ASSESSMENT THE VULNERABLE AREA OF CLIMATE CHANGE IMPACTS ON THE COASTAL REGION OF MEKONG RIVER USING GEOGRAPHIC INFORMATION TECHNOLOGY (GIS) TECHNIQUE

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ABSTRACT

The coastal provinces of the Mekong River Delta (MRD) is considered the most effective climate change that will impact directly on people's life, economy and food security in the region. This research was used GIS method to determine vulnerable riskon land use typesin the coastal areas based on inundation and saltwater intrusion scenariosto create for whole Mekong Delta region in current conditions of 2004 and sea level rise scenarios in 2030 and 2050. The result shows that the vulnerable areas affecting on one factor of flooding are focused on Long An and TienGiang provinces; while the effect of saltwater intrusion, the vulnerable areas are mostly distributed in the coastal provinces including KienGiang, Bac Lieu, Ca Mau, SocTrang, TraVinh and Ben Tre. Using both inundation and salinity factors, the most vulnerable areas is located in SocTrang province and next distribution in two provinces of Ca Mau and Bac Lieu, a small distribution on the province of Ben Tre, TienGiang and TraVinh with total area at 12,257 ha in 2015. Moreover, coastal impact for both flood and salinity instrusion affecting on land use in the coastal area not only on forest-shrimp and shrimp farming but also on double rice crop, triple rice crop, sugarcane and upland are vulnerable effect due to climate change scenarios.

Keywords: Climate Change; GIS, Vulnerability, Coastal area, inundation and salinity.

1. Introduction

The effects of climate change could be devastating to vulnerable coastal area as well as to the function and structure of ecosystem. Increasing sea level (1,7 mm/year) changes the shape of coastlines, contributes to coastal erosion and leads to flooding and more underground salt-water intrusion. The challenge of climate change needs to be addressed through integrated and ecosystem-based approaches such as integrated coastal management. These are crucial to build the foundations for sustainable coastal management and development, supporting socio-economic development, biodiversity and ecosystem services. Coastal ecosystems is crucially important to a robust economy, a safe population, and a sustainable quality of life for coastal residents. Demands on coastal resources is rapidly increasing and as coastal areas become more developed, the vulnerability of human settlements to hurricanes, storm surges, and flooding events also increases. There are strong interactions both in which as well as between the natural and human systems in the coastal system. Mekong Delta region is mostly nearby the sea that will exacerbate the problems already occurring in these vulnerable ecosystems due to increasing coastal populations, habitat loss, nutrient pollution and invasive species. Thus, there is a need to have an integrated approach for the management of coastal zones to adapt the impacts of climate change in the coastal provinces of the Mekong Delta.

2. Study area

The Mekong Delta is the region in southwestern Vietnam where the Mekong River approaches and empties into the sea through a network of distributaries. The Mekong delta region encompasses a large portion of southeastern Vietnam of 39,000 square meters, accounted for 12.2 % of the natural area of the country and a coastline of 73.2 km streching from 106°26´W, 11°1´N to 106°48´E, 8°33´S including 8 coastal provinces of Long An, Tiền Giang, Bến Tre, Trà Vinh, Sóc Trăng, Bạc Liêu, Cà Mau and Kiên Giang (Figure 1).

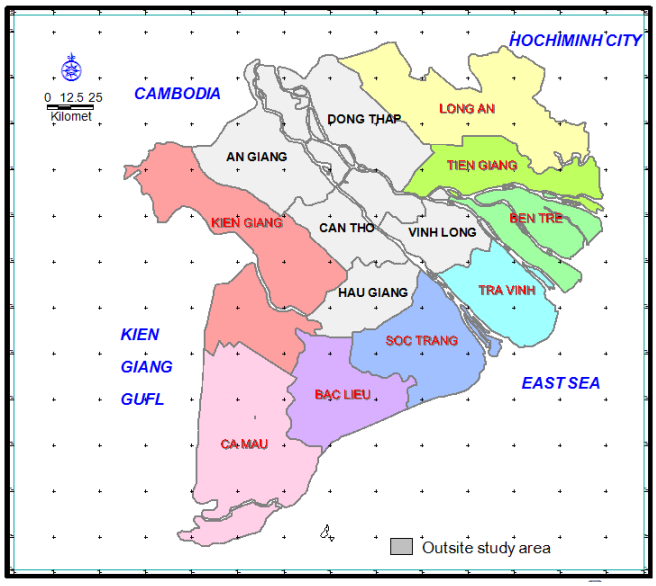

Figure 1. Study area in Coastal provinces in Mekong Delta

3. Methodology

2.1 Data collection

- Land use map of Mekong Delta in 2013 to interprete from MODIS satellite imagery (Source: Land Resources Department, CTU).

- Climate change scenarios (Source: CLUES Project, The Southern Institute of Water Resources Research) .

- Mekong Delta Administration map in 2008 (Department of Land Resources, CTU).

- Documents related to assess the impact of climate change, natural and socio-economic conditions in coastal provinces of the Mekong Delta.

2.1 . GIS methods

- Using the results to predict flooding and saltwater intrusion for SLR30 scenario (sea level rise scenario to 2030) and SLR50 (sea level rise scenarios to 2050) based on the base year in 2004. The floodplain maps were developed during the period from July to December and salinity maps to be used from January to June in year.

- The data of salinity and inundation were classified into three levels based on tolerance for rice levels on salinity and flooded of the International Rice Institute (IRRI, 1997) that inundation is classified into 3 levels including high (≥ 1.5 m), medium (from 0.6 to < 1.5) and low inundation (< 0.6 m) and salinity is classified into 3 levels consist of high (> 8 ‰), medium (from 4 to 8 ‰) and low salinity (< 4 ‰).

- Vulnerable areas were identified of th highest salinity levels (> 8 ‰) and the highest inundation (depth > 1.5 m) based on those scenarios and then to monitor climate change impact on land use distribution in coastal region of Mekong Delta.

- Overlaping the maps were between vulnerable area, salinity and inundation maps on land use and administrative boundaries maps to determine land use types impact by climate change in coastal of Mekong Delta region .

3. Result

3.1. Vulnerable zoning based on salinity and inundation scenarios by climate change

Vulnerable area due to salinity (> 8 ‰) and inundation (> 1.5 m) in the base year of 2004 to identify the area at243.95 hectares occupying the lowest affected area and increasing in 2030 at 2,274.33 hectares around 10 times higher than in 2004 and . the highest vulnerability in 2050 of 12,257.49 hectares over 50 times compared to 2004 (Figure 2) .

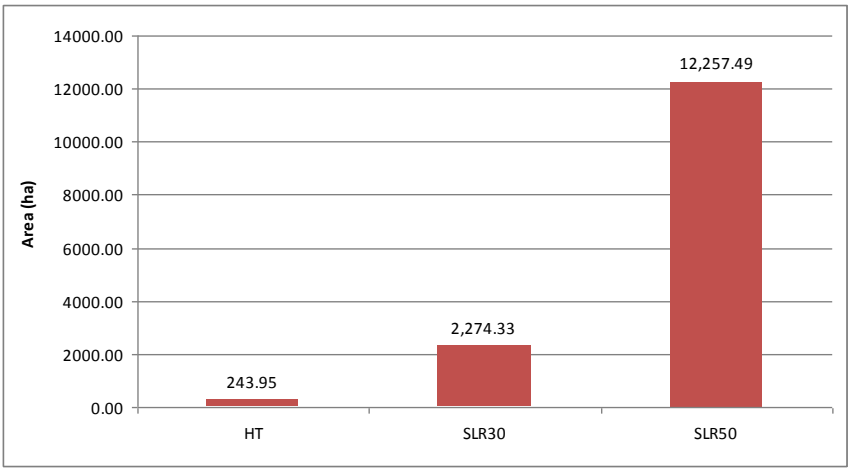

Figure 2. Vulnerable areas distribution based on climate change scenarios

Due to salinity factor, the highest salinity (> 8 ‰) has no significant difference vulnarabal affected area between those years. Vulnerable location was concentrated in Ca Mau province at 422,426 ha in 2050. Also, inundation factor, the highest flooding (> 1.5 m) was gradually increased in each senerios year and almost affected on Long An province of 215,105 ha in 2050 .

3.2. Vulnerable zoning by inundation and salinity on administration

Soc Trang is the first province to be affected by salinity and inundation scenarios in 3 years (the base year of 2004, 2030 and 2050) with vulnrability area increasing from 228 to 6,400 ha that is the highest province comparing to the other provinces Four provinces including Ca Mau , Bac Lieu, Tien Giang and Tra Vinh are affected on two years in 2030 and 2050 scenarios in which Ca Mau and Bac Lieu provinces having the highest area affected in 2050 and increasing from 56 to 2,336 ha (in Ca Mau province) and from 132 to 2,063 ha (in Bac Lieu province). Tien Giang and Tra Vinh provinces have been less area affected increasing from 20 to 148 hectares (in Tien Giang province) and from 16 to 977 hectares (in Tra Vinh province). Ben Tre and Long An are 2 provinces only appearing vulnerable area in 2050 at 208 and 125 ha, respectively. Lastly, unique Kien Giang province has no affected by both salinity and inundation for 3 years of climate change scenarios (Figure 3).

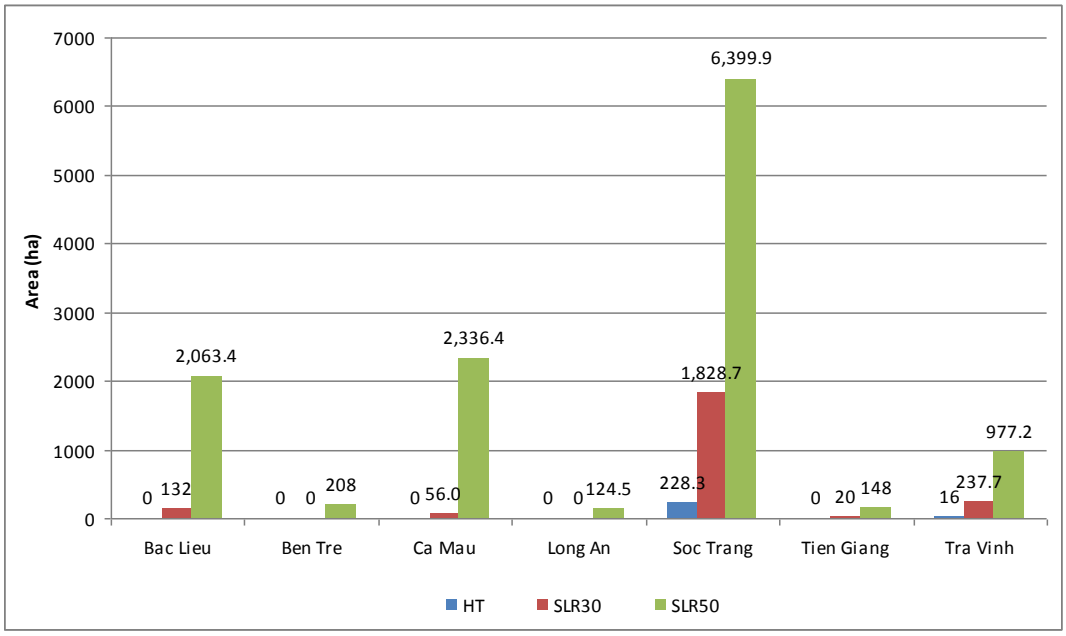

Figure 3. The vulnerable area to be impact on the coastal administration of Mekong Delta

3.3. Vulnerable zoning by inundation and salinity on land use

3.3.1. On the base year in 2004 scenario

Two provinces of Soc Trang and Tra Vinh have vulnerable area in both factors of salinity and inundation, the other provinces have no hot spot area (Figure 4) .

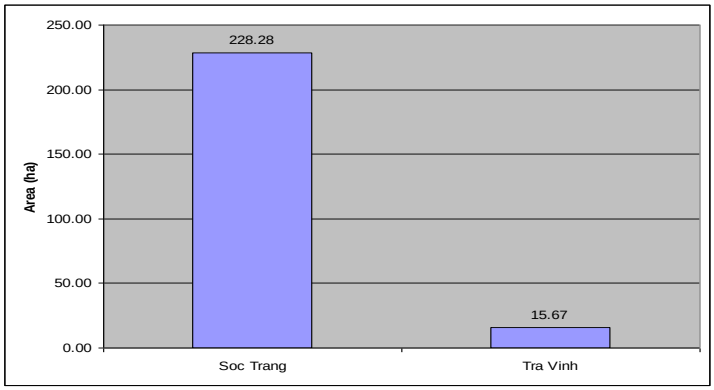

Figure 4. Vulnerable area distribution in coastal zoning in 2004

In Soc Trang province, vulnerable area covers around 228.3 hectares to be distributed on sugarcane, residential orchard garden and triple rice crops. In Tra Vinh province, the affected area is about 15.67 ha to distribute on mangrove forest, shrimp farming and residential and orchard garden. Based on salinity factor with the highest level (> 8 ‰) impacts to whole coastal provinces in which Ca Mau province has the highest affected more than 429,000 hectares and is distributed on shrimp farming, residential and orchard garden, mangroves forest and rice farming. For inundation factor with the highest level (> 1.5 m) affects on the provinces of Long An, Tien Giang, a part of Ben Tre and Kien Giang in which Long An province has the highest affected

more than 192,600 hectares and distribution on shrimp farming, rice crop, residential and orchard garden, rice-shrimp and mangroves forest (Figure 5).

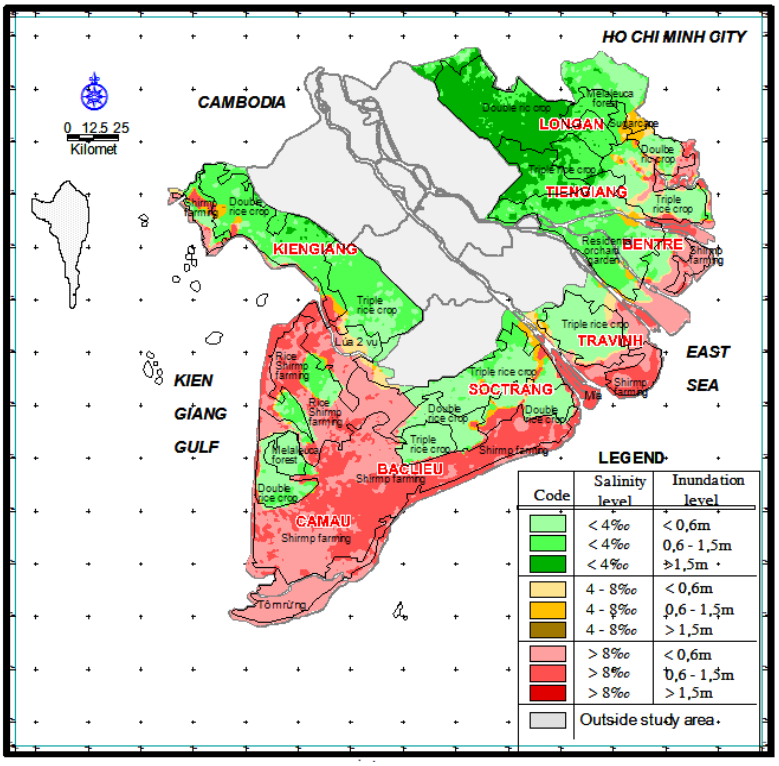

Figure 5. Vulnerable zoning map by salinity and flood damage in 2004

3.3.2. In the scenario of 2030

In the year scenario of 2030, there are 5 of 8 coastal Mekong delta provinces will be damaged by salinity and inundation factors including Bac Lieu, Ca Mau, Soc Trang, Tien Giang and Tra Vinh. Soc Trang province has the highest area affected of 1,829 ha comparing to the other provincs. Land use will be impacted on shirmp farming, sugarcane, residential and orchard garden and triple rice crops in which the remaining provinces will be affected mainly on shrimp farming , rice crop, residential and orchard garden and forest-shrimp farming (Figure 6).

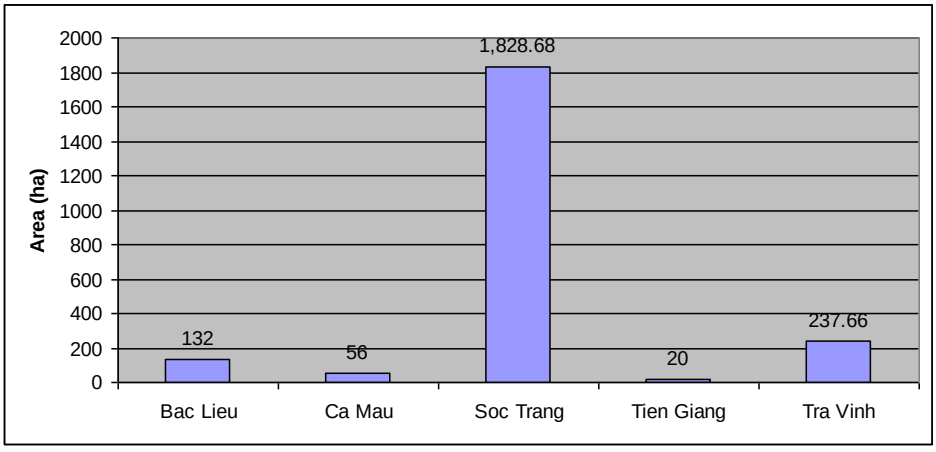

Figure 6. Vulnerable area distribution in coastal zoning in 2030

For one factor of salinity with the highest level (> 8 ‰), the vulnerable area will impact whole coastal provinces in which Ca Mau province has the highest effect more than 422,000 hectares and it's distribution on shrimp farming, residential and orchard garden, mangrove forest and Rice-shrimp farming. On inundation factor with the highest level (> 1.5 m), the vulnerable area will affect on the provinces of Long An, Tien Giang, one part of Ben Tre and Kien Giang in which Long An province has the most affected more than 203,500 hectares and mainly distribution on shrimp farming, rice farming, residential and orchard garden, rice-shrimp farming and upland crop (Figure 7).

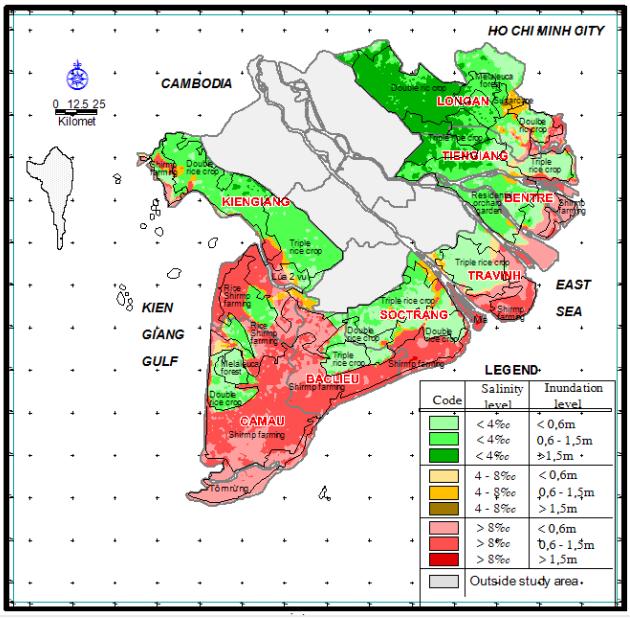

Figure 7. Vulnerable zoning map by salinity and flood damage in 2030

3.3.3. In the scenario of 2050

Almost the coastal Mekong Delta provinces are affected by both salinity and inundation factors excepted Kien Giang province in which 3 provinces of Soc Trang , Ca Mau and Bac Lieu having the highest affected area at 6,400 ha, 2,336 ha and 2,063 ha, respectively (Figure 8). The vulnarable area will affect mostly on shrimp farming in whole coastal provinces and the other land use types mainly affected on double rice crops, triple rice crops, residential and orchard garden, mangrove forest and sugarcane.

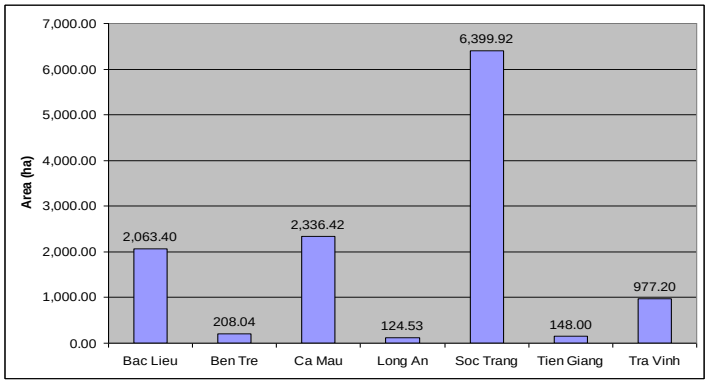

Figure 8. Vulnerable area distribution in coastal zoning in 2050

Similar to the scenarios above, salinity factor with the highest level (> 8 ‰) will appears in eight coastal provinces in which Ca Mau province having the most affected about 420,000 hectares on mainly shrimp farming, residential and orchard garden, rice-shrimp farming and rice crop. For only inundation factor with the highest level (> 1.5 m) will appear in Long An and Tien Giang provinces and a part of the Ben Tre, Tra Vinh and Kien Giang in which Long An province having the highest effect by inundation approximately 215,000 hectares and distribution mainly on rice farming, residential and orchard garden, melaleuca forest, shrimp farming and upland crop (Figure 9).

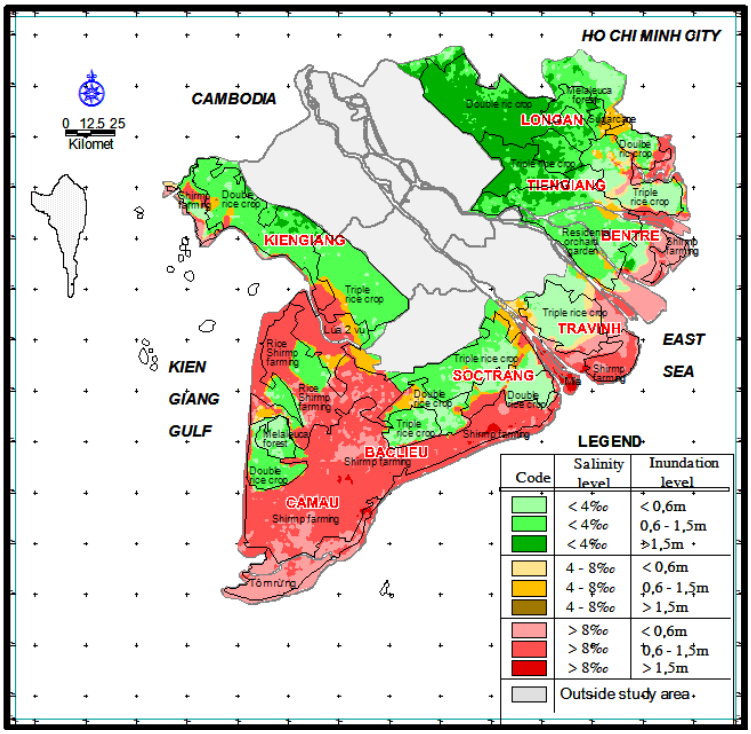

Figure 9. Vulnerable zoning map by salinity and flood damage in 2050

5. Conclusion

- The vulnerable area for both salinity and inundation during three climate change scenarios have been affected on land use in coastal zone and increasing in each scenarios period. Land use types have been impacted on double rice crop, triple rice crop and shrimp farming and distribution almost on the province of Soc Trang , Ca Mau and Bac Lieu provinces.

- For land use types to be affected by neither salinity nor inundation are mostly impacted all of coastal provinces, almost in Ca Mau province, next in Kien Giang and Long An provinces on shrimp farming, rice crops, residential and orchard garden and rice shrimp farming .

- This results will support coastal managers making decision and giving a plan to deal promptly saltwater intrusion and flooding for ensuring people life in the coastal areas.

- GIS technique is a powerful tool to support completely developing for climate change scenarios and this results have high sinificant data comparing to field work data thus for further research to be applied remote sensing to study climate change situation for whole Mekong Delta to cope with and adapt to land resources in coastal provinces.

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