and American-Vietnamese wars. Finally, the introduction of intensive agriculture following the war period has dramatically altered the Plain of Reeds that surrounds Tram Chim.

Rice Agriculture

Until the 18th century all of the Mekong Delta wetlands remained in their pristine state. Over the next two hundred years migrants from the northern highlands of Vietnam introduced over 200 varieties of rice to the region for cultivation. Rice agriculture caused little damage to the area because seed was directly broadcast rather than transplanted and minimal drainage and harvesting impacts occurred. Years when rice production was low due to floods or drought, aquatic products such as shrimp and fish were exploited. As population levels increased in the 19th century, canals were constructed for transportation, irrigation and communication. The new canals opened the area to unrestricted reclamation for farming and canal excavation. V.R. Pantulu believes reclamation activities may have initially aggravated the acid sulphate soil problem in the area. He feels high levels of acid sulfate prevent the growth of many native plant species. Instead, a small number of acid tolerant species such as *Eleocharis atropurpurea, Carex sp., Eleocharis dulcis, Phragmites karka, Saccharum spontaneum,* and *Ischaemum aristatum* moved into the area and reduced biodiversity (Pantulu, 1988). Also, runoff from areas with high acid sulfate can also contain elevated concentrations of iron and aluminum that destroy crops and cause fish kills. On the other hand, Jeb Barzen feels the acid tolerant species are native to the area. He is of the opinion that although populations may have increased due to rice agriculture, their presence in the landscape had not changed dramatically due to reclamation (Barzen, personal communication).

Damage from agriculture in the Mekong River Delta was minimal in what is now the Tram Chim Nature Reserve because most farmers were concentrated along the Vaico and Mekong riverbanks that surround the Plain of Reeds (Beilfuss, 1991). On these natural levees, the acid soils were buried deeply under river alluvium and provided for good rice crops. Farmers that did live in or near the Tram Chim instead depended on a sustainable harvest of wetland resources. They also migrated into the plain during the dry season and then left during the flooding season (Barzen, personal communication). The annual burning of the dense vegetation mats covering the wetland was the strongest impact these inhabitants had on the Tram Chim. The burns were done at the end of the dry season to thin the mats and harvest food. This practice had a minimal negative effect on the landscape, and actually provided important habitat for foraging birds and increased emergent vegetation regeneration. Thus, the Tram Chim remained ecologically stable into the beginning of the 20th century (Beilfuss, 1991).

War

The French-Vietnam and American-Vietnam wars caused more impact to the region in a few decades than had occurred over hundreds of years previously. Beginning in the early 1960's and continuing for the next ten years, the U.S. army used *ecocide*, the destruction of the environment for military purposes, as one of their main military tactics in their fight against the Vietcong. In the Plain of Reeds, their goal was to eliminate tree cover where the Vietcong could hide. The U.S. armies attempted to dry the Plain of Reeds by draining the wetlands so the area could later be burned to remove tree cover. Canals as large as 70 m wide and 6 m deep were dug to quickly drain the area (Kuznik, 1994). When reduced sulfur was dried and exposed to air it was oxidized. The acidic materials produced were released into floodwaters that entered the area, making the pH drop to 3.9 and below (Barzen, personal communication). The low pH affected not only soil conditions, but also the vigor of plants and fish.

Ecosystem Conditions after the War

After the reunification of Vietnam in 1975, locals were left to support themselves with a devastated landscape. The land was so well drained that vegetation died and the dried remains fueled frequent wildfires. Each year, low pH soil caused floodplain waters to become non-potable, non-swimmable, and biologically sterile during the monsoon season (Beilfuss and Barzen, 1994). Displaced farmers attempted to reestablish rice agriculture in the Plain of Reeds, but in these wasteland conditions attempts yielded reduced harvests.

Project Initiation

When Nguyen Xuan Troung began a dike-building program in 1984, he hoped resources like *Melaleuca cajiputi*, rice, marsh sedges, and wetland animals such as fish, snakes, eels, turtles, shrimp, and crabs would be re-established in the area (Ngan, 1989; Truong, 1991; Beilfuss and Barzen 1994). As water filled the area, native flora and fauna did indeed return to the Tram Chim. One of the most exciting animals to arrive was the rare *Grus antigone sharpii*. In 1985, local people reported seeing cranes returning. As soon as the news spread, a group from Hanoi University came to verify the sightings. The *Grus antigone sharpii*, which was thought to be extinct in Southeast Asia, had indeed returned to the Tram Chim (Quy, 1990). At that time Vietnamese scientists convinced local authorities to ban wildlife hunting and agricultural development of the Tram Chim and protect the rich ecological qualities of the area by designating it as a nature reserve (Beilfuss and Barzen, 1994). The Vietnamese had impressive wisdom to agree to sacrifice farming and hunting on that land during a time when they were recovering from a war and were desperate to support themselves.

After the initial success of the dike installation, the biological improvement of the area reached a plateau. Although the water was now being successfully trapped in the area, it was not being released, and the stagnant water began to have negative impacts on the flora and fauna that had recently returned. As plants died and began to decompose their byproducts were not allowed to escape. Inadequate drainage caused a buildup of detritus and dissolved nutrients that normally would have been mixed and diluted to a safe concentration (Beilfuss and Barzen, 1994). Also, the excess water reduced the vigor of plants that can not withstand such waterlogged conditions (Barzen, personal communication).

Now it was critical that the wetland produces abundant resources or be converted back to rice production. American scientists from the International Crane Foundation did not want the habitat improvements to the area to be reversed. In 1988, Vietnamese scientists and scientists from the International Crane Foundation formed a long-term cooperative agreement to restore the Tram Chim Nature Reserve (Beilfuss and Barzen, 1994). West Germany's Wolf Brehm Fund for Bird Conservation has also provided funding to support ornithological studies in the area (Duc, 1987).

Restoration Goals

The Vietnamese population in the Mekong Delta during the war was substantial, and after the war, population levels swelled to more than 13.5 million people. The enormous need for food placed intense demand on the Tram Chim to produce natural resources or be converted into rice farming. The main goal of Vietnamese officials was to create an area productive in natural resources (Beilfuss and Barzen, 1994). The pressure they felt to produce natural resources quickly made determining and observing management decisions difficult. The main concern of the International Crane Foundation was to recreate a portion of the Plain of Reeds ecosystem that, in part, served as *Grus antigone sharpii* (or crane habitat). Many Vietnamese also hoped to restore the Tram Chim (Barzen, personal communication). However, the desire to also produce abundant natural resources made decision-making tricky.

In 1991, a management plan for the Tram Chim Reserve was developed. It was agreed that the land within the reserve would be restored and 15,000 haof land buffering the Tram Chim would be reclaimed by various land uses excluding paddy rice cultivation. Uses that were deemed acceptable were floating wild rice, grazing, and *Melaleuca cajiputi* production (Barzen, 1993). Additionally, some historic ecosystems within the buffers would be restored (Kiet, 1993). Restricting the land-uses surrounding the reserve was an important decision, because without such restrictions unlimited pollutants and sediment would likely seep into the restored Tram Chim during monsoon season and compromise the success of the project.

A major goal of the restoration was to bring back *Grus antigone sharpii* into the area. A habitat that could support *Grus antigone sharpii* and the plants necessary for its survival needed to be restored. To rebuild the wetland habitat it was essential that historic physical, chemical, and biological conditions be restored (Barzen, 1993). Once the natural biotic and abiotic processes were reestablished the area would invite other wetland animals and support a higher diversity of wetland plants. Recreating the historic hydrology of the area was the key component of the system that had to be replaced before any other habitat improvements were possible (Beilfuss and Barzen, 1994).

Many important hydrologic conditions needed to be reestablished. The timing, magnitude, and distribution of water fluctuations required management. Nutrient and natural chemical transport needed to be controlled to restore soil pH and composition. Also, water sediment loads required reduction (Beilfuss, 1991).

Hydrologic Restoration

Four water gates consisting of four, 2.0 X 2.0 m opening, variable-crest box culvert barrels in parallel were installed into the existing dikes surrounding a portion of the Tram Chim called “A1” in 1991 (see Figure 1). In 1993, another two gates were installed in the “A2” portion of the Tram Chim (Barzen, personal communication). These gates use gravity to allow water inflow and outflow during the rainy season. During the dry season wooden flashboards are used to prevent any unnatural drainage. This style of water gate was selected to maintain equilibrium between water levels in the reserve and in the surrounding floodplain during the climax of the monsoon season. The gates also reduce water seepage losses while simultaneously allowing byproducts from decomposing vegetation to naturally drain. The physical labor necessary to maintain and operate the gates is also minimal (Beilfuss and Barzen, 1994).

The installation sites of these gates were in locations where large natural stream flows intersect reserve dikes. Natural stream flows were allowed to enter and exit the Tram Chim through the gates. An operational plan for the water gates includes a sequence of seven steps that strive to mimic the natural water flow of the region before the France-Vietnam and America-Vietnam wars. The timing of these steps varies yearly according to climate, so the management plan is based on the average water flow (Beilfuss and Barzen, 1994).

In the period proceeding the rainy season, December when water elevations in the reserve average 0.5 m, the water gates are closed (Barzen, personal communication). The closed gates retain moisture in the Tram Chim and alleviate difficulties with acid sulfate oxidation. In May, when the rainy season begins, the water gates remain closed, preventing acid sulfate and sediment flowing in channels on surrounding land from entering the Tram Chim Nature Reserve. By late June rainfall increases greatly. The water gates are opened when non-channelized surface water flow reaches the Tram Chim, which occurs between June and August. The non-channelized surface water that is allowed to enter the Tram Chim is lower in sediment and acid sulfate than the water found in channels. From August to October precipitation increases even more. Water levels rise to 2-3 meters above the soil substrate. Water is easily distributed throughout the reserve at this time, and with it dissolved nutrients and other debris are also transported. From October until December precipitation continues, but the floodwater greatly recedes. During December, precipitation decreases and floodwaters continue to recede. When water levels reach the height that would pond over the wetland prior to channelization the gates are closed. The water gates remain closed while water levels slowly recede to the soil substrate and then below. The operational pattern then starts over (Beilfuss and Barzen, 1994).

Opening and closing the water gates at the Tram Chim strives to restore the natural timing and fluctuation of water that enters and exits the reserve. The pattern also maximizes natural mixing processes and reduces potentially harmful processes that have arisen since the degradation of the French-Vietnamese and the American-Vietnamese Wars (Beilfuss and Barzen, 1994).

Local residents reported that fires occurred historically in the Plain of Reeds, but less frequently and with lower intensity than had occurred since channels were created. Experimentation with prescribed burns has been conducted to determine the effect fire has on the wetland, and to create needed firebreaks along the tree buffers that surround the reserve. When residents living near the reserve feel more comfortable with effects fire will have on the landscape, implementing the proposed hydrology plan will receive more support.

No plants were reintroduced into the Tram Chim. Instead, plant species were allowed to return to the area through natural dispersal, from the existing seedbank and from remaining adult plants (Barzen, personal communication).

Project Status

Although Tram Chim restoration plans have been established for ten years, controversy over the affects following plans would have on the value of*Melaleuca cajiputi* harvests pushed the project to a stalemate for years. The area historically burned every dry season, and locals feared that if the drawdowns outlined in the management plan were permitted fires would destroy *Melaleuca cajiputi*. Ignoring planned seasonal drawdowns has caused populations of other native flora and fauna in the Tram Chim Nature Reserve to crash. As water levels remain high all year, egrets move into the area and cranes move out (Barzen, personal communication).

During the dry season of 2000 managers conducted the Tram Chim's first partial drawdown. The following year, from December to May of 2001 managers administered a complete drawdown according to management plans that had been initially outlined in 1991. It is too early for formal studies to determine what lasting affects drawdowns have had on the flora and fauna of the region. The Field Ecology Director of the International Crane Foundation, Jeb Barzen, suggested waiting at least three years before conducting tests so native ecosystems have time to respond to the new management practices. Barzen did, however, share anecdotal reports of habitat improvements within the Tram Chim since the drawdowns. He reported seeing germinating *Oryza sp.* or wild rice in the park during his visit to the Tram Chim in August 2001. *Oryza* had once been abundant in the region, and since the war had disappeared. Barzen also observed a similar response in populations of *Eleocharis spp.* or spikerush that

have a history similar to the wild rice (Barzen, personal communication). The return of these plant species indicates that new management actions more closely mimic historic conditions.

Conclusion

Before a restoration plan can be effectively implemented it is essential that local residents, politicians, and scientists agree on proposed management plans. The disproval of any one of the aforementioned parties can force a restoration into stalemate.

There is a combination of reasons why the 17-year-old Tram Chim restoration is only in its second year of implementation. Resource managers and Vietnamese residents were not convinced that the proposed management plans would most effectively restore the Tram Chim Nature Reserve. Locals feared the land could be more productive if it was in agricultural production and that drawdowns would threaten timber production. Finally, politicians that had planted the *Melaleuca cajiputi* feared fire would burn the trees. They did everything in their power to keep the reserve from burning (Barzen, personal communication).

It is important that time be invested in understanding cultural norms and gaining residents' trust. Considering the Tram Chim restoration is a cooperative effort between countries that were at war just a decade earlier, the restoration has made excellent time.

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Figure 1. Diagram of the water gate control structure installed at the Tram Chim Nature Reserve. Variable crest box culvert depiction adapted from Beilfuss (1991) and Beilfuss and Barzen (1994). Not drawn to scale.