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Preliminary assessment of sea level rise impacts to coastal ecosystems in Thua Thien - Hue

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Abstract. Coastal ecosystems such as estuaries, lagoons, gulfs, mangroves, coral reefs, sea grasses support high productivity and biodiversity in Viet Nam. The coastal ecosystems play a crucial role not only in biodiversity reserve but also in socio-economic and local residents' daily life. In the setting of increasing affection of climate change, researching impacts of sea level rise to the coastal ecosystems is necessary. This paper provide picture of coastal ecosystems and assessment of sea level rise impacts on the ecosystems in Thua Thien – Hue. In this study, climate change vulnerability is applied as methodology for the assessment. The focused factors caused by sea level rise include inundation, flood, erosion, wetland loss, and increased salt water intrusion. The analyses show that, sea level rise has different impact on communities in the coastal areas in Thua Thien Hue. Among them, seagrass communities in the lagoons seem to be more vulnerable compared to the others.

Keywords: sea level rise, coastal ecosystems, vulnerability, adaptation, lagoons

1. Introduction

Natural resources are human development and vital foundation no matter what age, region or race in the world. Global climate change has the clearly negative impacts on natural resources all over the world. Climate change exposes numerous problems to every nation. Climate change increased extremely events such as typhoon, heavy rain, rising heat, drought over recent decades. Asia, which consists of Vietnam, has to face sea level rise hazard. According to research by the World Bank, Vietnam shall be one of two developing countries (Vietnam and Bangladesh) to be the most seriously impacted by sea level rise. Most of the flat lands would be inundated, agriculture as well as GDB are also affected badly (Dasgupta et al., 2007) [1]. According to Pilgrim (2007) [2], in Vietnam, 1 meter sea level rise will impact on 78 important nature reserves (27%), 46 natural conservations (33%), and 23 nature conservation sites consisting of 9

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main biodiversity areas (21%). In Viet Nam, local people much depend on these natural resources.

Simultaneously, climate change scenarios for Viet Nam developed in 2009 have been brought out until 2010, and base on that, the most optimistic scenario considered 0,65 m of sea level rise, meanwhile, this interval in the worst one is 1,0 m. In that context, research as well as assessing impacts of sea level rise to coastal ecosystems in Thua Thien – Hue, where is proposed Hon Hai Van-Son Tra Marine Protectd Area located in the region between Cau Hai lagoon (in the south-west of Thua Thien Hue) and Da Nang Bay, has been conducted. The research results would provide the foundation to serves biodiversity conservative implementations.

The IPCC concept of climate change vulnerability is applied in order to analyze impacts on ecosystems [3]. Climate change vulnerability is "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes". Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (or inadaptive capacity) (Figure 1).

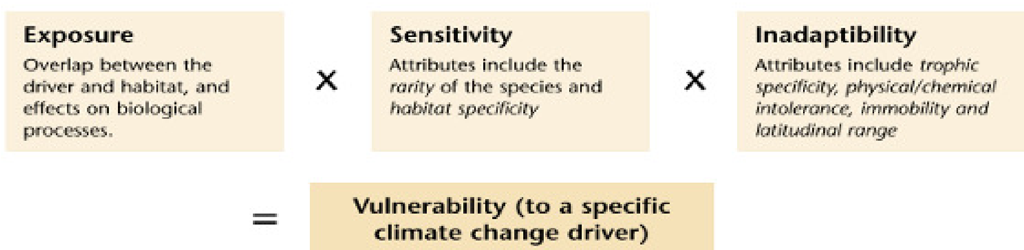

Figure 1. Main component of vulnerability.

Exposure and sensitivity are 'negative' components that describe the potential impacts of climate change. Exposure to a specific climate change driver depends on following factors: the extent to which the species' geographic and depth range overlaps with the climate change driver; and, the extent to which the climate change driver affects the habitats and ecological processes upon which the species depend.

Sensitivity is a 'negative' component where high sensitivity equates to increased potential impact from climate change. The sensitivity of species/communities to a climate change driver depends on its ability to resist or adapt to change. A rare species has a small population and may lack genetic variation. Smaller populations are more sensitive to pressures as they have fewer individuals or 'chances' to cope with climate change drivers. Secondly, their lower abundance means a lower net reproductive output. This reduces the species' ability to recover from climate change related mortality. Some species may be restricted to a particular habitat as these provide the species with necessary resources such as suitable prey or refuge from predators. These species may not be able to compete effectively in other habitats whereas more flexible species are able to exploit alternative habitats should one habitat type be adversely affected. Species with high habitat specificity have high sensitivity. Sensitivity to sea level rise and other drivers is ranked as low, moderate or high.

Adaptive capacity is a 'positive' component that describes a species' ability to acclimate or accommodate change. High adaptive capacity means that a species is able to more readily accommodate change, which reduces the potential impacts from climate change drivers. Accommodation may occur where physiological or behavioral responses result in acclimation or compensation that allows the species to be successful in the new conditions. This is the opposite of the other two components of vulnerability (exposure and sensitivity), which are 'negative' components and the higher they are, the greater the potential impact.

In this study, main methods/tools will be applied as follows:

♦ Overview information about the method, the sensitivity, adaptability of ecosystems/ species;

♦ Collation and analysis of existing data, and supplementary investigation on ecosystems, species in study site;

♦ Assessment of impacts of sea level rise on ecosystems based on the concept of climate change vulnerability.

2. Coastal ecosystems in Thua Thien Hue

Along the coast of Thua Thien – Hue, typical ecosystems include lagoons, sea grass beds, coral reefs, mangroves, sandy bars, and other ecosystems such as agricultural ecosystems (Figure 2).

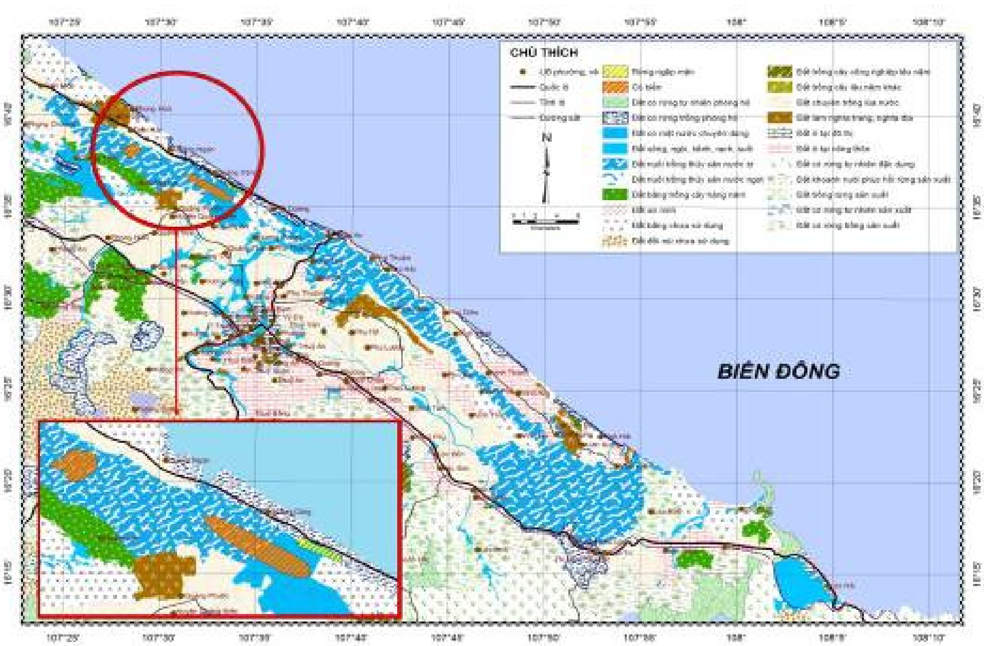

Figure 2. Coastal habitats in Thua Thien Hue.

Sand bank includes a system of sand dunes and modern beaches prolong 102km from Cua Viet (Quang Tri) to Tu Hien (Thua Thien Hue). The sand dunes and beaches act as a wall between the sea and lagoon systems (Thua Thien Hue People Committee, 2002). The sandbar between the sea and lagoon, stretching over 70 km length, is connected to the existence of lagoon ecosystems in the past thousands of years. The semi-inundated area is subject to the direct influence from sea level, tide and wind. In this areas, some brush species, e.g. *Acanthus ilicifolius*, *Cerbera manghas, Clerodendron inerme, Thespesia populnea, Melaleuca leucadendton*, *Pandanus tectorius* Soland, *Pandanus odoratissimus etc.,* may survive. The coastal sandy wetland is less influenced by tides, but prone to saline intrusion, and the ground is characterized by tight soil. This is the favorable area for some species such as *Acanthus ilicifolius, Clerodendron inerme, Melaleuca leucadendton*, *Melastoma affine* D. Don , *Rhodomyrtus* sp*, Pandanus tectorius* Soland, *Pandanus odoratissimus, etc*. Sand dunes and sand turfs make up a huge proportion of the coastal area of Thua Thien Hue, and may be a habitat for *Rhodomyrtus tomentosa, Cactaceae spp, Ormosia pinnata* (Lour.) Merr. *Ageratum conyzoides, Celtis sinensis, … some timber plants, such as Barringtoria acutangula, Ricinus communis, Hibiscus tiliaceus, Heritiera litoralis, Premma integriolia, may also be vital… However, the plants in biggest coverage are of exotic species, e.g. Acacia auriculiformis A.Cunn, Acacia mangium Wild, Acacia orassicarpa A.Cunn ex benth.*

There are two major lagoon systems in Thua Thien Hue: Tam Giang - Cau Hai and Lang Co. The Tam Giang - Cau Hai (TG-CH) lagoon system (largest lagoon in Vietnam) located within coordinate $16^0$14' - $16^0$42' N and $107^0$22' - $107^0$57' E, elongating 70km from Phong Dien to Phu Loc with total area is about 21,620 ha, the widest is 10km and the narrowest is less than 1km. The Tam Giang - Cầu Hai lagoon is semi-closed, connect to the sea through 2 mouths Thuan An and Tu Hien. Lang Co lagoon is known as the Lap An lagoon, which located in the north of Hai Van Pass with an area of about 1,500 ha and water provided by rivers originating from the northern side of the Hai Van Pass. Lang Co lagoon is connected to the sea through a mouth. On east and south of Cau Hai lagoon and around Lang Co lagoon, original rock (granite and gabro) is covered along shoreline. The remaining shore of Tam Giang Cau Hai lagoon is constituted by loose sediment. Behind the Tam Giang - Cau Hai lagoon systems, coastal flat shoreline topography is a little differentiation with common altitude from 3 - 6m, and highest point does not exceed 10m (Thua Thien Hue People Committee, 2002). There is swamp with altitude less than 1m covered by pasture, with some areas used for growing rice one crop. In the lagoon shore appears terrace type discontinuously, 1m in height and flooded in the rainy season likely warp flats in south of Thuy Tu. The bottom topography of the lagoon is relative flat, depth ranges from 0.5-2m, and the deepest near Thuan An mouth is 5-6m. Sediment structure of the bottom is mostly sandy mud or muddy sand. Based on difference and ecological function, 8 types of habitat were selected and specific described as following:

♦ Agricultural land where growing rice irregularly with area of 1,648.96 ha (6.94% total of the lagoon) mainly distributed in O Lau, Huong, Truoi - Dai Giang river mouth area and around the lagoon.

♦ Swamp with mangrove, with area about 3ha (0.01%) and most in Tan My area (Thuan

An town, Phu Vang district) and Ru Cha (Huong Phong commune, Huong Tra district).

♦ Warp flat with grass flooded in rainy season, with area 1408.5 ha (5.93%), distributed in southern Thuy Tu.

♦ Tidal flat, with area 599.08 ha (2.52%) distribute around Sam and Thuy Tu.

♦ Water grass bed, area about 11,420.44 ha (48.08%) mostly distributed in around basin of the lagoon to depth of 1m or 1.5m.

♦ Muddy bottom, area is about 711.92 ha (2.99 %), distributed in basin of the lagoon and Dai Giang river mouth area.

♦ Bottom is sandy mud, area 3673.67ha (15.46%), distributed in around the lagoon mouth.

♦ Aquaculture ponds area is 4287,44ha, occupied 18.05% total area of the lagoon, and distributed in almost districts around the lagoon but more concentrated in Dam Sam and Cau Hai.

The salinity at Lang Co always maintains at high level. There are nearly 200 phytoplankton species of five algae phylums, i.e. Cyanophyta, Rhodophyta, Bacillariophyta, Pyrrophyta and Chlorophyta in the lake. Marine aquatic species are dominant, but their structure changes from season to season. Similarly, marine zooplanktons, in addition to 33 brackish water species, are overwhelming. 32 benthos species and crustaceans dominate in terms of species number, while the mollusks dominate in terms of the number of individuals, including some high-economic value species such as blood cockles, green mussels, estuarine oysters, mud crabs, etc. 115 fish species, of which 20 are of high economic values and great production, have been recorded. The freshwater organisms are only found in flooding season at estuaries as lower-basin of Bach Ma.

In results of investigation, there are about 15 mangrove species in Tam Giang Cau Hai lagoon are *Avicennia mariana, Rhizophora apiculata, Bruguiera sexangula,* etc. The main function of mangrove is scenery, habitat of waterfowls as well as protection of shoreline. Mangrove plants, which are mainly distributed at the estuaries of Hoi Mit and Hoi Dua, south of Lang Co swamp, have 28 species, 26 genes, 22 families, notably *Rhizophora apiculata, Arucennia lanata, Sonneratia caseolaris, Aegyceras corniculatum, Excoecaria agalocha, etc.* The narrow topography, short and steep rivers contribute to the small coverage of mangroves. Moreover, the boom of shrimp ponds and formation of a road around the lagoon, combined with poor water exchange since the road was constructed, have hampered the mangroves growth and area expansion.

According to Nguyen Van Tien (Ed.) (2000) [4], the species of seaweed found in Thua Thien – Hue consists of *Halophila beccarii, H. Ovalis, Thalassia hemprichii, Halodule pinifolia, Zostera japonica, Ruppia maritima*. In addition, we have found 9 species of fresh water plant with high biomass and 2 seaweed species *Hydrilla verticillata* and *Valisneria spiralis* used to as a food for fresh fishes. Since the distribution of aquatic plants is closely related with salinity in the lagoon, it therefore may divide into different ecological groups that correlate to changing in salinity. Seagrass and other water plants cover almost surface water area. They grow at depth of 0.7m to 2m; however, different sub-zones have a different distribution of aquatic plant. The salinity increased result in fresh water grass was died and replaced by sea grass. The survey result estimated that there are about 1800 ha of sea grass in Tam Giang - Cau Hai lagoon.

According to Do Cong Thung's (2009) [5] estimation, there are about 1000 species living in the Tam Giang - Cau Hai lagoon, among them 938 - 953 species have been named. Probably this lagoon was the most fully study. Phytoplankton has the highest in number of species (287 species), fish (215 to 230 species), bird (73 species), zooplankton (72 species), benthos (193 species), seaweed (46), higher plant (31), and water grass (18) (of which 7 are sea grass species). At Tam Giang – Cau Hai, there are 230 fish species, belonging to 65 families and 16 orders. 65% of these species are marine finfish, 19.2% are brackish. These two groups are of wide distribution and found in both rainy and dry seasons. The endemic species include *Cyprinus centralis* and 20 other species of high economic value. Among 73 bird species, there are 34 migrant species such as *Fulica atra atra, Anas poecilorhyncha, Anser anser, Tringa erythropus, Anas querquedura* with tens of thousands individual often observed at the estuaries of O Lau and Sam rivers, as well as Sam lake, from November to March. Out of these, one species is listed in the Red Book is *Limmodromus sémipalmatus*, and 30 others listed as endangered species and subject to strict protection by the EU, such as *Ardea purpurea manilensis*, *Pandion haliaetus haliaetus*, *Falco tinnunlus interstinctus*, etc.

Thus, coastal ecosystems in Thua Thien Hue have the great ecological value and typically represent for Vietnam lagoon ecosystem. There are typical sub-ecosystems here also represented for Vietnam Central Middle, such as sub-ecosystem of sand dune, sea grass and mangrove sub-ecosystem, and well-off estuaries.

3. Sea level rise impact to coastal ecosystems at Thua Thien Hue

According to Nicholls (2003) [6], the most of impacts are broadly linear functions of sea-level rise, although some processes such as wetland loss show a threshold response and are more related to the rate of sea-level rise, rather than the absolute change. Most existing studies have focused on one or more of these factors: (1) inundation, flood and storm damage, (2) erosion, (3) wetland loss, and (4) increased salt water intrusion. The annual sedimentation Tam Giang lagoon is around 2.4 mm. The deposition of sediments at Cau Hai has been at the rate of 1-1.4 mm annually since Tu Hien became the secondary gate. Without annual sedimentation of no more than one millimeter from dunes, islets, and mud flats, the lagoons will be filled up only after 1,500 years. In case of 2.4 mm sedimentation per year from rivers, islets and dunes, the time to fill up may be just 600 years (Tran Thi Tuyet Mai, 2005) [7]. Based on the scenario until 2100, our estimates of sea level rise for Vietnam are as below:

- Sea level rise by 50 cm (sometime between 2070 and 2080): average sedimentation is 0.63 – 0.76 cm/year;

- Sea level rise by 75 cm (sometime between 2080 and 2100): average sedimentation is 0.78 – 1.05 cm/year;

- Sea level rise by 100 cm (around 2100): average sedimentation is 1.1 cm/year.

Mangrove ecosystem

Mangroves and salt marshes are within the intertidal zone of low energy coasts and are highly sensitive to rising sea level. Mangrove trees are adapted to being inundated salt-water but only in some extent within physiological capacity. Sea level rise can cause mangrove loss and changes to intertidal wetland communities depending on a range of interacting factors, including geomorphologic setting, tidal range, sedimentation, subsidence, tree growth rates and species composition. Ellison AM and Farnsworth EJ (1996) [8] indicated that as the frequency and duration of inundation increases, growth of trees will decline and forests may retreat landward. Geological records indicate that previous sea-level fluctuations have created both crises and opportunities for mangrove communities, and they have survived or expanded in several refuges.

Mangrove plants, scattered along the banks of lagoons, may be destroyed by rising sea level. Due to the limits set by infrastructure works and small coverage, the possibility for their recovery and expansion is low. As commented, the sedimentation speed in these areas is slower than sea level rise, even when the sediment-containment capability of mangrove plants is better than tidal mudflats.

Ru Cha, located near Tam Giang lagoon, is a low-lying place where mangroves coverage is rather good. Adjacent to mangrove plantation are ponds and short-term agricultural plant areas. When the sea level rises, the mangroves may penetrate into the shore, if there are no works in the surrounding areas set up to prevent water exchanges with the lagoon waters (e.g. pond/paddy field).

Mangrove areas near Lang Co are situated on relatively elevated platforms, and separated with the lagoon by a surrounding road. A majority of the mangroves are 0.5-0.7 meters lower than the road surface, and the rest is limited by railway and mountains. Since the road was built, the tides flow in and out the lagoon through an estuary and some sluice gates. For this reason, the development and growth of mangroves are somewhat influenced. When the sea level rises, and with an hypothesis that the road is made higher than present, the mangrove area may become a 'man-made lake' suffering from inundation over longer time and thus make mangrove plants die gradually. This area is limited by infrastructure development, so mangroves cannot be expanded by seed scattering.

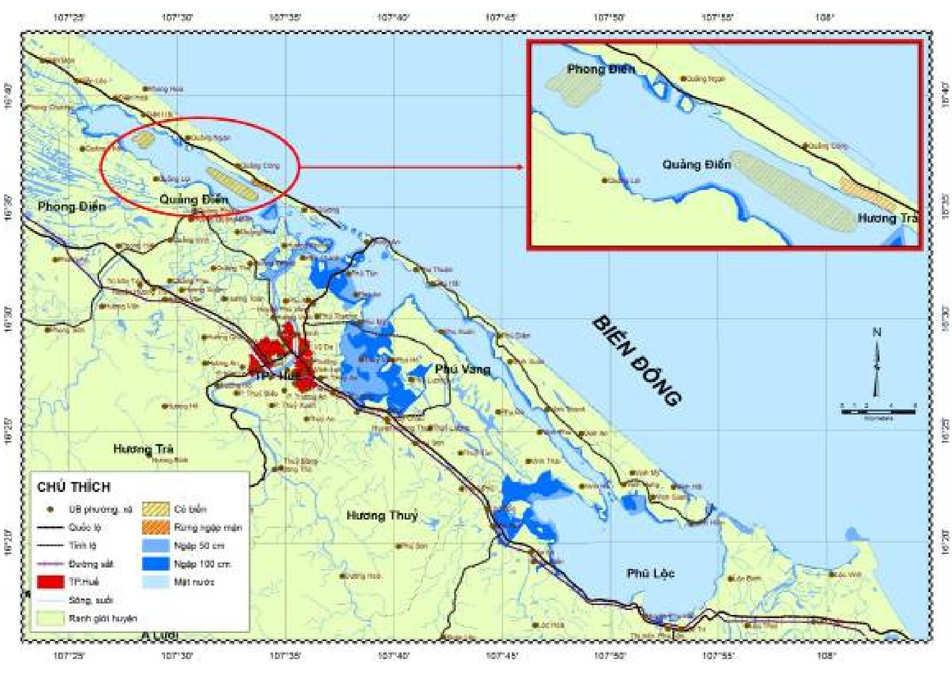

Figure 3. Inundated level follow the 50cm and 100 cm scenarios at Thua Thien Hue.

Corals

Sea levels are one of the factors to control coral distribution. Most coral reef communities are expected to be able to keep pace with projected global sea-level rise. Brown, 1997 [9] mentioned that, reef accretion rates range from 1-10 mm per year in average. But reef systems may be able to build upward around 20 mm per year, when they are growing in water depths of less than 20 m where there is abundant sunlight for photosynthesis. Some reef communities may experience mortality as a result of relative sea-level rise. Due to the slowing effect of other factors on growth, there is the potential that coral populations might be left behind by rapid sea level rise. Ove Hoegh-Guldberg et al. (2007) [10] mentioned that previous reviews have all concluded that these changes in sea level are relatively slow when compared to the rate at which corals are able to grow (up to 20 cm per year for branching coral in Great Barrier Reef), and hence do not represent a major challenge for healthy coral populations.

If assuming that the coral reef development in Vietnam is similar to that at the Great Barrier Reef, and sea level rises by 100 cm between now and 2100, coral reefs in North Hai Van may keep up with projected sea-level rises. It is, nevertheless, notable that the reef coverage is still low and on the verge of decline, and this adversely impacts the development of reefs and their adaptability to sea level rise and other harmful factors of climate change.

Plankton

Sea level rise will lead to change of nutrient and salinity within the lagoon, linked to saltwater – freshwater interface. Changing nutrient inputs to the water column will affect planktonic species and communities to some degree. Diatoms are likely to be particularly responsive to changes in nutrient availability. Zooplanktons are not directly affected by nutrient enrichment. The plankton community will adjust to changes in nutrient inputs and availability by changing its composition. For that reason, at different sensitivity, the vulnerability to sea level rise is not so high but there will be clear changes in distribution and density of phyplanktons and zooplanktons.

Sea grass

Björk Mats et al. (2008) [11] in dictated that rising sea levels may adversely impact sea grass communities due to increases in water depths above present meadows (thereby reducing light), changed currents causing erosion and increased turbidity and seawater intrusions higher up on land or into estuaries and rivers (favouring land-ward sea grass colonisations). It can be seen that, all seagrasses in the lagoons in Thua Thien Hue will be exposed to changes in sea level and therefore a reduction of light penetration and habitat availability. Seagrass distribution is usually limited by light penetration. Increased water depth caused by sea level rise will further attenuate light penetration to seagrass. All seagrasses are capable of responding to light reductions by altering their physiological capacity and morphological structure. However, at the depth limit, the meadows are already at the extreme edge of their light tolerance range and are unlikely to adapt to further light reductions. For shallower seagrasses some response to reduced light availability is certain. This is likely to include reduced growth and biomass. The sea level rise by 50 cm leads to 50% reduction of diffuse light, and 30-40% reduction of seagrass growth. Estuarine seagrass species exposed to brackish water, such as *Ruppia sp*., are tolerant to the salinity of some 10‰ but they will be vulnerable if the salinity exceeds 45‰ (Dang Ngoc Thanh and Nguyen Huy Yet, 2009) [12]. Seagrasses could colonise newly inundated lands; however, inappropriate coastal sediments, rocky shores or other barriers will limit the capacity of seagrasses to colonise. The simplest outcome would be for the meadow to migrate up slope the same distance that the lower edge was lost (no net loss of seagrass habitat or biomass) however we do not believe this is likely in many cases (Waycott et al., 2007) [13]. As mentioned above, the seagrass species are distributed near or over islets, and close to shorelines of Thua Thien Hue province. The species attached by fixed roots to the bottom in the submergence condition, mainly distributed at the depth from 0.5 – 2m. Because of this, if the sea level rises by 50-100 cm, the seagrass bed will be heavily influenced. Without statistics of seagrass bed distribution by depth, we cannot calculate the damage levels of seagrass beds that are two meters under the surface. The growth of seagrass at 1.5 m or deeper, will be subject to 30-40% damage if the sea level continues to rise by additional 50 cm. If submerged deeper (75-100cm), the grass bed slows down in its development. Sea grass beds in these areas may be tolerant to wider range of salinity, from 5-32‰. The euryhalines including *Halophila ovalis* and *Zostera marina* may survive within the range of 5-34 ‰ salinity. When the salinity is lower than 5‰, their growth is adversely affected. The salt intrusion, therefore, does not generate major impacts on seagrass growth in Thua Thien Hue.

Macroalgae

Intertidal species of macroalgae are likely to expand in area in response to sea level rise due to colonisation of newly available substrate. Reduced light levels at deeper depths may shift the distribution of deeper-water species. High rates of colonisation, growth and reproduction will, together with high biodiversity of turf species, reduce the vulnerability of all macroalgal groups to sea level rise. According to Truong Van Lung and Vo Thi Mai Huong (2005) [14], in dry season, the optimal conditions for seaweed growth in Thua Thien Hue lagoons are 15-25% salinity and 20-28^{0}C temperature. At 40 cm underwater, seaweed photosynthesis is most intense, even more than the 20 cm column. At 60 to 80 cm column, the photosynthesis intensity is lower than that at 80 cm. However, since seaweed and macroalgae may float on the water surface regardless of level, the adaptability of macroalgae is relatively high. For this reason, vulnerability of macroalgae to rise in sea level is low.

Benthic

Seasonal salinity and uneven distribution of this factor from place to place is a typical feature of the lagoon environment. As a result of sea level rise, intertidal/lagoon communities will be impacted by physical loss of habitat in some areas and more frequent storm events, but perhaps also with expansion of habitat in other areas. Data derived from the mid to late Holocene record of a southeastern Australian lagoon indicates that sea level fluctuations and associated changes in sedimentation caused community change in estuarine and intertidal environments, with a shift from dominance by molluscs and foraminifera to charophytes, associated with a sea level drop and closure of the lagoon (Pat Hutchings et al., 2007) [15]. However, the different adaptability to salinity among species is determinant to the changes in distribution and composition of species in places where salinity fluctuates. Freshwater or slightly brackish water groups (to 5‰) include shellfish species under Amphipoda, Isopoda, Tanaidacea, and Brachyura, insects under Odanata, snails (*Sermyla sp.*, *Semisulcospira sp*), clams (*Corbicula sp.*) and *Tylorhynchus hetoropoda*. The strong brackish water species (5-25‰) include most of the Polychaeta species (except for *Tylorhynchus hetoropoda*), Alpheidae, gastropods of Neritidae and Potamididae, and bivalves of Tellinidae, Anomiidae, Mactridae and Solenidae (Pham Dinh Trong, 1997) [16]. Thus, their vulnerability is not high.

Birds

Both rising sea level and altered rainfall patterns will influence seabird reproductive output through the effect they have on the availability of breeding habitat. Sea level rise will alter erosion and deposition patterns that will cause significant changes in the distribution and abundance of specific vegetation types. Based on this, sea level rise and changing rainfall patterns are likely to impact the majority of seabird breeding colonies within region in some way. However, these are longer-term processes that are unlikely to have consistently negative impacts. Due to influences of rivers, there exist an ecological sub-system (estuarine) in Tam Giang – Cau Hai lagoon, which is highly nutritious, of low salinity and therefore suitable for the development of salt marshes and submerged plants, and this is a habitat for northern waterfowls to migrate in winters. Grassy marshes and estuarine flats during winter are grounds for migratory birds, even in the number of tens of thousands individuals (Tran Duc Thanh, 1997) [17]. Due to sea level rise and socio-economic activities, the habitats are being reduced in their area and suffer to some impacts with average vulnerability.

Salinity change in the lagoon and intertidal areas

Flora composition in the lagoon consists of 12 freshwater species (8.93 %), brackish and slightly brackish (12, 34), typically brackish 0.85, highly saline (15-30‰) 72.76% và marine 5.1%. Phytoplankton species make up 78.36%, among which 171 are marine and 19.29% are freshwater species. Inside the lagoon, at 10% salinity are 25 species and 5% - 6% species. When the salinity is artificially reduced, marine phytoplanktons are destroyed and replaced by freshwater ones, and their biomass descends. Regarding aquatic grass, there exist 11 species, including those tolerant to high salinity (23-30‰) such as *Hylaphylla ovalis* and *Halodule tridentata*, brackish environment (7-20‰) such as *Ruppia maritima* and *Halodule beccari* and high salinity (15-30‰) *Cymmodocea rotundata*. Salinity lower than 10% hampers the growth of these species, and when the water is fresh they suffer from mass mortality and are gradually replaced by *Valisneria spiralis* (at <5%) and *Najas indica* (0-25%). The changes of sea grass beds subsequently result in changing distribution of herbivorous animals, mostly fish (Truong Van Lung, Vo Thi mai Huong, 2005) It can be seen that, climate change and sea level rise will be able to cause the change of salinity in the lagoon; and consequently, they will result in the change of fauna and flora communities in the lagoon.

4. Conclusion

Sea level rise would affect Thua Thien Hue coastal ecosystems and the dominant reason is the increasing inundation at different levels.

Salinity and salt intrusion changes also cause the changes in distribution, composition and density of some marine aquatic species communities. Due to adaptive ability to sea level rise of species communities depend mostly on their "healthy", so numerous ecosystems are degrading, need to protect and develop in order to achieve the healthy ecosystem status, adapt to the sea level rise conditions. The conservation of endanger flora and fauna, especially in marine nature reserves Hai Van - Son Tra is really necessary in order to meet the requirements of biodiversity protection in Thua Thien Hue.

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