Impacts of Climate Change on Marine Tourism in Southern Indonesian Islands of Java, Bali, Lombok and Nusa Tenggara

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Abstract: **- Marine tourism plays an important role for the tourists and the people living in the coastal regions of Indonesia. Due to climate change, marine tourism is facing an immense threat. The changing climate is having impacts on the marine resources, aquatic ecosystem and coastal weather to name a few. Secondary impacts follow soon further leading to reduced number of tourists and economic losses. In the last fifty years however, adaptation and mitigation programs has been formulated. International and regional organizations are coming together to support the government and working towards adapting to the current climatic patterns and mitigating to reverse the climatic impacts. This paper reviews the importance of marine tourism for recreation, presents updated knowledge on the impacts of climate change on activities in these environments followed by identifying adaptation and mitigation measures taken up by the government and international and regional organizations. The focus area for this study is the islands of Southern Indonesia namely Java, Bali, Lombok and Nusa Tenggara. This study provides a strong knowledge base for understanding climate change relationship with marine tourism and proposes a number of future research areas.**

I. MARINE TOURISM

Introduction

Climate and weather are important factors of our daily lives. Our lifestyles, health and social well-being are affected by the changing climate. Although the changes may vary from place to place during different times of the year, it still poses a challenge to adapt to these changes. Tourism is no exception to climate change and in the years to come, the management and development of tourism will become a critical issue. Tourism sector is similar to agriculture, energy and transport sector in terms of climate sensitivity. Destinations are already witnessing direct and indirect impacts of climate change. For example, USESCO has identified a number of its heritage sites under threat. Some examples are the rising sea level in Venice, glacier retreat in Waterton International Peace Park, USA and Coral bleaching in the Great Barrier Reef (UNEP, 2008). Such impacts are influencing the decision makers in the industry to take steps towards adaptation and mitigation measures.

At the same time, tourism sector is also contributing to climate change through the emission of greenhouse gases (GHG's). The transport sector and the accommodation sector are major contributors of GHG's in the tourism industry. In rural tourism destinations of South-east Asia where rice is the primary crop, methane gas is the main source of GHG's (Becken, 2010). Although methane makes up only nine percent of greenhouse gas in the atmosphere, it can trap twenty one times more heat than carbon di oxide (Tuibello, 2012). Therefore, the tourism industry has partly become a cause and a victim of climate change.

The impacts of changing climate on the tourism industry are most visible on the coastal cities. Tourism in coastal regions has been growing continuously with introduction of new activities each year (Moreno and Amelung, 2008). Several countries have realized the importance of such cities and its potential to contribute to the economy. For example, the Ministry of Tourism in Mexico has launched systems to accelerate the time to approve licenses for foreign investments in the coastal zones (OECD, 2008). Similarly, countries of South-east Asia are accelerating to adapt and reverse the impacts of climate change. Among all the South-east Asian nations, Indonesia is receiving lots of attention as the world's third largest emitter of greenhouse gases (Maesey, 2010). In spite of Indonesia, being rich in natural resources and bio diversity, environmental degradation is continuing at a rapid rate. Indonesia's marine ecosystem has supported an unmatched variety of underwater life forms, including four hundred species of reef building corals and at least one out of four of the world's fish species (Zikra, 2015). The Global Reef monitoring network claim that more than ten percent of coral reefs have degraded as a result of direct human activities. The coastal cities of Indonesia such as Bali, Surabaya, Jakarta and Semarang are severely affected due to changing climate. Due to the exploitation of natural resources in these cities, the air and water pollutions are severe. Now this has to change as much of tourism in the country depends on coastal resources for revenue generation through tourism. If tourism is managed well, it can play an important role in reversing climate change to manageable levels. A global effort

is required to innovate and mobilize the resources of this vast sector and propel it towards achieving this goal.

II. CLIMATE CHANGE

According to National Weather Services, climate change is a long term shift in the weather statistics. However, the recent climatic conditions have changed since the industrial revolution in Europe. Our climate has been changing since the formation of the Earth 4.6 billion years ago. The geological records hold sufficient evidence to indicate large scale climatic changes in the past. However, the climate change was gradual over millions of years as a natural process. This natural process has been altered due to human activities over the last hundred years.

Earth's atmosphere naturally contains gases such as Carbon di Oxide, Water Vapor, Sulphur di Oxide, Ozone and Methane - all of which are greenhouse gases. These gases kept our earth warm by trapping heat and creating a greenhouse effect. The Intergovernmental Panel on Climate Change (IPCC, 2008) claims that human activities especially in the last hundred years have added large amounts of greenhouse gases in the atmosphere. Burning of Fossil fuels and use of natural gas and coal has released large quantities of these gases in the atmosphere leading to an increase in the temperature across the planet. This may further result in secondary impacts such as unusual weather anomalies, ocean warming, temperature extremes, and wind patterns. Besides, atmospheric feedback mechanism further heats up the atmosphere in several ways. The IPCC has also anticipated a high probability that the rate of climate change will increase with the continued emission of greenhouse gas at or above current rates. Over the last century, the average mean temperature had risen by $0.75^{o}C$ due to the increase in the atmospheric concentration of Carbon di oxide from 278 parts per million before the industrial revolution to 379 parts per million. By the end of this century, it is predicted that the temperature may rise from anywhere between $1.8^{O}C$ to $4^{O}C$ (Moreno, 2009).

The increase in temperature may lead to extreme events such as tropical cyclones, floods, draughts, unseasonal precipitation, etc. Our natural environment, economy, social life and related sectors will be effected due to the changing climate. Melting of ice and snow in the mountains and polar regions will result in rising sea levels, soil erosions, landslides and flooding. Altered rainfall patters may cause flooding and draughts. Food shortages may arise due to changes in crop growing seasons. Some species of flora and fauna may become extinct due to the rising temperatures. The fourth assessment report IPCC (2007) concluded that that the climate will continue to warm even if the emission of greenhouse gases reduce. Hence it is important to determine climate change adaption strategies along with mitigation measures. In many coastal destinations, residents have already started to adapt to climate change. For example, houses are being built on bamboo stilts as a response to increased flooding. Dependence on fishes as a source of food is also reducing as they are diversifying their lifestyles.

III. MARINE AND COASTAL TOURISM

Coastal tourism includes a range of activities oriented towards leisure and recreation that take place in the coastal areas such as beaches, backwaters and lagoons (Hall et al, 2001). It is related to a combination of resources such as sun, water, sand, sea food, etc. Many coastal destinations have developed because of the presence of these resources. Activities related to coastal tourism include beach treks, wildlife watching, sunbathing, beach sports, etc. Marine tourism on the other hand predominantly covers water based activities such as snorkeling, deep sea fishing, underwater sea walk, cruising, whale watching, etc. Corals, cichlids and coral fish species are the prime attractions of marine tourism.

Coastal tourism is found at the border of land and sea environments where as marine tourism is purely within the marine environments. These transitional regions are known for their rich biodiversity. Some of them are home to fragile ecosystems on the planet like the mangroves of Sundarbans and corals of Papua New Guinea and the Great Barrier Reef. In many coastal areas, tourism is considered as the primary income generator. For example, in 2002 in the coastal town of Calvia in the island of Majorca, Spain; ninety-five percent of the population was involved in tourism (UNWTO, 2005).

Tourism in coastal destinations does not always lead to a positive outcome. In several destinations, pollution, food shortages, water shortages, climatic changes, etc. are common occurrences. For example, Sanur beach- once a pristine beach in Bali has suffered serious sea erosion and water pollution due to uncontrolled mass tourism. In some cases, it was found that water pollution was due to poor waste management practices by some of the resorts such as The Inna Sindhu beach resort and The Mercure Accor Hotel.

A report on "Jakarta Post" dated 5th December 2016 stated that more than 18 percent of 2.5 Million hectares of coral reef is in poor condition. Around 40 percent of 2.9 million hectares of mangrove forests suffered severe degradation.

IV. COASTAL AND MARINE TOURISM IN INDONESIA

Located north of Australian mainland and south of Phillippnes, Indonesia takes its place as the largest archipelago in the world. A nation with over 18,000 islands, it is also the most widely spread country in South-east Asia. Indonesia has a total coastline of 54, 720 km. Much of the coast of Kalimantan and the northeastern coast of Sumatra are known for low lying swampy mangrove ecosystem. The northern regions of Java and Sumatra and South-western Sulawesi are known for fish farming in the brackish tidal waters. The southern coastlines of Java, Sumatra, Bali, Lombok, and Sumbawa are known for some of the world's best surfing beaches which attract large number of tourists each year. Tourists are also attracted to the atolls and coral

reefs that extend down the southwestern coasts of Bali, Lombok and Sulawesi islands.

Indonesia is known for its coral reefs and diverse species of fishes. Several ornamental fishes such as Amphiprion, Dascyllus, Labrida and Gorisaygula are exported to United States, Japan and European countries as well. Apart from fishes, the water around these islands offers a rich variety of conches and shells.

- *Riau Archipelago*

Riau Archipelago is known for the sunken vessels of world war two. Although being a historical site on water, is still carries an air of mystery. This archipelago is accessible from Pekanbaru in Sumatra or from Pontianakan in west Kalimantan. Bintan Island is popular for corals and pristine beaches. The islands offer opportunities for island hopping tours as well.

- *The Pulau Peucang & Pulau Peniatan*

These islands lie just off Java's western end and are part of the Ujung Kulon nature reserve. They can be accessed from Labuan, a town on Java's western coasts. The islands are known for snorkeling and diving. Most popular is the "Under water cliffs" of Tanjung Layar. Panaitan Island offers day tours for experiencing reef platforms on foot.

- *The Kepulauan Seribu*

Kepulauan Seribu is a group of small islands in the Bay of Jakarta. They are easily accessible form Jakarta by speed boat or chartered boat. Most of these islands have been developed as tourists' resorts or as protected areas for Birds and Marine life. The islands in the north have been declared as national parks to preserve its underwater life and resources. Pulau Putri, Pulau Pelangi and Petondan are known for their upmarket accommodation, restaurants and a dive shop and boats for hire.

- *Bali and Lombok*

Perhaps the most popular destination of Indonesia, Bali offers beautiful diving reefs to explore. The wreck of SS Liberty is also an attraction just 40 meters off the beach at Tulamben. Kuta is the most popular beach, and is ideal for those desiring for sun sand, surf and socializing. The beaches are full of shacks, restaurants and kiosks. The nearby places of Nusa Dua and Lombok are known for quitter beaches and less crowded beaches which are known for their cultural heritage.

- *Maluku and Banda Neira Islands*

These islands in Ambon are home to excellent beaches, reefs and seascapes. For adventurous solo travellers, Maluku is a magnificent paradise. Pulau Pombo and Pulau Kasa are two small island-marine reserves near Ambon. South east of Ambon, is a small island group of Banda. It offers crystal clear waters, full of corals and tropical fish species. These islands are also known for its colonial history dating from the year 1321

- *The Bunaken, North Sulawesi*

The Bunaken region is home to spectacular coral reefs and sandy beached. It is also known for the Tangkoko nature reserve which can be accessed in a speedboat. Accommodations are available in Batu Puthi village. The coral reefs which ring the islands of Bunaken are considered to be on par with some of the great reefs of the world and have been rated by international organizations and renowned divers.

V. IMPORTANCE OF MARINE AND COASTAL TOURISM FOR INDONESIAN MARINE TOURISM

Coastal and Marine tourism is a combination of unique resources at the interface of sea and land. It offers beaches, scenic beauty, pristine clear waters, rich biodiversity, diversified culture and heritage. It includes a diversity of activities which take place both in marine environments and sandy beaches. Such diversity in tourism activities helps in the development of tourism capacities such as hotels, homestays, resorts, etc. It also supports infrastructural developments such as sea ports, marinas and diving spots, public utility services, information centers and much more. Coastal recreational activities in Indonesia have been increasing in both volume and in number during the last ten years.

Coastal tourism in Indonesia is strongly dependent on natural weather and climate. It involves activities which **require specific weather conditions and** location. For example, the beaches of Kuta with high waves are suitable for surfing whereas as that of Seminyak with calm beaches are favorable for relaxing and sun bathing (Ryan, 2001).

Besides physical conditions, the growth and development of tourism in coastal regions are related to **socio-cultural and economic features**. Some of these include local community interest, political factors, religious beliefs, health and security, family income and foreign exchange. Environmental conditions such as unseasonal torrential storms, draughts, algae blooms, extreme winds and hurricanes affect tourism in these regions. For example, the Jakarta floods of 2007 affected more than seventy districts and displaced and average 4,30,000 people from their homes (Maesey, 2010).

Since these untouched beaches were discovered, it became the site for many international events. For example, the beaches of Bali and Lombok became known for the ASEAN Beach Volley ball, International Sky diving championship of 1988, the Sanur village festival since 2005, Kuta Carnival, canoe races, kite festivals and many more. Several of these festivals have been initiated and organized by the local villagers and supported by tourism organizations and governments. The involvement of local villagers at such levels has contributed to a new spirit of tourism, primarily focusing on marine based activities.

Coastal cities of Lovina, Surabaya and the Riau Archipelago are popular for dolphin watching tours. Such tours attract large number of tourists and provide economic benefits to the

local communities. For example, a study conducted on aquatic wildlife tourism indicated that the dolphin tours bought about 37,000 tourists in the year and contributed to about Rp 41 billion to the local economy (Putra, 2014). The tours were conducted early mornings and therefore the tourists had to stay overnight in hotels and resorts. This further added to the economy.

Local communities and tourism organizations have realized that continued presence of dolphins is important for continued economic benefit. If the numbers of dolphins reduce, tourist will be unhappy and their influx will reduce and result in economic slowdown. Hence, preservation of coastal and marine tourism is critical for the development of Indonesia at the national and local levels.

VI. IMPACTS OF CLIMATE CHANGE ON THE COASTAL CITIES

The increasing amounts of GHG in the atmosphere may produce changes in the long run in the climatic systems that impact the physical environment of the coastal regions. The biodiversity in the coastal regions may be disrupted due to ocean and atmospheric temperature fluctuations. The corals and shelled creatures in the oceans will suffer bleaching due to ocean acidification. The melting ice from the Antarctic and Polar ice caps can put enough fresh water into the oceans leading to changes in the oceanic currents. These are some of the impacts which may occur due to the changing climate of our planet. Such impacts are clearly visible in Indonesia's long coast line. Several villages and cities are affected due to the unseasonal and intense weather anomalies.

- *Severe storms*

The frequency of tropical cyclones in Southeast Asia is likely to remain stable but the intensity of such storms may increase. Such storms can be in the form of Hurricanes, Cyclones, extreme winds and heavy torrential storms. These storms lead to secondary impacts such as flash floods and landslides (IPCC, AR4). For example, on June 18th, 2016 Central Java faced severe torrential rain which triggered floods and mud avalanches killing 24 people and more than 20 people missing. Purworejo district was worst hit (International Business Times, June 19, 2016). In May 2016, fifteen students holidaying in Western Indonesia were killed in a landslide (talkvietnam.com, May 17, 2016). Coastal cities face the worst effects of such storms. Sea side restaurants and hotels are either completely destroyed or heavily damaged. Villagers are forces to abandon their homes and move inlands. All modes of transportation cease to operate because of which tourists get stranded. Even in the days to come, tourism inflow rate remains low. Volunteerisms and disaster tourism do rise in the face of such events.

- *Extreme sea levels*

Extreme sea levels caused by high tides and sea storms can be devastating to the coastal regions. Almost 1500 islands of Indonesia are vulnerable to rising sea levels. A report published by Zubaidah Nazeer in *The Dawn* (20th February 2015) indicates that more than 1500 islands will be underwater by 2050. Threats from the changing climate and its impacts are worst for Indonesia due to several socio economic factors. The report also mentioned that the Soekarno- Hatta International airport may be wiped off the map by 2030. Even the capital city of Jakarta is at extreme risk as more that 40% of the city is below sea level. According to Ancha Srinivasan, principal climate change specialist with the Asian Development Bank, Indonesia's biggest threat is the rising sea levels, where 42 million people living within three kilometers from the coast are threatened by the rising sea level which may reach up to 90 centimeters by the end of the century.

- *Winds and Waves*

Changes in wind climate significantly affect the large scale wave climate. Changes to wind and wave climate can have an impact on the sediment dynamics and shoreline processes. Extreme winds and waves are a threat to coastal populations (IPCC, AR4). Although large waves can be seen as favorable condition for surfing and other water skiing, it also poses a threat to the beaches and infrastructure. Large waves hit the beaches with increased force and decrease the beach sand area. Less space forces the tourists to concentrate in smaller areas which are not always favored by them. Shop owners are forced to go inland. Buildings, houses, restaurant and other infrastructures which are fixed to the ground are most threatened. Building wave controllers in beaches may save these infrastructures but will lead to complete closure of any beach activity which may reduce tourism in the short run as tourists may go to other beaches. Therefore it is important to develop efficient mitigation measures or adapt to climate change impacts.

- *Sea Surface Temperatures*

Climatic studies indicate that more than 70% of coastlines are experiencing a rise in sea surface temperatures during the past 30 years (IPCC, AR4). Extreme events are also being reported. In 2010, the Indian Ocean experienced a sudden rise in temperatures because of the La Nina effect in the Pacific Ocean (Australian Bureau of Meteorology, 2016). Rise in sea temperatures increases the rate of ocean acidification which causes coral bleaching. Warming oceans are also responsible for cyclones. Tropical cyclones extract its energy from the warm tropical oceans and forms when the sea temperatures cross 26.5^{O}C. These cyclones can persists for several days and can follow erratic paths which make it highly unpredictable about its landfall (Australian Bureau of Meteorology, 2016). For example, tropical cyclones devastated the coastal regions of Nusa Tenggara on January 2014 causing severe damage to life and property. Another tropical cyclone named Cyclone Narella made land fall near Jakarta in January 2013 causing losses of billions of Indonesian Rupiahs'. Typhoon Bopha also caused immense losses in the North Moluku province of

the Morotai Islands. Warming oceans also affect marine bio-diversity. For example, corals are highly sensitive to temperature. The outer skeletons of corals are covered by an organism called Zooxanthellea. This organism gives coral its color. A slight rise in temperature causes these organisms to leave their tissue thereby tuning the corals white. The Coral triangle of Indonesia has started to degrade due to increasing temperatures.

- *Ocean Acidification*

Almost one third of carbon di oxide released into the atmosphere due to human activities is absorbed by the oceans. As carbon di oxide increases, ocean Ph. decreases and the water becomes acidic. Corals require calcium carbonate to maintain their skeletons. With ocean acidification, it is difficult for corals to absorb calcium carbonate. Eventually the coral skeleton dissolves in the ocean and disappears. If the release of carbon di oxide into the atmosphere continues at the current rate, oceans will acidify even further and more corals will perish. Other undersea creatures such as snails, clams, urchins, etc. are also affected due to ocean acidification as they too require Calcium Carbonate to build their shells. At this rate of Carbon di oxide emission, the Ph. of oceans will fall to less than 7.5 by 2100 (teachoceanscience.net, n.d.).

VII. ADAPTATION TO CLIMATE CHANGE

Adaptation to climate change refers to an adjustment in the human or natural systems in response to the expected or actual climatic condition or their effect, which moderates, harms or exploits any beneficial opportunities (IPCC 2007b). All economic sectors and societies will have to adapt to climate change one way or the other in the decades ahead. In some sectors adaptation is already occurring such as agricultural and tourism. Some countries and regions are more vulnerable to climate change impacts then others due to their geographic characteristics which determine their exposure to such impacts. The economic condition is these vulnerable countries also determine their adaptive capacity to climate change. According to UNWTO, adaptive capacity is the potential or ability of a system to respond effectively to climate variability and change and includes adjustments in both behaviour and in resources and technologies. According to a report jointly published by United Nations Environment Program (UNEP) with Oxford University in 2008, the presence of adaptive capacity has been shown to be a necessary condition for the design and implementation of effective adaptation strategies so as to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change.

The unique and dynamic nature of tourism industry and its ability to cope up with terrorism attacks, SARS virus, natural disasters, indicate a relatively high climate change adaptive capacity within the industry overall (UNWTO, Oxford University, 2011)

Indonesia is among the countries most at risk from climate change impact. A report published by the Asian development bank (2012), concluded that Southeast Asia is highly vulnerable to climate change. It suggested that Indonesia may lose 6.7% of the GDP by 2100, three times the global average. Indonesia's long coastline makes it particularly vulnerable to sea-level rise, as millions of its people live in coastal zones - many of them in densely populated cities. It is estimated that a one-meter sea-level rise could displace around 10 million people in Indonesia.

The Indonesian Ministry of Tourism in collaboration with UNWTO has developed several programs to tackle the impacts of climate change. They have also involved a few local and regional organizations and are focusing on tourism sector to implement adaptation and mitigation plans through it.

- *Community involvement*

In 2006, the Indonesian ministry of Tourism launched the "STREAM" project - a project to revitalize the tourism in Pangandaran. It is one of the examples where a tourism sector has engaged the local communities to be part of the solution to fight climate change. More than 2000 people from various organizations and communities had been participating in the project. Around 450 school children were part of the "Mangrove Ambassadors Program". The project also achieved implementation of energy efficiency and renewable energy measures in several of hotels and restaurants, and the development of a Low Carbon Planning Software Tool that helps to envision and develop low carbon tourism in the area. The project has also launched comprehensive rehabilitation programmes to restore and protect Pangandaran's mangrove forests and coral reefs – over1,400 coral segments and 38,000 mangroves were planted with high rates of success.

- *The Bamboo Project*

The coastal village of Cemarajaya in West Java was a victim of sand abrasion. The rising sea levels in the Pisangan Coast of Java Sea caused the sand to erode and wash away into the sea. The land area was decreasing gradually and the wave height also increased. Houses close to the sea were damaged and had to be rebuild or moved to another location. However, the problem did not stop as the land area continued to decrease.

The Adventist Development and Relief Agency (ADRA) Indonesia took up the responsibility to restore the village coast. After thorough analysis, they came up with the Bamboo Project. Bamboo stilts were dug-in around the perimeter of the coasts on the coastal side forming a wall. The stilts acted as a filter and prevented the sea sand from washing ashore. Sand bags were also used to create a barrier against the waves. Within a year, the sea water backed away and about five meters of sand was re-taken. In another six months about 10 meters of land was visible and could be used for tree plantations. ADRA Indonesia launched the Tree plantation

program. School children were bought to the village and provided education on sustainability and the importance of community involvement. The entire project aimed at increasing community's adaptation and assist them take mitigation measures to cope up with climate change.

- *Indonesia's Coral Reef Restoration Project*

The project was launched in the year 2000 when Late Wolf Lillbertz built the first biorock reefs in Pemuteran and conducted first Indonesian Biorock Coral Reef Restoration Training Workshop. Subsequent workshops trained hundreds of reef restorationist in hands-on construction of reefs and now there are over a hundred separate biorock reefs in Pemuteran. A wasteland of dead corals has now been turned into a vibrant colorful coral reef, swarming with fishes. This had restored the reef and fisheries and became a world famous eco-tourism attraction. Local hotels and dive shops led by Taman Sari Resort, Amertha Villas and Bali Diving Academy are all involved in the project to help and support it, educate guests, and support community environmental education and management initiatives to make Pemuteran not only a wonderful place for visitors, but to improve the quality of life for villagers through their own efforts. School children use the project to learn about how to protect their own marine resources and propagate them for the future.

- *Coastal Wetland Conservation*

Many mangrove belts along the coasts of Java, Sumatra and other parts of Indonesia are severely degraded or completely gone. Shrimp farms in particular have cleared large tracts of mangroves and coral reefs along the coastal and marine environment. The Indonesia's Ministry of Fisheries in collaboration with Wetlands International launched an initiative to restore these wetlands. The local communities were involved in the project. They used the government's "Bio-rights" microcredit scheme which was a combination of nature conservation and local community livelihood improvement. Along with the aid of local and regional NGO's and research institutes, large scale research are conducted to gather information on the importance of mangrove conservation for coastal protection and the maintenance of fish stocks. The tourists are educated on such initiatives and asked to participate in the programs.

- *Beach Nourishments with sand engines.*

In Bali, construction of the airport in the sea was followed by erosion of Kuta beach, a popular tourist destination and a surfing hotspot. Indonesia is interested to restore and protect this beach by mimicking an innovative method also applied in the Netherlands called the Sand Engine.

The Sand Engine used huge volumes of sand and applied along the West coast of the Netherlands. Nature, namely wind, waves and currents further spread the sand along the coast and make the coast broader and safer.

- *"Building with nature" initiative*

Building with Nature is an approach whereby sustainable coastal development is planned, designed and operated whilst creating new opportunities for nature and at the same time utilising natural forces whenever possible.

Rather than presuming the worst – that a coastal infrastructure project will harm the natural environment – and acting defensively, Building with Nature explores positive, pro-active opportunities, using the dynamics of the natural system as a starting point.

VIII. CONCLUSION

As an archipelago with over 17,500 islands and over 81,000 kilometres of coastline, Indonesia coastal area is highly vulnerable to climate change. Increasing trend of sea level rise, warmer ocean temperature and increased wave height are among a few example of what climate change can bring to Indonesia. These problems have received serious attention from government to develop adaptation and mitigation plans for future development associated with coastal areas. These areas are greatly affected by climate change due to the rise in sea level, and thus the Indonesian government has prepared long term adaptation strategies to counter these effects. The government has also promoted the rehabilitation programs for planning and management of coral reefs by collaborating with several local and regional organizations to tackle several issues related to climate change. It has continued to strengthen water resource management and ensure water availability in the event that it becomes contaminated by pollutants. In spite of aggressive initiatives to tackle, adapt and mitigate climate change, Indonesia still remains among the top three greenhouse gas emitter. Most of the emissions are due to deforestation and land clearing for cultivation of palm oil. The coastal regions where majority of the population thrive will face the worst impacts. With this reality, the government has to do more to adapt and reverse the changing climate.

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