International Journal of Multidisciplinary Research and Development
www.allsubjectjournal.com
ISSN Online: 2349-4182 ISSN Print: 2349-5979
Received: 25-08-2022, Accepted: 12-09-2022, Published: 27-09-2022
Volume 9, Issue 9, 2022, Page No. 64-70

Assess the impact of climate change on marine ecosystems in Vietnam

Ai Huu Tran, Phúc Nguyễn Anh, Lê Nguyễn Vương Ngọc, Bich Đinh Nguyệt
Van Hien University, Vietnam

Abstract
The report has assessed 10 factors originating from climate change (Climate Change), directly affecting 12 distinct marine ecosystems in Vietnam. In order to decrease influence, the influencing factors include: increase in water temperature, storms and waves, sea level rise, turbidity, acidification of seawater, local freshening, salinization, erosion, interference marine circulation disturbances, and sedimentation. According to the decreasing degree of impact, the Ecosystems are classified into 4 groups: The group is very strongly affected, including 1 Ecosystem which is the coastal lagoon; the Strongly affected group includes 6 Ecosystems, including seagrass beds, coral reefs, sandy beaches, tidal flats, estuaries, and mangroves; The group with moderate impact includes 3 Ecosystems including saltwater lakes, permanent wetlands, and upwelling waters; The weakly affected group includes 2 Ecosystems: seabed and intertidal reefs. Ecosystems are distributed over 6 marine ecological regions, classified into 3 groups according to the degree of influence of Climate Change: High-impact areas include the Gulf of Tonkin (Northern and North Central Coast) and the East Sea. Male; The group of moderately affected regions, including the Central Central Coast, South Central Coast, and Southwest Seas; The group of low-impact areas includes the waters of the Hoang Sa and Truong Sa archipelagoes. The article proposes a list of specific ecosystems in each sea area that need to be prioritized for Climate Change response.

Keywords: marine ecosystem, climate change, impact, vietnam

Introduction
Climate change is a global environmental issue, but has profound and comprehensive effects on Vietnam, and has attracted the attention of the Government, managers, policymakers, and scientists. The assessment of the impact of Climate Change on the environment and marine ecosystems, although it has been approached quite early (Tran Duc Thanh *et al*., 1994, 1995), is only at the beginning. Recently, there have been many publications, most of which are overviews, not many specific quantitative studies, while the problem has a large scale, complex nature, and limitations on methods and sources. In such conditions, the response to Climate Change to the marine environment in general and marine ecosystems, in particular, is still scattered and lacks focus and this is reflected in the strategy, action plans, and regulations of the Government of the whole country (Ministry of Natural Resources and Environment, 2016b) [2] and localities. This paper is an attempt to assess the impact of Climate Change in the medium scenario on marine ecosystems and marine ecoregions in Vietnam, to identify priority ecosystems to respond to climate change. Climate Change in different seas.

Materials and Methods
- **Document**

The article uses materials from published research works or research topics on marine ecosystems in general (Tran Dinh Luan, 2015; Nguyen Huy Yet, 2010; Do Cong Thung and Massimo, 2004; Do Cong Thung, 2004). *et al*., 2014) and specific ecosystems such as coral reefs (Vo Sy Tuan *et al*., 2005), seagrass beds (Nguyen Van Tien, 2013), mangrove forests (Phan Nguyen Hong, 2006) [9]; lagoon (Tran Duc Thanh *et al*., 2010; Nguyen Van Quan *et al*., 2016) [10, 19], estuary (Vu Trung Tang, 2009) [20], tidal zone (Do Cong Thung, 2015) [24], saltwater lake (Nguyen Dang Ngai, 2009). *et al*., 2016), upwelling waters (Fisheries Department, 1996)…; assessment documents on the status and forecast of Climate Change according to scenarios (Ministry of Natural Resources and Environment, 2016a; Phan Van Tan, 2010; Phan Van Tan and Ngo Duc Thanh, 2013; Nguyen Van Thang *et al*., 2010; Dinh Van Uu, 2010) [1, 8, 21, 23] and their impacts on the environment and ecosystems (Mai Trong Nhuan *et al*., 2011; Mai Trong Nhuan *et al*., 2015; Tran Van Thuy *et al*., 2016) [16, 17]. The article is also supplemented with many years of actual investigation by the authors on the status and extent of the degradation of marine ecosystems.

- **Method**

DPSIR (Driver – Pressure – State – Impact – Response), derivation analysis method was used, here: The source (driver) is Climate Change; Pressures include 12 factors related to Climate Change; State is the health of ecosystems and the perceived effects of Climate Change; Impact is the current level of impact under the low scenario and the potential for the medium scenario Climate Change (Ministry of Natural Resources and Environment, 2016a) [1]; The response within the scope of the article is to select priority ecosystems in specific sea areas in plans and programs to respond to Climate Change.

The method of matrix analysis and weighting is used to analyze and evaluate the relationship between the factors affecting the source of Climate Change and the degree of impact on the marine ecosystems in Vietnam and determine the relationship between them. relationship between the degree of impact of marine ecosystems due to Climate Change and geographical regions.

There are 10 influencing factors selected for evaluation, including: (i) rising sea temperature; (ii) sea level rise; (iii)

storm and rain protection; (iv) circulation disturbances; (v) acidification of seawater; (vi) local sweetening; (vii) salinization; (viii) turbidity; (ix) erosion; and (x) sedimentation.

There are 12 typical marine ecosystems selected to assess their impact on Climate Change, including (1) coral reefs; (2) seagrass beds; (3) mangroves; (4) tides; (5) sea sand; (v6) reef tides; (7) estuary area; (8) coastal lagoons; (9) saltwater lake (tung, aqua); 10) permanent wetlands; (11) upwelling waters; and (12) high seas. In the matrix of impact-affected relationships, each factor affects 12 ecosystems and each ecosystem is affected by 10 factors in turn.

+ A weighted score of 0 for negligible or no impact: stable ecosystem health.

+ A weighted score of 1 for weak impact: ecosystem health is less affected, able to adapt, withstand and recover if there is no negative impact from the agent.

+ A weighted score of 2 for moderate impact: ecosystem health is significantly affected, less able to adapt, withstand and recover, and easy to degrade if there is a negative impact from the agent.

+ A weighted score of 3 for strong impact: ecosystem health is severely affected, very poorly adaptive, resilient, and resilient, and can be degraded, even destroyed, if no solutions are available. protection and active response.

According to the distribution of ecosystems with the degree of impact, assess the impact of Climate Change on 6 marine ecological regions: (1) Gulf of Tonkin; (2) Central Central Region; (3) South Central Coast; (4) Southeast; (5) Southwest; and (6) the waters of the Hoang Sa and Truong Sa archipelagoes.

Results and Discussion

▪ Influence factors

According to the degree of impact on ecosystems (Table 2.1), influencing factors are classified into three groups: large influence (a weighted score of 20 or more), moderate influence (from 15 to less than 20), and influence low (below 15). In theory, the total maximum impact is 360, the total calculated impact is 177, showing that the overall impact of Climate Change on Vietnam's marine ecosystems is at a near-average level (49.2%).

Table 1: Matrix on the impact relationship between the influencing factors for Climate Change and Vietnam's marine ecosystems

No	Impact / Ecosystem	Increa sing water	Tempe-rature Cyclones and waves	waves Sea level rise	chiseled	Axit hóa nước biển	Sweete-ning	Acidifi-cation of seawater	Salini-zation Erosion	Circulatory disturb-ance	Settlement	Total
1	Lagoon	1	2	2	2	2	3	2	2	2	3	21
2	Seagrass carpet	3	2	2	3	2	3	1	2	1	3	22
3	Coral reef	3	3	1	3	2	3	1	2	2	1	21
4	Sea sand beach	2	3	3	3	2	1	1	3	2	0	20
5	Tidal beach	2	2	3	3	2	1	1	2	2	2	20
6	Estuary area	2	2	3	2	1	1	2	4	2	2	21
7	Mangroves	2	3	3	2	1	1	2	4	2	0	20
8	Salt Lake	2	2	0	2	2	2	2	0	0	2	14
9	Regular wetlands	2	2	2	2	2	2	2	0	2	2	18
10	Upwelling waters	3	2	0	0	2	0	3	0	3	0	13
11	Bottom of the sea	2	2	0	2	2	0	1	0	2	0	11
12	Tide reef	2	1	2	2	2	1	1	0	0	2	13
	Total	26	26	21	26	22	18	19	19	20	17	214

Source: Author's calculations

▪ Group of factors with great influence

+ Increase in sea temperature. Systematic documentation on sea temperature fluctuations in Vietnam is limited. Along with increasing atmospheric temperature, the increasing sea water temperature can change the bio-geochemical cycle and nutrient balance, and the food chain, change the population structure, and affect the ecology and physiology of the species. Some species can decrease in size or even die when temperatures spike. This factor affects all marine ecosystems, stronger in coastal ecosystems and most pronounced in coral reefs and upwelling waters. During El-Nino 1998, in the world's reefs, corals died on average 17.7% due to bleaching due to high water temperature, the Indian Ocean died, 46%, the Arabian region 33%, and the Sea area died. East and Southeast Asia, 18% (Coral Reef Targeted Research and Capacity Building for Management Program, 2009) [6].

+ Cyclones and waves destroy ecosystems and components directly or indirectly. Waves cause turbidity and sedimentation, disturbing the bedrock and directly destroying many ecosystems. These factors affect entire ecosystems, most strongly in the coastal zone, typically ecosystems by sea sand and coral reefs. Regarding Climate Change, in recent years, storms in Vietnam's coastal areas have experienced many significant changes (Vu Thanh Hang *et al*., 2010) [8].

Cyclones and waves destroy ecosystems and components directly or indirectly. Waves cause turbidity and sedimentation, disturbing the bedrock and directly destroying many ecosystems. These factors affect entire ecosystems, most strongly in the coastal zone, typically ecosystems by sea sand and coral reefs. Regarding Climate Change, in recent years, storms in Vietnam's coastal areas have experienced many significant changes (Vu Thanh Hang *et al*., 2010) [8].

+ Sea level rise (Nguyen Ngoc Thuy and Bui Dinh Khuoc, 1994; Dinh Van Uu, 2010) is considered the biggest threat of Climate Change in general, causing many negative impacts on the marine environment, such as flooding, erosion, saltwater intrusion... Only the inundation impacts on marine ecosystems are considered here. The average sea level at Vietnam's coastal hydrographic stations tends to increase by an average of 3.34 mm/year from 1993-2014 (MONRE, 2016a). The main impacts, such as deep sinking, and narrowing of the distribution area, sometimes change the structure of the system, leading to changes in the

structure of ecosystems..., by sea, sand, tides, flooded forest salinity, and estuary area's ecosystem because sea sand is particularly susceptible to erosion with sea level rise. Bruun (1962) [4] proposed the equation to calculate the rate of shoreline erosion due to sea level rise:

$$R = SL / (h + B)$$

Here, R - Back speed on the beach (m/year); S – Sea level rise rate (m/year); L – Width of cross-sectional profile moving sediment (m); h – Depth beyond the sediment movement zone (m); B – The height of the top of the beach (m).

Group of average influencing factors (from 15 to less than 20 points)

Dear Vice Presidents for Academic Affairs, Deputy Vice Chancellors for Academic Affairs, Heads of International Relations Office, and Chief Quality Officers,

+ Increased turbidity due to increased rainfall and erosion in the basin, large and irregular storm waves, and narrowing of trapped mangrove forests and sedimentation. An increase in turbidity can be seen in riverbanks and canals, with long-term effects on water availability. Erosion can reduce the quality of habitat for fish and other organisms. Turbidity increases, affecting photosynthesis and primary productivity of aquatic organisms when sedimentation can cause the death of corals, many plant species, especially sea-grass, and some benthic species... This factor has a strong impact on the ecosystems of seagrasses, coral reefs, and lagoons.

Research shows that four out of the five Great Genocides are linked to ocean acidification. If left unchecked over a long period of time, ocean acidification could trigger a Mass extinction event, due to an increase in atmospheric CO2 levels.

Earth's atmosphere isn't the only thing affected by rising levels of carbon dioxide and other harmful gases; The oceans are also facing a serious threat from pollution.

Ocean acidification reduces calcium carbonate – a mineral from which the skeletons of many shellfish and corals are formed. Mineral decline slows the growth of marine species, if acidification continues at this rate, it is predicted that ocean pH could drop 2% by 2100. This impact causes a decrease in metabolic rate and immune response in some organisms and causes coral bleaching, making it more difficult for marine life to make bioavailable calcium carbonate, threatening the end food chains. n for the oceans. Coral reefs are the ecosystem strongly influenced by this factor.

+ Local sweetening is at increased risk due to increased rainfall, unusually heavy rainfall and when coastal water bodies are closed more due to inundation, changing species adaptability, population structure x, even Many species even died out. This impact is strongest on lagoon ecosystems (Tran Duc Thanh *et al*., 2010) [19], coral reefs (Nguyen Huy Yet, 2000), and seagrass beds (Nguyen Van Tien, 2013).

+ Salinization of sea surface water changes the structure of organisms and the adaptability of many species, affecting the structure and thermodynamic process. The coastal seabed sediments are quite rich in phosphorus, which is an important source for plants to change the surface layer thanks to the vertical upwelling water, through the water-mutation mechanism, in relation to the freshwater source from the river out. In the dry, hot, and rainy year (El-Nino), the amount of freshwater decreases dramatically, the sea surface becomes salty, the phosphorus source from the bottom decreases, and fish production also decreases. In the East China Sea, after El-Nino 1982-1983, Navodon's sapient fish production decreased by over 60%, corresponding to a 50% decrease in coastal rainfall (Chen, 2000) [5]. Salinization affects marine ecosystems and near-shore water bodies, especially upwelling waters and lagoons.

+ Vietnam's coastal water system includes three main types: estuarine waters, lagoons, and bays, distinguished by the characteristics of origin, evolution, and dynamical and morphological factors., structure and ecology. In some cases, morphological transitional waters exist between species, or one type is a subcomponent of another. The degree of closure, circulation, erosion-accumulation correlation, and water salinity is the most important features of coastal waters. Estuary waters are divided into two types: plains and estuaries. Deltas include areas dominated by alluvium (e.g. Red River Delta), areas dominated by waves (Thu Bon River Delta), and areas dominated by tides (Red River Delta) Mekong River).

- **Group of factors with low influence**

Circulating disturbances are caused by changes in the thermo-salt structure of the open sea or topographic changes in the coastal aquatic ecosystems. In years when the ENSO phenomenon occurs, there are often large climate disturbances and the hydrological structure of the sea can change abnormally. In the El-Nino year 1997-1998, the warm Kuroshio current, when passing through the waters south of Japan, shifted northwards by great distances, over three latitudes (inagake and Saitoh, 1998). This factor has the potential to affect upwelling, seabed, and coastal lagoon ecosystems. This is also the cause of the appalling ecosystem instability and displacement of fishing grounds (Ministry of Fisheries, 1996) [3].

+ Sedimentation mainly affects coastal ecosystems, arising from increased sediment flows from rivers because of more rain, due to shore erosion releasing material, and from storm surge stirring up the bottom and then re-deposition. The impact of sedimentation can deplete coastal waters and kill benthic organisms, especially aquatic plants, with great impacts on lagoon ecosystems and seagrass beds.

Ecosystems Affected

The analysis and evaluation results allow classifying 12 impacted ecosystems into 4 groups: the very impacted ecosystem group (a weighted score of 20 or more), including the lagoon ecosystem; groups of ecosystems that are strongly affected (from 15 to under 20), including seagrass ecosystems, coral reef ecosystems, intertidal ecosystems, estuary ecosystems, and mangrove ecosystems; ecosystem groups that are moderately affected (from 10 to under 15), including saltwater lake ecosystems, permanent wetland ecosystems, upwelling water ecosystems; and the weakly affected ecosystem group (under 10), including the seabed ecosystem and the reef tidal ecosystem (table 2.1).

The group of ecosystems is strongly affected

Tam Giang - Cau Hai is the largest typical brackish water lagoon in Asia, with high biodiversity value, and plays an important role in the coastal ecosystem of Thua Thien Hue province. This study aimed to identify three toxic metals (Pb, As, Hg) in sediments and assess ecological risks in this area. Sediment and water quality samples were sampled at eight sites in the wet and dry seasons. Toxic metals were determined according to the USEPA method for atomic

absorption spectrophotometer. The concentrations of Hg, Pd, and As in the study area ranged from 0-2. 64mg/kg, 4.83-22.13 mg/kg, and 1.18-6.24 mg/kg, respectively. The results show that the concentration of Hg, except in the sediments in some places is higher than the Vietnamese critical standard QCVN 43: 2012 / BTNMT, Pb, and As are all below the regulated level. The ecological risk assessment results show that the ecological risk (ERI) ranges from moderate to high, the order is Hg > As > Pb, and ranges from 43.9 to 582.9, where the risk highest risk is in the areas near Thuan An Shipbuilding and Input Area. In the rainy season, increased rainfall and closed doors will cause widespread flooding and freshening, which will kill a series of seagrass beds - a specific sub-ecosystem of the lagoon and salt-loving species.

Fig 1: Tra O lagoon ecosystem (Binh Dinh) is sweetened and separated from the sea because Cua Ha Ra is regularly filled with other sediments (Tran Duc Thanh *et al*., 2010) [19].

The dry season coincides with the hot season, so the temperature increases, causing evaporation, increasing the salinity, and sometimes reaching super salinity when the lagoon door is closed. Water environmental conditions become extreme and change greatly with the seasons. Despite sea level rise, the lagoon tends to be shallower due to being more closed, due to increased rainfall and erosion from the basin.

Groups of ecosystems are strongly affected

+ Ecosystem of seagrass beds. Vietnam has 15 species of seagrass. By 1995, the area of seagrass beds was about 10,770 ha (Nguyen Van Tien, 2013), by 2010, it was 12,830 ha, of which in Phu Quoc was 10,063 ha and Tam Giang – Cau Hai lagoon 1,200 ha, However, the area of seagrass disappearing is estimated to be about 40-50% and many of them completely disappear (Nguyen Huy Yet, 2010) due to both anthropogenic and Climate Change Localized turbidity and sweetening (Figure 2.2) and sedimentation are the strongest negative impacts on ECOSYSTEM seagrass beds. Acidification of seawater also has a large potential impact (Hall-Spencer *et al*., 2008) [7].

+ Ecosystem of coral reefs. According to Spalding *et al*., (2001), Vietnam estimated that about 1,100 km2 of coral reefs are concentrated in the Hoang Sa and Truong Sa archipelagos and are present in all seas from North to South, however, according to the 2010 inventory, the area The coastal area is only 141.3 km2 (Nguyen Huy Yet, 2010). Rising water temperature, pollution, waves, turbidity, and sweetening are the causes of reef degradation and coral death (Nguyen Huy Yet *et al*., 2000), in the future, seawater acidification becomes a major threat to the reef coral (Hall-Spencer *et al*., 2008) [7]. The mass bleaching of Bach Long Vi coral in 1997-1998 (Figure 2.3) can be attributed to both increased water temperatures (El-Nino) and cyanide pollution (Tran Duc Thanh, 2007). Coral bleaching in Con Dao in 1998 and 2010 due to high temperature and cumulative effects of high temperature and low humidity in Con Dao (2005), floodwater from the mainland affecting the waters of Cu Lao Indigo (2006), and mass bleaching of corals in the waters of Phu Quoc (2010)..., have severely reduced coral cover due to the destruction of coral reefs at many specific locations bleached corals come from 50% to 90% (Vo Sy Tuan, 2013).

The 36-month heatwave and global bleaching event were exceptional in a variety of ways. For many reefs, this was the first time on record that they had experienced bleaching in two consecutive years. Many reefs—including those in Guam, American Samoa, and Hawaii—experienced their worst bleaching ever documented. In the Northern Line Islands in the South Pacific, upwards of 98 percent of the coral at some reefs were killed. Reefs in the northern part of Australia's Great Barrier Reef that had never bleached before lost nearly 30 percent of their shallow water corals in 2016, while reefs a bit farther south lost another 22 percent in 2017.

Fig 2: Bleached coral in Australia's Great Barrier Reef appears bone white compared to the remaining healthy coral, which is golden brown and purple. Photo by Mia Hoogenboom, for ARC Centre of Excellence for Coral Reef Studies.

Ecosystem beach sand. Vietnam's coast and islands have thousands of sandy beaches, distributed over a length of more than 3,200 km along the coast and along hundreds of large and small islands. The marbles are from a few dozen to a few hundred meters wide and can be up to tens of kilometers long, like those of Tra Co and Lang Co. Although the ecosystem is poor, it is very special, it is the place to lay eggs of sea turtles. This ecosystem is very vulnerable to the effects of cyclones, waves, sea level rise, and shore erosion. The most common coastal erosion in Vietnam is concentrated on sandy shores (Figure 2.4). Total erosion sections (Tran Duc Thanh, 2002; Pham Huy Tien *et al*., 2002) are counted as 397 sections, with a length of 920 km, the size of each section from a few hundred meters to tens of kilometers, the speed of each section is a few hundred meters to tens of kilometers. average erosion 5-10 m/year, can reach 50-100

Group of ecosystems with moderate impact

Fig 3: Mangrove forest ecosystem in Nam Can, Ca Mau was encroached on by the sea due to erosion and destruction by waves

+ Ecosystem of the saltwater lake (locally called Tung, Ang) distributed mainly in Quang Ninh and Hai Phong, formed and developed from limestone funnels and valleys submerged by seawater. The isometric ponds (Figure 2.8) have about 70 plants, with an area of 0.1 ha or more, and a depth of 1-8 m, the largest being the 23.2 ha of Vem Pond. The trees have elongated shapes, a total of 57 pieces, the largest is the Gauge tree with 220 ha and the smallest is the May Den tree with 1.5 ha (Tran Van Tri *et al*., 2003; Nguyen Van Quan *et al*., 2010) [19].

This ecosystem has a quite high biodiversity and many valuable and rare species; However, they have a small, closed area or limited exchange with the external environment, so they are vulnerable to the impacts of nature and humans, especially climate change (Do Cong Thung and Masimo)., 2004; Nguyen Dang Ngai *et al*., 2016) [15]. They are significantly affected by rising water temperature, turbidity, acidification of seawater, local freshening, sedimentation, and submersion due to sea level rise.

+ Ecosystem of wetlands is regularly distributed to a depth of 6 m compared to the lowest sea level, has a very large area, but has not been accurately accounted for. This ecosystem has high biodiversity, rich aquatic resources, many traditional fishing grounds, hot and dry practices with little rain, the weak elevation of seawater to the surface, and poor nutrition and productivity. In general, fishery production in particular has been severely reduced (Chen, 2000).

Group of ecosystems that are weakly affected

+ The seabed ecosystem includes sub-systems such as the soft bottom, hard bottom, and underground hill..., about 1 million square kilometers wide, with bottom depth from 6 m to thousands of meters. In this ecosystem, the bay can be considered particularly patriarchal because it is located close to the shore, the depth is small, and the water body has a certain degree of closure. Vietnam has a total of 48 coastal bays (pools with an area of less than 50 square kilometers, bays of 50 square kilometers or more), depths ranging from a few meters to 30 meters, with a total area of about 4,000 square kilometers (Tran Duc Thanh and *et al*., 2008). This system is significantly affected by high water temperature, seawater acidification, and water circulation disturbance.

+ Ecosystem of intertidal reefs has a common distribution, but the area is limited (Do Cong Thung and Masimo, 2004). In addition to the common features of daily tidal exposure and tidal exposure, the nature of the ecosystem in any place depends heavily on bedrock characteristics and geographical zoning. The system is significantly affected by temperature rise (Figure 2.9) and sea level rise. In hot, dry areas, when the tide is low, the rock surface temperature can rise very high.

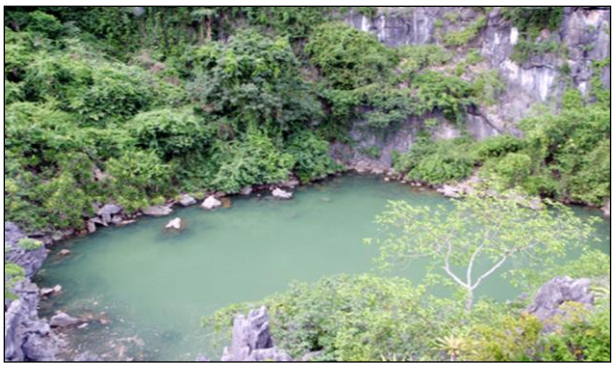

Fig 4: Pine and Ang ecosystem (karst funnel) is a typical ecosystem of the sea with limestone islands such as Ha Long Bay

Ecosystem properties need to be restored

The restored ecosystem contains a specific set of species present in the model ecosystem with a fully appropriate biome structure.

- When restored it will include native species to the greatest extent possible.
- Functional groups have stable and continuous development, preventing invasive groups.
- The system's physical environment is restored and develops in a stable trajectory.
- No signs of dysfunction in developmental stages
- Ecosystems form a unified whole through the exchange of biotic and abiotic material flows (living and non-living organisms)
- Potential threats to the stability and development of the ecosystem restored from the surrounding landscape will be eliminated or minimized as much as possible.
- The restored ecosystem is sufficiently resilient to the usual temporal stresses in its environment to help maintain ecosystem integrity
- Restored ecosystems are capable of sustaining themselves indefinitely under the environmental conditions in which they exist.

Affected seas and priority ecosystems for climate change response

The distribution of 12 typical ecosystems is not uniform across 6 marine ecoregions in Vietnam. The degree of difference in the Climate Change boundary (heat, rain, sea level rise) between regions is not large, except for storms that move more to the south, which is quite obvious. Therefore, each ecosystem may be affected by Climate Change to varying degrees in different marine ecoregions

Conclusion

The impact of Climate Change on Marine Ecosystems is a very large and complex issue, lacking an integrated and systematic view to prioritize research and develop response plans. Climate Change impacts many broad areas, of which marine Ecosystems are only one component. However, this is an important basis for building marine spatial plans, which are essentially ecosystem approaches.

The degree of impact of the marine ecosystem depends on both the influencing factors from Climate Change and the current state of the health of the system, in addition, the

synergistic possibility of anthropogenic impacts should be taken into account. So, within the same ecosystem, the level of impact can be different in different marine ecoregions. The degree of impact of Climate Change on 6 marine ecoregions in Vietnam represents the cumulative total impact of ecosystems distributed internally and their diversity.

Vietnam's sea is very wide, in the plan to respond to Climate Change's impact on ecosystems, it is necessary to have priority ecosystems and ecological zones. In this paper, priority ecosystems in ecological regions have been specifically proposed, and the priority order of regions has also been determined. However, this is only the initial result, suggesting an approach that needs more detailed and specific studies to supplement and adjust, in order to achieve better results.

Acknowledgments

The authors would like to thank Project KC.09.16/16-20 “Research and development of marine spatial planning options in the Gulf of Tonkin” for supporting this publication.

References

1. Ministry of Natural Resources and Environment (TN&MT). Scenario of climate change and sea level rise in Vietnam. Natural Resources - Environment and Map Publishing House of Vietnam, Hanoi, 2016a, 170.
2. MONRE. Circular No. 08/2016/TT-BTNMT stipulates the impact assessment of climate change and national climate assessment. Ministry of Natural Resources and Environment, Hanoi, 2016b.
3. Ministry of Fisheries. Fisheries resources of Vietnam. Agriculture Publishing House, Hanoi: 616 million, 1996.
4. Bruun P. Sea Level Rise as a Cause of Shore Erosion. ASCE. Journal of Waterways and Harbors Division,1962:88:117-130.
5. Chen TAC. The Three Gorges Dam: Reducing the Upwelling and thus Productivity in the East China Sea. Geophysical Research Letter,2000:27(3):381-383.
6. Coral Reef Targeted Research and Capacity Building for Management Program. Bleaching and Related Ecological Factors. Report of CRTR Working Group Findings 2004-2009. The University of Queensland, Australia, 2009, 217.
7. Hall-Spencer JM, Rodolfo-Metalpa R, Martin S, *et al*. Volcanic Carbon Dioxide Vents Show Ecosystem Effects of Ocean Acidification. Nature,2008:454(7200):96-99.
8. Vu Thanh Hang, Ngo Thi Thanh Huong and Phan Van Tan. Characteristics of storm activity in the coastal waters of Vietnam in the period 1945-2007. VNU Science Journal, Natural Science and Technology,2010:26(3S):344-353.
9. Phan Nguyen Hong (Ed.). The Role of Mangrove and Coral Reef Ecosystems in Natural Disaster Mitigation and Coastal Life Improvement. Agriculture Publishing House, Hanoi, 2006, 385.
10. Inagake D, Saitoh S. Description of the Ceanographic Condition off Sanriku, Northwestern Pacific and Its Relation to Spring Bloom Detected by the Ocean Color and Temperature Scanner (OCTS) Images. Journal of Oceanography,1998:54:479-494.
11. Jacobson MZ. Studying Ocean Acidification with Conservative, Stable Numerical Schemes for Nonequilibrium Air-ocean Exchange and Ocean Equilibrium Chemistry, 2005.
12. Geophys J. Res. 110, D07302.
13. Tran Dinh Lan (Editor). An economic evaluation of typical marine-island ecosystems for sustainable development of some outpost islands in Vietnam's coastal waters. State-level Project Report KC.09.08/11-15. Institute of Marine Natural Resources and Environment, 2015.
14. Bui Hong Long, Nguyen Ngoc Lam T. Pohlmann M Voss, Wiesner M. Some research results on upwelling in the South Central Coast of the cooperation project between Vietnam and Germany under the protocol, period 2003-2006. Collection of National Conference "East Sea - 2007". Nha Trang, September 12-14,2007:2007:3-14.
15. Nguyen Dang Ngai, Dau Van Thao, Cong Thung D, Le Thi Thuy, Pham Van Luong, Cao Thu Trang, Vu Thi Luu, *et al*. New data on the water environment and creatures in underground caves and saltwater lakes in Ha Long Bay, Cat Ba. Journal of Marine Science and Technology,2016:16(2):167-173.
16. Mai Trong Nhuan, Ha NTH, Quy TD, Hue NTH, Hien LTT. Integrated Vulnerability Assessment of Natural Resources and Environment for Sustainable Development of Vietnam Coastal Zone. VNU Journal of Science, Earth Sciences,2011:27(1S):114-124.
17. Mai Trong Nhuan, *et al*. Changing impacts of climate extremes and natural disasters on ecosystems and human systems. In: Vietnam Special Report on Disaster and Extreme Event Risk Management to Promote Climate Change Adaptation. Natural Resources - Environment and Map Publishing House, Hanoi, 2015, 143-188.
18. Ocean Acidification and Oxygen Working Group, 2009. Report of the Ocean Acidification and Oxygen Working Group. SCOR Biological Observatories Workshop. Venice, September, 2009. http://www.scor-int.org/OBO2009/A&O_Report.pdf.
19. Nguyen Van Quan, Tran Duc Thanh, Dinh Van Huy. Landscapes and Ecosystems of Tropical Limestone: Case Study in Cat Ba Islands, Vietnam. Journal of Ecology and Field Biology,2010:33(1):26-33.
20. Vu Trung Tang. Ecology of Vietnam's estuarine systems: Exploitation, maintenance, and management of resources for sustainable development. Vietnam Education Publishing House, Hanoi: 327 million, 2009.
21. Phan Van Tan, Ngo Duc Thanh. Climate change in Vietnam: Some research results, challenges, and opportunities in international integration. VNU Science Journal, Earth and Environmental Sciences,2013:29(2):42-55.
22. Tran Duc Thanh, Tran Dinh Lan, Nguyen Thi Minh Huyen, Dinh Van Huy, Nguyen Van Quan, Cao Thi Thu Trang, *et al*. Nature and environment of Bach Long Vi island. Natural Science and Technology Publishing House, Hanoi: 275 million, 2013.
23. Nguyen Van Thang, Nguyen Trong Hieu, Tran Thuc, Pham Thi Thanh Huong, Nguyen Thi Lan, Vu Van Thang. Climate change and impacts in Vietnam. Institute of Meteorology, Hydrology and Environment. Science and Technology Publishing House, Hanoi, 2010, 260.

24. Do Cong Thung (Editor). Research on the current state of the environment, changes in resources, and biodiversity of the ecosystem in the coastal intertidal zone in the North of Vietnam (from Quang Binh onwards), propose a mining model. exploitation, farming, conservation and sustainable management, 2015. State-level thesis report KC.09.07/11-15.