Article

Potential of mangrove forest in adaptation to climate change in Mekong Delta, Vietnam

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Abstract: The Mekong Delta's mangrove forests are crucial for providing seafood, storing carbon, and defending coastlines from soil erosion and severe waves. Despite these advantages, mangroves have suffered tremendous damage from both natural and societal factors, and this harm is still occurring today**.** By examining satellite imagery, the opportunities and difficulties in future mangrove restoration were also evaluated. Mangrove forest area in the research area increased from 79,593 ha in 2015 to 90,777 ha in 2020, an increase of 11,184 ha (or around 2,237 ha per year). These findings proved that mangrove restoration initiatives and programs were crucial in sustaining and expanding the Mekong Delta's mangrove forest cover. Moreover, this study confirmed interdisciplinary of agriculture, forestry, environmental conservation for potential of mangroves forest in coastal areas in Mekong Delta.

Keywords: Mangrove; climate change; Mekong Delta

1. Introduction

The benefits of mangroves have not gotten much attention in the past. because it is really a variant of inland forest that is coastal. Contrary to popular belief, these diverse ecosystems are now crucial to maintaining ecological balance, safeguarding people's livelihoods, protecting coastal areas, slowing erosion, preserving sea dykes, maintain ecological balance and protect people's livelihoods. The Mekong Delta region contains 73,372.04 hectares of mangroves, or 50.5% of the nation's total area of mangroves, according to survey findings from the Institute of Ecology and Construction Protection. Rhizophora apiculata, Avicennia marina, Sonneratia caseolaris, Nypa fruticans, and Avicennia officinalis are among the most often grown species. However, under the impact of climate change and humans, the area of mangroves in this area has been seriously reduced. According to a report by the Ministry of Agriculture and Rural Development, in the period from 2011 to 2016, the area of mangroves in the whole region decreased by nearly 10%, from 194,723 hectares in 2011 to 179,384 hectares in 2016 (ie. has decreased by about 15,339 ha). The Mekong Delta is one of the most vulnerable places to climate change, home to nearly 20 million people, which is facing many challenges caused by climate change such as high tides. , sea level rise and saline intrusion.

2. Materials and Methods

In this study, both WorldView-2 and Sentinel-2 (Sentinel-2A and 2B) images were used. WorldView-2 is a high-resolution satellite. All figures is used from reliable sources (Pham et al 2022)

The accuracy of land cover classification was evaluated using validation data from Google Earth and ground truthing land cover maps for the years 2020 and 2015, respectively. Each

land cover class's validation points were converted to raster. Then, each land cover layer's validation raster was compared to each other in order to determine metrics for accuracy such as producer's accuracy, user's accuracy, overall accuracy, and overall kappa statistic. (Landis and Koch, 1977; Fisher et al., 2018).

3. Results

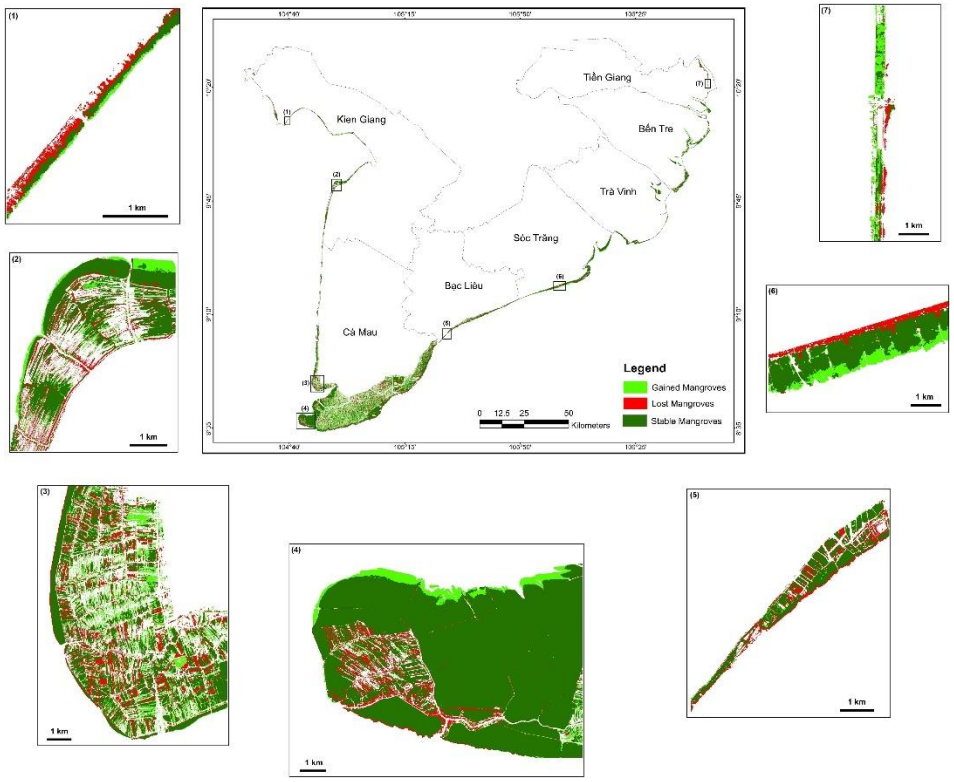


Figure 1. Spatial distribution of existing (stable) mangroves and mangroves change in the Mekong Delta from 2015-2020. (Source: Pham Hong Tinh et al 2022)

Mangrove forests on the western coastal area were significantly more fragmented than along the eastern coast due to the influence of aquaculture under the forest canopy over the previous several decades and the dramatically increasing erosion of the shoreline in recent years. On the eastern and southern coastal areas, mangroves were more coherent and well-developed. Mangrove forests were dense and uniform in Ca Mau Cape, where they were well-managed by national parks and protected forest management boards.

In the research region, the area covered by mangrove forest increased from 79,593 ha in 2015 to 90,777 ha in 2020. Between 2015 and 2020, mangroves were lost on 16,138 ha (about 20.3%), whereas they were restored or newly planted on 27,322 ha (about 34.1%). As a result, the net area of mangroves in the Mekong Delta expanded by 11,184 hectares (or roughly 2,237 ha per year). The results of the classification showed that roughly 80% of the mangrove area remained intact.

The entire nation implemented 140 projects to protect and develop coastal forests between the years of 2015 and 2020. In which 4 million trees are planted in scattered locations across a 22,390 ha area, with 295,164 hectares of coastal forest protected. Furthermore, 39 projects were implemented to protect and develop coastal forests in seven coastal provinces of the study area as a result of national projects like the National Target Program to

Respond to Climate Change and Green Growth from 2016-2020 (Decision No. 1670/QD-TTg dated 31 October 2017) and other related programs.

Table 1. Magrove restoration projects in Mekong Delta during 2015 - 2020

No.	Province	Total number of projects	Mangrove project area		
			New plantation	Restoration	Protection
1	Tien Giang	4	150	–	–
2	Ben Tre	4	221	–	4,236
3	Tra Vinh	11	695	–	10,185
4	Soc Trang	6	1,864	850	23,426
5	Bac Lieu	3	208	44	–
6	Ca Mau	7	1,330	1,162	49,000
7	Kien Giang	4	832	–	1,331
Total		39	5,300	2,056	88,178

Sources: MARD (2021) and Pham et al. (2022).

These initiatives and projects collectively made a substantial contribution to the programs and projects for mangrove restoration that have been successful in preserving and expanding the mangrove forest cover in the Mekong Delta.

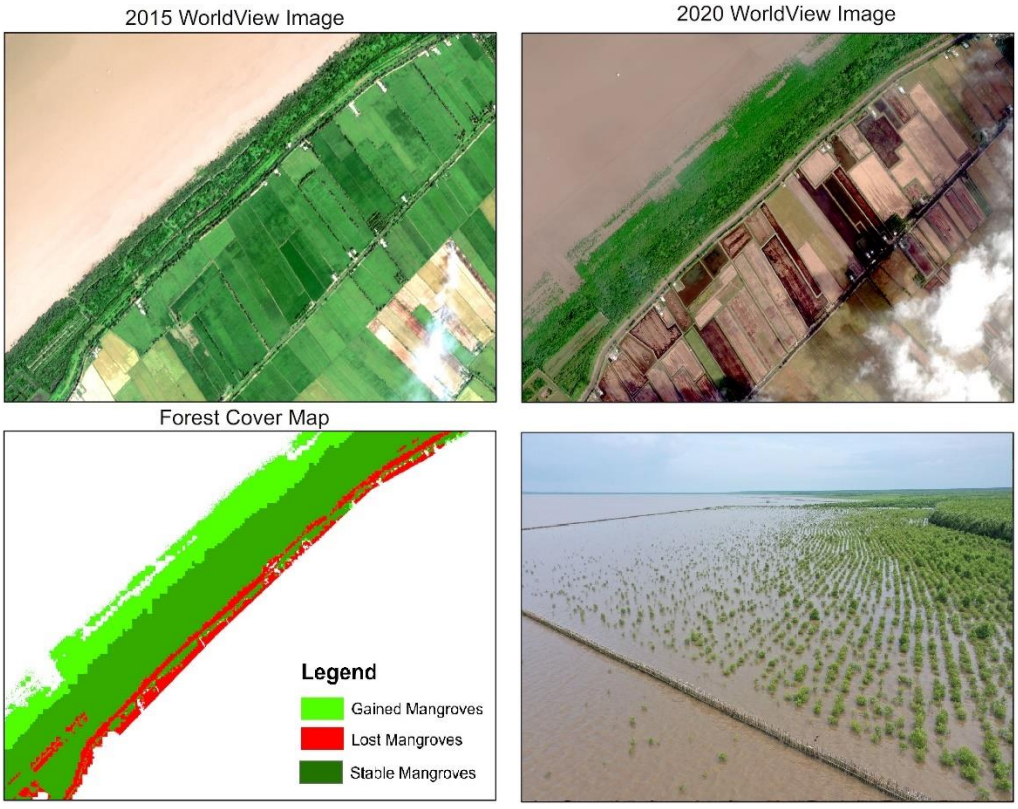
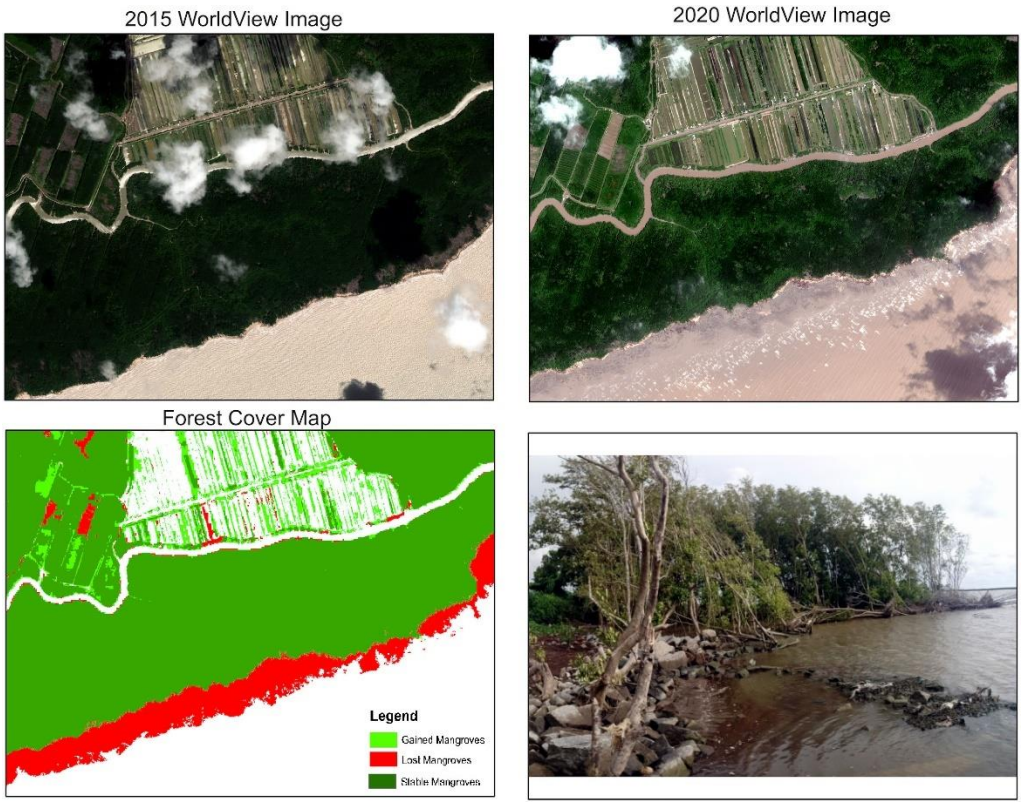


Figure 2. Mangroves are successfully restored to the sea and attributed to high sediment deposition and land creation that occurs along these shorelines. (Source: Pham Hong Tinh et al 2022)

4. Discussion

Additionally, even though a sizable area has been set aside for mangrove restoration, those restoration programs still face several difficulties due to anthropogenic and natural influences. As a result of erosion at the oceanic mangrove interface and development at the mangrove upland interface, which restricts mangrove's ability to migrate inland,

mangrove forests are typically distributed in small strips along the coast that are susceptible to coastal squeeze (Phan et al., 2015; Truong et al., 2017). At many of tested sites, observed coastal erosion and the building of sea dikes to increase the amount of inland space for fish/shrimp farming and cultivation as well as to prevent salinity intrusion.



Second, the transformation of mangroves into other still-functioning land uses, such as agriculture, aquaculture, and other socioeconomic pursuits in areas planned for mangrove restoration limits the success and effectiveness as well as justification for restoring those areas. Third, the restoration of mangroves in the Mekong Delta is also anticipated to be significantly impacted by management-related challenges (Hai et al., 2020). Co-management was a successful strategy for preserving and expanding the mangrove forest's capacity for protection while also generating income for nearby communities. According to Macintosh and Ashton (2003), integrated mangrove aquaculture systems, such as mud crab fattening in mangrove pens and cages, combined shrimp-mangrove-crab-cockle systems, or integrated mangrove fish or shrimp farms, were seen to be an efficient way to enhance local livelihoods. Futhermore, in many locations, it is required to construct structural solutions to induce land reclamation after many years in order to be able to plant forests. The task of afforestation is becoming more difficult and complicated due to natural catastrophes, high tides, coastal and estuary erosion, and these factors are also significant factors. For coastal regions, where there are several hazards of natural disasters, protecting the forest is the primary objective of afforestation. There is very little planting of production forests and scattered trees, and this work is frequently done by homes, groups, and individuals on their own. Low returns on investment are the results.

6. Conclusions

In safeguarding coastal populations from storm surges and tsunamis, mangroves are 5 times more cost-effective than man-made infrastructure since they lower wave heights by up to 60% and tsunami flood depths by 30%. Mangroves not only boost resilience but also

give local communities short- and medium-term means of subsistence and revenue. Mangrove shrimp farming is one of the beneficial practices used in Vietnam. Participating in the market for carbon credits is a long-term strategy for protecting and promoting mangroves.

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