Kingdom of Cambodia
Nation Religion King

Project "Building climate resilience of urban systems through Ecosystem-based Adaptation in the Asia-Pacific region Project (Urban EbA Asia)"

Biodiversity, Climate Change Vulnerability and Adaptation Needs Assessment of Kep Province

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Contents

Abbreviations and Acronyms

CBD	Commune Data Base
CBD	Convention on Biological Diversity
CPR	Common Pool Resources
DANIDA	Danish International Development Agency
DFC	Department of Fisheries Conservation
EbA	Ecosystem-based Adaptation
EEZ	Exclusive Economic Zone
FA	Forestry Administration
FAO	Food and Agriculture Organization
FFPRI	Forestry and Forest Product Research Institute of Japan
FiA	Fisheries Administration
GDANCP	General Directorate of Administration for Nature Conservation and Protection
GDLC	General Directorate for Local Community
IFAD	International Fund for Agriculture Development
IUCN	International Union for Conservation
JICA	Japan International Cooperation Agency
KNP	Kep National Park
LACRM	Local Area Coastal Resource Management
MAFF	Ministry of Agriculture, Forestry and Fisheries
MFF	Mangroves for the Future
MFMA	Marine Fisheries Management Area
MLMUPC	Ministry of Land Use, Urban Planning and Construction
MoE	Ministry of Environment
MRC	Mekong River Commission
NCCMD	National Committee for the Coastal Management and Development
NCDM	National Committee for Disaster Management
NIS	National Institute of Statistics
NRMAP	Natural Resources Management Action Plan
NSAP	National Strategy and Action Plan
NTFP	Non-Timber Forest Product
PDA	Provincial Department of Agriculture
PDE	Provincial Department of Environment
PDHI	Provincial Department of Industry, Science, Technology and Innovation
PDLMUPC	Provincial Department of Land Use, Urban Planning and Construction
PDT	Provincial Department of Tourism
PDPWT	Provincial Department of Public Work and Transportation
PDWRM	Provincial Department of Water Resources Management and Meteorology
PFP	Physical Framework Plan
PPCR	Pilot Program for Climate Resilience
REDD	Reducing Emission from Deforestation and Forest Degradation
SOER	State of Environment Report
UNEP	United Nations Environment Program
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization

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Executive Summary

This report is to undertake the vulnerability assessment on biodiversity at Kep which focuses on services provided by the urban ecosystem aiming at guiding the implementation of the EbA's project intervention. Furthermore, assessment is to validate biodiversity and ecosystems through field observations, literature review, and discussions with Kep Technical Working Group and other relevant stakeholders. There are two main themes of natural resources and environment for this assessment to be suggested for the EbA's implementation site in Kep urban area.

Kep province is the smallest amongst other Cambodian coastal provinces. Kep consists of inland natural resources and coastal/marine resources which are rich in biodiversity and play a significantly important role in terms of ecosystem services for protecting the environment and sustaining community livelihoods at large. Kep National Park and Marine Fisheries Management Area have been designated as protected and sustainable management areas.

Kep province has been increasingly exposed to climate change, such as rising temperatures, changes in rainfall, frequency of droughts, floods and storms. The degree of susceptibility to the impacts of climate change was examined and reported to be high. People living in the province already observed extreme storms and floods that have potential impacts on coastal ecosystems. Urban people also noted that climate change caused serious risks and impacts on coastal resources, ecosystem services, and vulnerable communities. Meanwhile, some negative human activities still occur, such as mangrove fragmentation, forest disturbance, and fuelwood collection harming sustainable natural resources management.

Due to its urgent demand for climate change adaptation and resilience, Kep city has been selected to benefit from specific EbA interventions. This report covers an assessment of natural resources, environment, climate change, natural hazards, vulnerabilities, and adaptation in Kep city and the entire province. It will be used as a supportive document to assist the implementation of the EbA interventions. In the context of Kep urban area, the EbA's implementation site needs to be recommended for its intervention. As a result, although urban area covers coastal resources, such as mangroves, seagrasses, and fisheries resources, those resources are fragmented/degraded. The abundance of mangroves, seagrasses, and coral reefs are located elsewhere outside the urban area. Given such critically important thoughts, it is recommended that terrestrial resources be an EbA's implementation site at Kep urban area.

Finally, following the scope of the EbA intervention (urban area of Kep city) and the provincial and national level planning and initiatives, the report found that the terrestrial forest of Kep National Park is recommended for implementing the EbA's initiatives. This justification came from assessment and findings that emphasize on two main themes- coastal resources and terrestrial resources. The reason is that no elsewhere in urban area has significant conservation value but Kep National Park in which it plays an important role in protecting biodiversity and ecosystems, stabilizing environment (erosion, landslides/avalanches, etc.), and attracting tourists to visit its beautiful aesthetics and associated landscapes.

1. Introduction

Building climate resilience of urban systems through Ecosystem-based Adaptation (EbA) in the Asia-Pacific region (project referred to as "Urban EbA Asia" in the text) is a four-year regional GEF-funded project of the Least Developed Countries Fund (LDCF), that will be implemented by UN Environment. The aim of the project is to reduce the vulnerability of poor urban communities in Asia-Pacific Least Developed Countries (LDCs) to climate change impacts using Ecosystem-based Adaptation (EbA), with interventions in selected municipalities in Cambodia, Lao PDR, Bhutan and Myanmar. Each of the four countries will benefit from the regional components that will include institutional strengthening and capacity building of city management authorities in pilot cities to plan and implement urban EbA and disseminating knowledge and raising public awareness on urban EbA in pilot cities.

In Cambodia, the Kep City will benefit from specific EbA interventions under the second component of the project[1] The EbA interventions will be based on the recommendations from this assignment relate to the ecosystem assessment, livelihood improvement potential, socio-economic impacts including impacts on vulnerable groups, water shortage, proofing of infrastructure in the city, sustainable city and so on.

Kep province is a coastal and mountainous landscape with 13 beautiful islands[2]. The province is characterized by the Phnom Voir mountain range in the north with a gentle flat area for agriculture to the southward of the coast. This province is situated in the southwest part of the country and it borders with Kampot province and it is in between Kompong Bay district in the northwest and the east of Kompong Trach district of Kampot province. The total area of Kep province is about 187,24 km^2 (mainland) (Kep, 2019). In 2019, the total population is about 41,798 persons (Male, 20,615 persons and female, 21,183 persons) with 9,347 households, and the population density is 124 persons/km^2(NIS, 2019). Most of the population livelihood relies on natural resources. It is noted that about 79.68 % of the total population rely on agriculture including fishing and salt farming, about 20.23 % of them are involved in service provider activities (tourist resort, hotel, guesthouse, transportation, and electrician), about 9.22 % of them migrate in the country for jobs, and only 1.5 % of them migrate to find jobs out of the country (Ibid).

Kep city is a beautiful coastal tourist city located about 174 km southwest of Phnom Penh. This city has good transportation access to connect to Phnom Penh City and other provincial cities. Highway No.33 plays a vital role to connect the municipality to Phnom Penh in the northeast, Bokor National Park, Kampot and Sihanoukville in the west, and National Road No. 3 in the east. Besides, Kep has an easy railway connecting to Phnom Penh and Sihanoukville. Also, the city has a sea-based waterway to connect itself to international destinations (MoE, 2002a; MoE, 2002b & Kep, 2019).

Like other coastal provinces of Cambodia, Kep province has been increasingly exposed to climate change, such as rising temperatures, changes in rainfall, frequent floods, droughts, storms and windstorms. It is reported that the degree of susceptibility of the coastal zone to the impacts of climate change was examined and the susceptibility levels of all communes in Kampot and Kep provinces were found to be generally more susceptible than those in Preah Sihanouk and Koh Kong provinces (PPCR, 2013). People living in the province already observed extreme storms and floods that have potential impacts on coastal ecosystems such as loss of coastal wetland habitats, shoreline erosion and

[1] EbA mean Ecosystem-based Adaptation utilizes bio-diversity and ecosystem services as part of an overall climate change adaptation strategy." (CBD, 2009)

[2] Including Koh Tonsay , Koh Kork, Koh Mtes , Koh Svay, Koh Tbal, Koh Hal Trei, Koh Svay Prey, Koh Sarang, Koh Pou, Koh Makprang, Koh Angkrorng, Koh Ach Seh and Koh Snguot.

saltwater intrusion that destroyed their crops. Urban people also noted that, climate change has caused serious risks and impacts on coastal and marine resources, ecosystem services, and vulnerable communities. The appropriate interventions and approaches are needed to reduce the vulnerability of coastal and marine ecosystem services and poor urban communities, and to build climate resilience of urban systems to cope with climate change impacts.

Under the second component of a four-year regional GEF-funded project[3] that is implemented by the United Nations Environment Program (UNEP), Kep city has been selected to benefit from specific EbA interventions due to its urgent demand for climate change adaptation and resilience. The implementation of EbA interventions will be based on the comprehensive assessment related to biodiversity and ecosystem services, socioeconomic, agriculture and livelihood improvement, environmental protection and natural resources management, etc.

This report presents an in-depth study, analysis and assessment of the natural resources (biodiversity and ecosystem services), environment and climate change risks, vulnerabilities, and adaptation in Kep city and at the provincial scale. It will be also served as a supportive document to assist the implementation of EbA interventions to reduce the negative impacts of climate change on biodiversity, ecosystem services, environment, and livelihood of the urban communities.

2. Objectives

The overall objective of this report is to collect, update, and assess data and information on biodiversity and ecology in order to identify possible option for interventions in Kep province. Specific objectives are:

- To collect, update, and assess data and information on biodiversity and ecosystem services, environmental pollution, climate change vulnerability and adaptation in Kep;
- To identify appropriate adaptation options for interventions in some vulnerable areas.

3. Methodology

3.1. Qualitative Approach

Qualitative approach is applied to collect data, information, perception, and inputs from relevant documents and stakeholders. This method covered: i) desk reviews of relevant documents and reports and publications; ii) key informant interview (KII) and focus group discussion (FGD) which include individual interviews using structured, semi-structured or in-depth interviews as appropriate; and iii) field visits for further consultation and discussion with stakeholders to get additional data and information and for direct sites observation.

As aforementioned, from the literature review and field data collection, several issues concerning natural resources and environmental related issues are identified, and assessed. The assessment results are further validated through unstructured/structure discussions/interviews. Discussions were held with relevant stakeholders, for instance, Kep Technical Working Group which are from different provincial departments, such as Provincial Department of Environment (PDE), Provincial Department of Public Work and Transportation (PDPWT), and Provincial Department of Water Resource and

[3] Building climate resilience of urban systems through EbA in the Asia-Pacific region is a four-year regional GEF-funded project aim at reducing the vulnerability of poor urban communities in Asia-Pacific Least Developed Countries (LDCs) to climate change impacts using Ecosystem-based Adaptation, with interventions in selected municipalities.

Meteorology (PDWRM), Provincial Fisheries Administration (FiA) and so on. Individual meeting was also conducted with relevant Provincial Departments, commune councilors, and communities to validate and update relevant information on biodiversity assessment. Besides, field observations to sites such as Kep National Park and shoreline and mangroves forests were conducted. Discussions on the thematic issues related to i) natural resources; and ii) environment and field visits aiming at assessing and understanding the climate change vulnerability and natural hazards (droughts, flood, extreme storms, increase temperature) that bring potential impacts to ecosystems and sustainable natural resource management were conducted. Several sub- themes are considered during field visits, for instance, coastal resources including mangroves, coral reefs, seagrasses, and fishery resources. Environmental pollution including land-based pollution that resulted from agriculture runoff (chemical fertilizer and pesticides), wastewater as well as stormwater were also discussed to understand the general status of water quality change.

There were three FGDs discussions conducted in three communes of Kep, Prey Thom and Ou Krasar while eighteen people of key informants including local authorities in four communes of Prey Thom, Ou Krasar, Kep and Angkaol communes, interviewed to get understanding in general status of natural resources, environment and climatic constraints including flood, drought and natural calamity as well. In addition, as it is being advised by health competence of social distancing during coronavirus pandemic, interviews by calling were also conducted with key local community people (after receiving contact number from commune councilors and FiA's staff in Kep). Each FGD discussion with several 5 to 7 people was focused particularly on natural resources, climate change risk, vulnerability, risk reduction and adaptation as well as environment related issues. Interviews and discussions took between 30 minutes to an hour with direct questions and snowball questions through semi-structurer approaches. In addition, some key informants were interviewed by meeting and asking for interviews. Others were informed by FiA's staff and commune councilors.

3.2. Comprehensive Analysis and Assessment

This section is to show the analysis and assessment of the collected data and information. The assessment and analysis of climate change vulnerability and adaptation were based on the result of the desk review and the meeting/consultation with key stakeholders in Kep province during field visits and workshop consultation. The in-depth analysis and assessment have four main purposes: i) to assess of status of natural resources and ecosystem services and, find out the main issues caused by climate changes exposures in Kep province; ii) to assess effects of environmental pollution, and climate change vulnerability on ecosystem services and livelihood communities; iii) to identify adaptation needs and priorities for the urban EbA intervention areas in Kep province; and iv) to provide evidence-based recommendations for EbA interventions.

Climate vulnerability assessment was analyzed the extent to which human and ecological systems are likely to be affected by climate variability and change. The target of the vulnerability assessment is related to climate risks and natural disasters, urban livelihoods, natural resources and environment, biodiversity, and ecosystem services in Kep province. The vulnerable people and communities, their living rely mainly on natural resources: land, water, and ecosystem services which should be protected from the adverse consequences of climatic variations, are the central concern of vulnerability assessment. Adaptation capacity needs assessment was focused on analysing the ability of the system to adjust to climate change, to moderate the potential damage from it, to take advantage of its opportunities, and to cope with consequences. Adaptation focused on the benefits that humans receive from biodiversity and ecosystem services, and the most practicable way to use these benefits in the face of climate change, e.g. protection and restoration of coastal natural resources to improve coastal ecological health and local livelihoods; maintenance and rehabilitation of mangroves and coastal

wetlands to lessen flood and erosion; management of waste and environment pollution to ensure the quality of human life and wellbeing; and conservation of forest in the catchment area to maintain water availability and protecting urban settlements.

4. Natural Resources

4.1 Terrestrial Forest

Ecologically, forests help to protect soil erosion, stabilize the watershed and regulate water flows and local weather systems. Moreover, forest ecosystems play a key role in removing pollutants, recycling nutrients, generating topsoil fertility, protecting landscapes, providing goods and services including fuel, construction materials, and traditional medicine (MoE, 2005c; MoE, 2007). Forest also provides water, air, timber, wildlife habitats, stable soil, and recreational opportunities.

Cambodia's natural resources were overexploited for the last few decades. Before 1960, the forest area covered 73% (13.23 million ha) of which mangrove forests in the coastal areas covered about 83,700 ha (MoE, 2007). However, several discrepancies in the estimated mangrove forest areas by various agencies, for instance, in 1997 mangroves covered 63,039ha and it dropped to 56, 241ha in 2002 (IUNC, 2011). Meanwhile, it was estimated by FiA in 2010, mangroves remain 78,405ha (MoE 2013a).

The main causes of deforestation stem from the following activities: commercial logging, illegally selective logging, habitat conversion through economic land concession, land grabbing (RGC, 2010). Additionally, non-timber forest products (NTFP) collection; unsustainable practices i.e. land encroachment for agriculture including shift cultivation; increasing population and poverty brings pressure and gradually diminish the forest areas and products from year to year. Forest areas in the coastal provinces have also been impacted due to legal and illegal logging activities. The shoreline areas are low altitude areas and sensitive to the deforestation of the upstream and peripheral areas. These impacts include increased sedimentation, pollution, and resource depletion. The area of forest is changed into other land use because of the expansion of agricultural areas and land grabbing for speculation (MoE, 2005c).

Table 1: Forest areas in the Kep province and coastal areas (1993-2016)

Years	Kep province		All coastal provinces		Country forest (%)
	Area(ha)	Percentage	Area (ha)	Percentage	
1993	7,260	48%	1,554,352	14.34%	59.82%
1997	4,943	33%	1,500,443	14.13%	58.60%
2002	4,766	31%	1,350,436	12.19%	61.15%
2005	3,733	24%	1,312,723	12.15%	59.60%
2010	3,084	20.3%	1,278,640	12.36%	57.07%
2014	3,094	20.4%	1,221,195	13.62%	49.48%
2015	3,094	20.4%	1,221,195	13.81%	48.81%
2016	3,016	19.9%	1,217, 567	13.93%	48.14%

(MoE, 2007, MoE, 2019 and UNDP, 2019)

Aforementioned, terrestrial forest is described in the scope of nationwide. Besides, In Kep province, terrestrial forest area is likely gone for decades, but approximately 2,455 ha of secondary forest and 1,11ha of rear mangrove forest remain (IUCN, 2011). In addition, forest area in Kep had dropped from 7,260ha (48%) in 1993 to 3,016ha (19.9%) in 2016 (UNDP, 2019 and MoE, 2019). The shortage

of firewood is a consequence of the loss of forest resources. Firewood collection is based on the locations where villagers can access to collect firewood and could lead to the decrease of mangrove forest close to villages (KII, 2020). No information was received from Kep Forestry Administration (FA) during field visit; however, the Provincial Department of Environment (PDE) reported that the remaining forest was in the protected area of Kep National Park. Furthermore, rampant forestland encroachment activities had occurred in Kep in the last several 6-7 years. Some unregistered land tenures, which are locally recognized by local authorities, have increased (FGD, 2020). These activities have gradually diminished forest area in Kep province.

It is also noted that wild-animals are mostly gone. Because of rapid growth of the poor coastal population and decades of disturbance to wildlife, it seems that wildlife habitats can no longer support wildlife. However, no any detailed information on wildlife has ever been collected in the adjacent area of Kep National Park and islands.

Because of loose management and limited financial support, forest area (including Kep National Park) is under degraded by land encroachment for agriculture and settlements. The non-timber forest products (NTFP) such as firewood, honey, rattan, and other NTFP products can be extracted from the park to alleviate the daily livelihood of poor villagers (KII, 2020).

No forest plantation in the degraded forest area has been mentioned in Kep province since 2002. (MoE, 2005c). Also, no data on forest plantation in Kep in 2004 is reported by FA (Ibid). In line with the declining rate of country forest area as mentioned above, the percentage of forest area in Kep province was notably declined, i.e. from 79.1% (or 12,099 ha) in 2005 to about 20.4% (or 3,094 ha) in 2015 (UNDP, 2019).

Figure 1: Map of Kep province
Source: Kep 2019

The distribution of forest is categorized by using two groups of forest known as forest and non-forest (conversion of forest areas into agriculture and other land uses). Most forest areas tend to decline in the coastal zone. Non-forest areas are mainly found in the eastern coastal zone particularly in the eastern part of Kampot province, Sihanoukville, and Kep, where the population relies on agriculture. Because the majority of population depends on agriculture and fishery, the number of forest areas in the coastal zone has been reduced in areas where close to agriculture land and fishing areas. The forest cover in the coastal provinces was in a steady decline from 84% in 1993 to 71% in 2005, with an average loss of approximately 1 % annually in 12 years. It is also informed that the forests in coastal watershed areas have declined as results of illegal logging, land encroachment for agriculture, and expansion for development including saltpans and shrimp farming, coastal development and settlement.

4.2. Fishery Resources

This section focuses mainly on various aspects of marine fishery resources, for instance, ecosystem, threats to biodiversity, fishing activities and geographical features of Kep province where is a targeted assessment site as well as management efforts in the fisheries sector in the past and up to date assessment through recent discussion with Kep Fisheries Administration and communities on present practices.

Recent report addressed that twenty-six percent of all Cambodia's fisheries are marine fisheries. Villagers and government officials claim that fishing catch is declining but it is not clear whether it is merely catch per fishermen that is declining while overall catch remains the same, or whether fish stocks are indeed decreasing (MoE, 2018a). It is also reported about biodiversity richness of fishery resources in Cambodia's coastal water, however, there are not any recent researches to update and confirm of additional findings of marine fisheries. IUCN reported that about 525 marine species are found and classified in 202 genera and 97 families with a total stock estimated at 50,000 metric tons (mt) (IUCN, 2011). Additionally, about 20 species of marine crabs, 42 species of marine gastropods, 24 species of marine bivalves and 11 species of marine mammals, as well as other species of cetaceans, that found in Cambodia's coastal waters, are the Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Common Dolphin (*Delphinus delphis*), Bottlenose Dolphin (*Tursiops truncatus*), Shinner Dolphin (*Stenella longirostris*), and Finless Porpoise (*Neophocaena phocaenoides*) (Ibid).

Nationally, the marine fish production has increased from 7,247mt in 1986 to approximately 55,000mt in 2003, and has not shown a general decrease by species and landing place, but there has been a decrease in some provinces for economically important fish (MoE, 2007). The annual fish catch in the coastal provinces generally increased from 110,000mt in 2013 to 120,250mt, 120,500mt, and 120,600mt in 2014, 2015, and 2016 respectively (MAFF, 2016). During the past decades fish catch has increased dramatically, but catch per unit has declined owing to an increase in population which puts more pressure on the natural resources, ecosystems, economic growth, and development of fishing technology (MoE, 2005c). Furthermore, the increase of total catch also includes foreign catches. If it is compared to the estimation of total fish stock, accounted about 50,000 mt, as observed by Russian scientists in the period 1983 to 1986 the marine catch has been over-exploited since 2003 to present (MoE, 2018a).

Mostly, two types of fishing boats are found in the coastal areas - the fishing boats with and without engine. Small family-scale fishing operates in near-shore extends from the coast to the sea at a water depth of 20m where fishing boats are without or with engines less than 50 horse powers (hp) engines. The commercial fishery is characterized by large-scale fishing from the sea at water depth of 20m to the limit of the exclusive economic zone (EEZ), where fishing boats, in general, use engines of more than 50hp. The numbers of fishing boats with engines have increased in most coastal provinces from 1996 to 2005. From 1995 to 2005, Preah Sihanouk had reported to have more fishing boats with engine than Kampot. From 2002 to 2005, Koh Kong province had a high number of fishing boats, whereas, Kep has had a low number (MoE, 2007).

Fishing activities in Kep is relatively small compared to the other three coastal provinces (FGD 2020). Various types of fishing gears include fishnets, hand-push-nets, shrimp nets, crab nets, crab traps, squid nets, and hand collectors. There are eight fishing docks for fishing boats with small engines of 5 to18hp. There are a few hundred fishing boats in the entire Kep province (Ibid). Presently, the number of fisherfolk and fishing gears increases slightly in Kep and they remain low compared to Kampot, Preah Sihanouk, and Koh Kong provinces. The seawater in Kep is very turbid and is generally too shallow for bigger ships. It is beneficial for local fishermen who use small boats or

rowboats to do all kinds of catching including collection of corals around Koh Por and Arch Ses islands. Presently, fishing by diving still occurs in some parts of the islands.

The total catch for year 2000 in Kep is about 457mt including crabs (168mt), trash fish (81mt), shrimps (50 mt), squids (15 mt) oyster (8mt) and other three classified fish quality (MoE, 2001). Also, among all the four coastal provinces, Kep has the lowest annual fish catch. Annual fish catch is found in Kep with a decline from 620mt in 2003 down to 400mt in 2005 (MoE, 2007). Although annual catch in 2016 had increased up to 120, 600mt for entire coastal provinces, and annual catch in Kep could expect to increase as well but no specific number was highlighted (MoE, 2018a). However, certain issues/constraints on marine fisheries in Kep were discussed. Even the number of fisher folks and fishing gears, including fishing boats, has increased comparing to the last few years, fishing area has remained the same. Seawater area is considered as common-pool resource (CPR). Fisherfolks, however, have a limit capacity of fishing gears, so they operate fishing near the shore of shallow water resulting in low catch, generally. Furthermore, an observation in Kep's Phsa Kdam market shows that most of the commercial value fishes are brought from Vietnam.

Cambodian coastal fisheries are under threat by direct and indirect factors creating a decline of fisheries. The degradation of the marine environment and resources as well as mangrove areas had occurred due to land encroachment for agricultural activities, fuelwood/charcoal production, seaport expansion/development, saltpans, shrimp farms, settlement and population growth and poverty (MoE, 2007). Even though fishing gears and unsustainable methods include pair trawling, light fishing, and other illegal fishing gears are prohibited, overfishing due to the increased amount of fisherfolks and fishing boats, illegal fishing gears and environmental degradation have put pressure on fisheries sustainability (Ibid). In addition, change in rainfall, drought, frequent storms, and extreme temperature could cause damage to agricultural crops and this could also cause adverse impact to fisheries resources as increasing a number of fisherfolk to involve in fishing. Sea level rise is another indication of sensitively negative affect to coastal habitats, for instance, coral reefs and mangroves and it also causes to shoreline change as resulted from erosion.

Nationally, demand for marine products has been increasing rapidly with an annual growth rate of 10% to 15% from 2003 onwards for local consumption of domestic markets, and statistics indicate an upward trend of fish catch, but there is concern about depletion of marine resources along the coastal area because of intensive trawl fishing in the area (JICA 2010). Most coastal fisherfolks are poor with small fishing equipment and small-scale fishing gears in the shallow water of inshore and mangroves. The offshore net catch capacity of Cambodian fishers is relatively small compared to the available exploitation potential. In Kep province about 7% of the total population involves in fisheries-related activities (NIS 2008; MoE 2009). Fisher-folks had expressed concerns on the decline in the fishery resources as resulted from illegal fishing of destructive fishing gears. Motorized push netting and trawling in the shallow waters together with dynamite fishing had led to the decline in fish stocks and key habitats of seagrass beds and coral reefs (FGD, 2020).

Fishing using small powered fishing boats and push-nets in shallow areas (2 or 3meter depth) of abundant seagrasses has destroyed the breeding grounds and feeding areas for marine organisms. Furthermore, fishery products in the range of 200-300mt of fry and crab seeds are destroyed by push-nets every year (MoE, 2002b) and by foreign fishing vessels in Cambodian waters (Rizvi and Singer 2011; Gillett. R 2004). Available literature generally highlighted that the unauthorized fishing activities have been on the rise despite increased surveillance by the Fisheries Administration (UNIDO, 2015).

In Kep province, illegal fishing gears and destructive fishing gears have consequently caused resource depletion. Fish catch has declined remarkably while fish resources have also extremely decreased due to the use of small mesh fishing net, destructive fishing gears, and so on.

The establishment of Kep's Koh Por and Koh Tonsay Archipelago Marine Fisheries Management Area (MFMA), covering the area of about 11,307ha, was declared to protect marine and coastal habitats and spawning grounds, to ensure responsible and sustainable fishing practices and effective management of marine fishery resources and coastal ecosystems, and to improve the livelihoods of local communities (MFF, 2018). This MFMA encompasses of habitat of endangered flagship marine species, such as dolphins, dugong, sea turtles, and sea horses, as well as coastal habitats, such as coral reefs, seagrass beds, and mangrove forests (Ibid). The MFMA has been zoned into four different sections of i) fishery conservation area; ii) fishery protection area; iii) fishery refugia and iv) scuba diving eco-tourism area, which have key roles and functions to ensure the sustainability of fishery resources and improving livelihoods of local coastal fishers, 80% of whom are small-scale, and building local resilience to climate change (Ibid).

4.3. Mangroves

Cambodia's coastline scattered with mangrove forests, coral reefs, seagrass beds, and other coastal ecosystems which play a significant role in providing ecosystem productivity for people. These ecosystems are fundamental to livelihoods and coastal protection, tourism and biodiversity (MFF, 2015). Cambodian coastal waters are considered among the richest areas in biodiversity resources, including significant aquatic resources and marine endangered species, such as green turtles, dolphins, sharks, groupers, shrimps, tortoises and dugongs (UNEP, 2005; MoE, 2013a). Mangroves are fertile, diverse saltwater ecosystems that provide food and shelter and/or habitats for a variety of aquatic and terrestrial lives in the intertidal zones.

Mangrove forests occur in all four of Cambodia's coastal provinces. The largest areas are found in Koh Kong, whereas the smallest areas of mangroves are in Kep (IUCN, 2011). Mangrove has been used as firewood and construction materials. Mangrove forests are important to local communities given that more than 70% of the coastal population rely on their products and resources. The conversion of mangroves into shrimp farms, saltpans, and charcoals have impacted adversely on marine fish habitats and its productivity, in protection against storms, and loss of firewood for use by the local community (Ibid). Subsequently, coastal resources, especially mangroves have been destroyed and such destruction caused the decline of other associated coastal resources as well (Ibid) and these could lead to saline water intrusion with sea lever rise because of conversion of mangrove forest areas into other land use. Mangroves were under the destruction including cutting for firewood and for making stick/poles, and clearing for saltpans. Inappropriate development activities, such as land reclamation, sand mining, uses-urbanization, coastal development (such as seaport construction that would cause marine pollution due to oil spills), may speed up the impacts on mangroves (MoE, 2002b; IUCN, 2011).

There are many discrepancies in the estimated area of mangrove forests by different agencies over a few decades in Cambodia. It is estimated that about 85,100ha of mangroves are located in Cambodia fringing coastal areas along the Gulf of Thailand (Bann, 2003; UCN, 2011). About 75% (63,200ha) of mangroves were found in Koh Kong, while 16% (13,200ha) were found in Preah Sihanouk. The remaining 9% (7,300ha) are located in Kampot including Kep province. In 1997, the mangrove forest area was reported to be reduced to about 63,039ha (IUCN, 2011), and by 2002, it was further reduced to 56,241ha (IUCN, 2011). The rapid loss of mangrove occurred mainly in Kampot and Preah Sihanouk coastal areas (MoE, 2005 and IUCN, 2011;). Surprisingly, according to FiA figure in 2010,

mangrove distribution is reported to remain around 78,405ha (MoE, 2013a). However, the Cambodia's State of the Ocean and Coast Report noted that the trend from 1993-2011 indicated the change in mangrove coverage in the whole of Cambodia's coastal area. It is approximately 12% of mangrove areas was declined (MoE, 2018a). Furthermore, it is simply calculated, as threats on mangrove forest have been continued declining from 2011 onward or this could be estimated at certain percentage change in mangrove coverage by 2020.

Table 2: Mangroves distribution in the coastal area

Provinces	Mangrove (ha)
Koh Kong	62,000
Sihanoukville	13,500
Kampot	1,900
Kep	1,005*

Source: (MoE, 2013a)

(*): It was estimated at 1,000ha by PDE, however, this figure is slightly different during anecdotal discussion with communities, it is about 952ha (FGD, 2020).

In Kep province, mangrove covers an area of about 1,000ha along the shoreline of Ou Krasar, Kep, Thmey, and Angkaol areas. The large mangrove forest is located in Angkaol commune stretching at least 5km along the coastline. The other mangrove forests are also found along the coastline in Kep commune, Pong Toek, and Ou Krasar communes (KII, 2020). In the coastline of Ou Krasar commune, the mangroves extend about 1,500m wide and 2,000m long (it is approximately 300ha). It is reported that the remaining mangroves in Kep commune and Prey Thom commune are 30ha and 122ha, respectively. About 500ha of mangroves are found in the coastline of Angkaol commune. Besides, there are 13 islands located in the administrative boundary of Kep and Angkaol communes. Some islands have suffered from land encroachment for agricultural farm- known as *Chamkar* and settlement (KII, 2020).

Commonly, mangroves forest stretches along Kep's coastline sparsely (100m width) and some patches are very thin (50m to 60m width). These mangroves are mostly dwarf of 2m to 4.5m height. Mangroves provide benefits for coastal communities if managed sustainably and this means that mangroves not only play an important role as a protection against natural disasters, coastal erosion, and natural purification but also as habitats and food web for several aquatic species and intertidal species (FGD, 2020). Mangrove forest provides important habitats for marine life, especially shrimps, crabs and fish. Mangrove forests are vital for providing food sources; shelters and nursery for both cultures and capture fisheries along the coastal zone.

Generally, mangroves in Kep are cut for firewood and construction material. Since 1996, about 50% of mangroves had been destroyed as a result of saltpan expansion (MoE, 2001; MoE, 2002a). Expansion of saltpans in the past has resulted in mangrove land diminishment (KII, 2020). Recent observations noted that saltpans have been almost abandoned for several years and they have been converted into other land uses (KII, 2020). The change in mangrove distribution in the coastal areas indicated the change of coastal ecosystem and biodiversity as well. Mangrove forests in Cambodia are under increasing threats from several anthropogenic activities and climate-related and natural hazards (Nasuchon, 2009) including sea level rise, severe rainfall with extreme storms, flood, etc. These threats are creating pressure on coastal ecosystems and coastal community's livelihoods, i.e. the rapid decline and loss of marine ecosystems have significant social, economic, and environmental consequences and will ultimately lead to increased poverty and a reduction in quality of life of the people (RGC, 2014).

So far, mangrove forests are being properly maintained and conserved by concerned ministries and local authorities. Significantly, all stakeholders fully participate in management planning, including appropriate implementation of environmental legal instruments and other related laws. It is understood that many environmental problems occur along the coastline including the destruction of the natural environment, mismanagement of natural resources, and pollution from recreation areas, residential zones, and industries, as well as pollution from ports and maritime activities, occur in different places in the coastal provinces of Koh Kong, Preah Sihanouk, Kep and Kampot provinces. However, local people tend to believe that the level of mangrove destruction is much higher when industrial ventures cause clear-felling in large tracts of mangroves (UNIDO, 2015). Furthermore, mangrove forests may be submerged by rising sea levels. Collectively, these effects will lead to the degradation and/or loss of forests, leading to decreased income security for forest-dependent communities (IFAD, 2018).

4.4. Seagrasses

Seagrasses stretch on shallow water and they are home for juvenile fish and nursery functions for many aquatic lives including invertebrates. Seagrass meadows are important feeding areas for endangered vertebrates such as dugongs and marine turtles. Furthermore, a significant proportion of the nutrient produced by seagrass beds can be transferred to adjacent ecosystems such as coral reefs (MoE, 2005a; MoE, 2013a). Seagrass along Cambodia's coast can be divided into two types: extensive seagrass meadows along the mainland and paths of seagrass interlinked with coral reefs around islands. Many locally consumed fish and shrimp species, which are also traded in both domestic and international markets, depend on seagrasses. The collection of invertebrates by fishers using snorkel and mask is also popular in inshore seagrass areas (UNEP, 2008).

Cambodia's seagrass meadows are estimated to be between 30,096ha (MoE, 2007) and 32,492ha (UNEP, 2008). It is revealed that the degraded seagrass meadow in the Cambodia's coast and general status of these seagrass habitats are poorly researched and documented (IUCN, 2011; Phauk S. *et al.*, 2011, Leng P. *et al.*, 2014 and IUCN, 2015). Many fisherfolks have also observed the treats of coastal habitats, particularly, mangroves, seagrass meadow and coral reef. Destructive fishing practices and increasing land conversion for urbanization and agriculture are main driver to direct adverse impact to coastal habitats and ecosystem services. Therefore, change in magnitude of seagrass meadows are inevitable.

One of the main threats to seagrass areas in Cambodia's coastal water is the encroachment of trawlers into nearshore fishing areas and trawling over seagrass beds. Seagrass beds are also susceptible to damage from increased sedimentation levels, dredging, and thermal and chemical pollution. Large seaweed farming areas that concentrated in the Kampot area can also affect the seagrass areas through direct shading and potentially nutrient enrichment. In line with direct habitat destruction from trawling as aforementioned that appears to be a serious threat to seagrass habitats; suspended sediments, eutrophication, and other water pollution, have also caused harm to the seagrass productivities (MoE, 2006). Land-based pollution and runoff, trawling in nearshore areas and seaweed farming are observably threatening seagrass areas. Although the MAFF policy is that seaweed farms may not be established over seagrass beds, existing data revealed that the seaweed zones are overlapped with seagrass areas. Apart from direct shading impacts, seaweed farms may also cause an increase in organic matter in the sediments and surrounding waters owing to detritus and deposition of algal matter on the seabed (Ibid).

In Kep, seagrasses are found in shallow coastal waters where extend to seaward and located in front of mangrove forests. Seven important species of seagrasses are identified, off Koh Tounsay, Koh Svay, Koh Tbal, Koh Ach Ses islands as well as Southern part of Kep shoreline. Seagrasses grow in

shallow water (2 m or 3 m depth) on the eastern part of Koh Tounsay islands, since this area faces weaker waves than the western parts of the island (MoE, 2005b). Furthermore, seagrass areas are found most densely in a triangle of Koh Tounsay, Koh Tbal, and Koh Por Islands and also occur elsewhere along the coast. However, these seagrass areas have heavily degraded by fishing with destructive gears and unsustainable fishing practices in seagrass beds and degradation of water quality (MoE, 2005c). In 2011, a survey on general status of these seagrass habitat using Satellite image of Advance Visible and Near Infrared Radiometer type 2 (ALOS AVNIR-2) with high resolution and following with ground truth survey in mid-2011, has observed the declined marine coastal habitats in Cambodia due to human activities (Phauk S. *et al.,* 2011). Therefore, natural habitats, especially seagrass meadows which are distributed in shallow bottom, must be conserved for sustainable development of coastal waters. At time being, coastal fisherfolk occasionally operate their fishing in the shallow water that result in further degradation of seagrass and this could diminish of seagrass area (FGD, 2020).

The change in water quality that affect the seagrasses is an accumulation of siltation due to logging, rising use of fertilizers and pesticides in the coastal agricultural areas and discharge of domestic and industrial wastewater (MoE, 2005c) and this leads to increase water turbidity which reduces the quantity of sunlight reaching seagrass plants, diminishing the photosynthetic capacity of the plants (UNEP, 2008). Seagrasses are also being disturbed and even extracted for a variety of reasons, often beyond the control and surveillance (UNIDO, 2015).

Threats to seagrass beds and coral reefs in Cambodia are much the same as those encountered in neighboring countries and include destructive fishing practices (particularly motorized push nets, shallow water trawling, and weighted bottom nets which rip up and destroy seagrass meadows, dynamite and cyanide fishing), collection of corals for trade, declining water quality due to unsustainable logging practices, and domestic and industrial waste disposal (Ibid). Destructive fishing such as push-net, trawlers, and over-fishing are classified as first and second ranks of threats to seagrass meadow (Ibid). The fifth national report to the convention on biological diversity identified major threats as management issues: enforcement issues, assessment of management plans, overlapping legislations, cross border issues, encroachment and coastal development issues etc.

In Kep, seagrasses had suffered a serious destruction by fishing activities like trawling boats, and motorizing pushing net (KII, 2020). The broken blades of seagrass have once been evident as they floated at the surface near the inshore and this because of fishing in the seagrass area. These sea-grass destructions cause loss of invaluable resources such as delicious sea crab, shrimp, and snail which have attracted many tourists to visit Kep (MoE, 2005b). Sea level rise, extreme temperature in the shallow water of seagrass beds, frequent storm could cause wave surge from strong wind in shallow water of seagrasses beds, and land-based pollution could cause water quality change of seagrass ecosystem and its habitat that resulted in adverse impact not only habitat loss and aquatic lives that depend on such habitat but also decreasing fish catch in shallow water of poor fisherfolk with poor fishing gears.

4.5. Coral Reef

The first coral reefs surveys were conducted in 1998 in some coastal water (MoE, 1999). In Kep, Coral reefs are found in several areas, i.e., Koh Por, Koh Tbal, Koh Tounsay, Koh Mteis, Ang Krorng islands, and other areas in the coastal zone. The coral species have been recorded in Cambodian coastal waters, generally around the inshore islands and in some rocky areas. Around 70 coral species are found in Cambodia's marine water (MoE 2013a). Kep has about 17 species of hard corals and one soft coral species. The species composition has been preliminarily identified for both hard coral and

soft coral species (MoE, 2001). Furthermore, coral checks have been made annually by FiA funded by UNEP. Several Cambodia's offshore islands are known to contain substantial areas of coral reefs but little is known of the diversity of plants and animal species in these areas.

Coral reefs are vital marine and coastal habitat. They are important ecosystems and habitats for different kinds of commercial fish species like groupers. Coral reefs are also important coastal ecosystems, providing local communities with a range of valuable social and economic goods and services.
So far, the coral benefits to local people are very little known, therefore ecotourism development should be carefully implemented with environmentally sound (MoE, 2013a). Coral reefs are one of the most complex and colorful tropical ecosystems, rivaling rain forests in their richness of life.

Likely to seagrass, Cambodia's coral reefs are threatened by an increasing array of impacts from unsustainable and destructive fishing practices; sedimentation and waste dumping; and increasing population and development in coastal areas.

Dynamite fishing is a very destructive practice. The increasing use of large trawler boats operating in shallow water and the rise in modern fishing equipment such as motorized push nets, all contribute to the destruction of marine habitats that are home to small fish and other marine species, thereby causing an overall decline in fish productions. Some fishing boats use destructive fishing methods (e.g. explosive and high-powered lights) for marine harvesting, contributing not only to decline in marine resources but also the destruction of marine habitats. Prioritization of the threats to coral reefs are direct threats, the most. Over-fishing and destructive fishing are considered as primary and second ranks of threats to coastal/marine ecosystems (EB-CAM, 2013). Besides, sedimentation, pollution, and coral bleaching, as well as unsustainable fisheries and aquaculture (seaweed culture), are also threats to the coral reef (Ibid).

Other types of ongoing activities that could damage coastal water quality, ecosystems, fishery, and habitats include dredging, untreated domestic and urban waste, and related heavy construction work associated with port and harbor improvement, maintenance, and building. The impacts of these activities have led to an increase in fragility of the physical coastal ecosystem, oligotrophic, coastal water pollution, eutrophication, public health deterioration, declining of ecotourism areas (Ibid). Marine pollution and destruction of critical habitats of marine species can affect feeding and natural breeding grounds, which in turn result in declining of important species such as shrimp species (MoE 2006; FGD, 2020).

In Kep, since 1994 a lot of coral reefs, particularly in Koh Por and Koh Ang Krorng islands were destroyed by dynamite fishing. Corals have been destroyed by fishing, explosive fishing, and seaweed plantation/culture in corals area. Dynamite fishing is characterized by illegal fishing in the area of coral reef, which has been addressed/concerned by fisherfolks (MoE, 2005b). In addition, there are a few more fishing practices that are destructive and unsustainable. The seaweed culture in the coral reef area may reduce light penetration for photosynthesis that has unfortunately damaged to corals, e.g. Koh Por Island experienced with such bad activities. It is also noted that, as seaweed product was in the lowest price that leads to abandoning of such culture in the coral reef area in Koh Por Island and elsewhere in the coastal area (KII, 2020). Not different from seagrasses ecosystems, sea level rise can change amount of light penetration for coral species, wave surge of storms can erode shoreline (including erosion and landslide of islands) where are nearby coral area. This could lead to have high concentration of sedimentation that damage to coral reef ecosystems and aquatic lives, especially coral fish.

4.6. Protected Area Management

There are 13 protected areas, established in Cambodia's coastal area. Those protected areas are categorized as multiple-use areas, national parks, wildlife sanctuary, protected landscape. Each category of the protected area has different purposes of its establishment, for instance, the purposes of national parks are to protect natural and scenic areas of significance for their scientific, educational, and recreational values (RGC, 1993). The multiple-use areas are established to provide a sustainable source of water, timber, wildlife, fishes, pleasure, and recreation, with nature conservation aimed primarily at supporting these economic values (Ibid).

Currently, Cambodia has 49 protected areas and several biodiversity corridors covering the area of about 7,467,909.65ha representing 41% of the country area (MoE, 2018b). Number of protected areas has further increased up to 69 areas in which consist of national parks, wildlife sanctuaries, protected landscapes, multiple use area, Ramsar sites, natural heritage parks and biodiversity corridors (MoE, 2020). The Ministry of Environment holds responsibility through its General Directorate of Administration for Nature Conservation and Protection (GDANCP) and General Directorate for Local Community (GDLC). The creation of natural protected areas systems can protect the natural resources, ecological system, and biodiversity, such as forests, mountains, freshwater/marine fishery, beaches, and freshwater that provide many benefits to the country environment, human wellbeing, and people livelihoods.

Kep is one of the country coastal provinces that has an abundance of natural resources, both inland and sea. The coastal resources comprise mangrove forest at the low and high tide coastline area, coral reefs, seagrass beds, marine fisheries (Kep, 2019). The forest areas, in particular the evergreen and semi-evergreen forest, are mostly found in the mountainous areas of Phnom Voir Mountains, and hilly areas including Phnom Kep mountain of Kep National Park.

Kep National Park, at present, covers an area of about 1,152ha (MoE, 2018). Kep National Park and Marine Fisheries Management Area were created and managed under the protected area system in Kep province. The management of Kep National Park is under the Provincial Department of Environment, while the Marine Fisheries Management Area is managed by Fisheries Administration (FiA). Besides, forests outside the protected area is managed by Forestry Administration (FA). Forest covers in Kep is dramatically degraded from 48% (7,260ha) in 1993 to about 20.4% (3,094ha) in 2015 (UNDP, 2019), due to increasing population, urbanization and human settlement, infrastructure development and other natural causes including shifts in weather patterns (FGD, 2020). Furthermore, unsustainable/destructive activities such as fuelwood collection, encroachment, and fragmentation/destruction, can lead to sustainable risk.

As aforementioned, Kep province has an abundance of natural resources both inland and coastal resources such as forest, mangroves, seagrasses, coral reef, sand beaches, fertile land for agriculture, beautiful landscape and islands for tourist attraction, etc. Due to natural resources potential, most population livelihoods rely on ecological services provided by those resources, e.g. marine fishery, saltpans, cropping and farming, tourism, and eco-tourism business and so on (Kep, 2019). The increased pressure that leads to declining coastal resources such as seagrass, coral reefs and mangroves have notably inspired the need for conservation and management at both local and national level, since they provide a large range of ecosystem services, including habitat and food provision, coastal protection, nutrient cycling, and water filtration. For example, the rehabilitation and restoration of mangroves and shellfish reefs/coral reefs in Kep Province would enhancement its vulnerable marine environment, create opportunities for aquaculture that would further provide benefit to the small-scale fishing communities (ICFC, 2016).

Mangrove forests are being properly maintained and conserved by concerned ministries and local authorities who fully participated in management planning. Furthermore, other environmental problems that occur along the coastline including the destruction of the natural environment, mismanagement of natural resources, and pollution from recreation areas, residential zones, and industries, as well as pollution from ports and maritime activities, have been well discussed and settled by all concerned stakeholders. To some extent, following land management reform (delegation of decentralization process to subnational government), some mangroves and forest areas are currently managed by local authorities.

Under the government policy related to the management of coastal resource and ecosystems, in Kep province, the National Committee for the Coastal Management and Development (NCCMD), plays a central role in the management, protection and conservation of mangroves and other coastal ecosystems, especially coastal development mechanisms, to ensure the sustainability of community livelihoods and coastal environments.

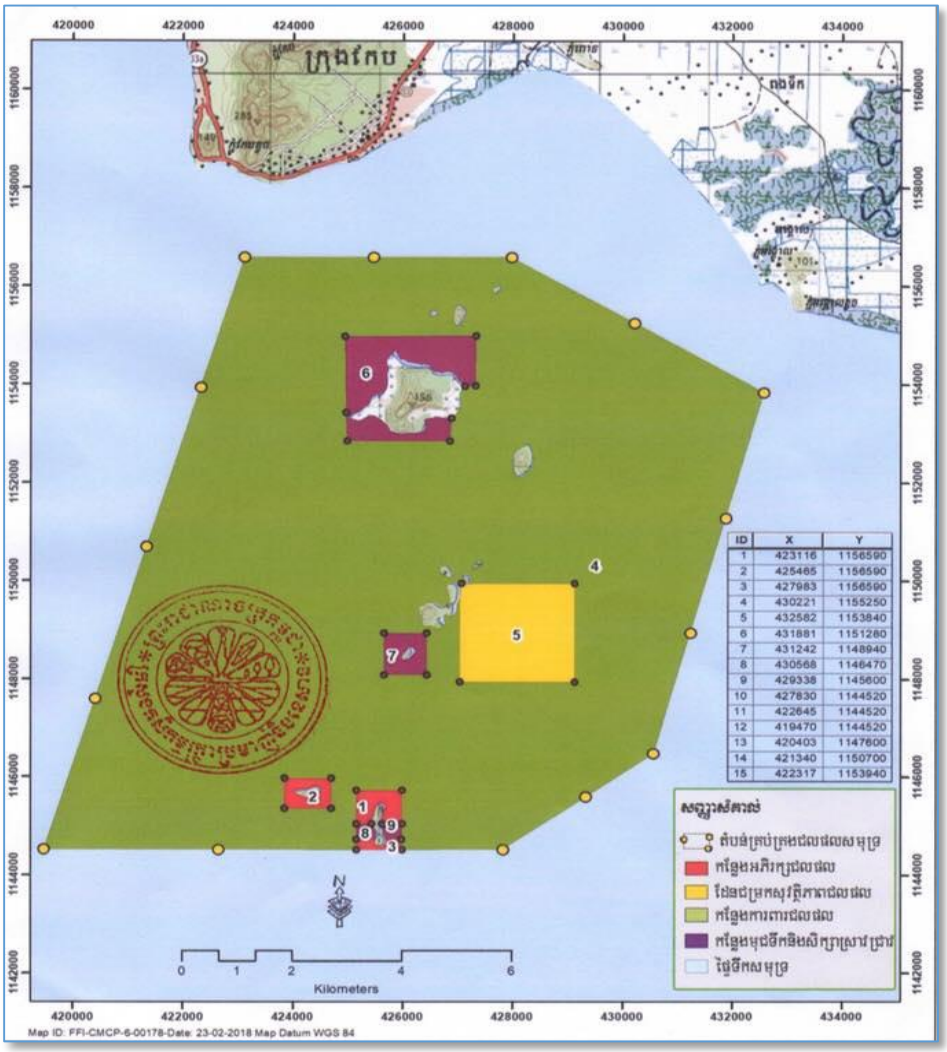

Figure 2: Map of Marine Fisheries Management Area in Kep province
Source: FiA, 2018

The establishment of Marine Fisheries Management Area (MFMA), off Kep's Koh Por and Koh Tonsay Archipelago would help protect marine and coastal habitats and spawning grounds; ensure responsible and sustainable fishing practices and effective management of marine fishery resources and coastal ecosystems; and improve the livelihoods of local communities (MFF, 2018). Also, MFMA covers an area of 11,307ha that is managed by the Fisheries Administration (FiA).

Significantly, within the MFMA, endangered flagship marine species and coastal habitats, would be better conserved and managed. MFMA consists of four different zones with its specific characteristic as: i) Fisheries Conservation Area **(**109ha), ii) Fisheries Protected Area **(**10,412 ha) - this protected area is rich of coral reefs, seagrass, and other fisheries habitats; iii) Fisheries Refugia Area (417ha) and iv) Scuba Diving Ecotourism Area (369 ha) that is for recreation, research and fisheries habitat rehabilitation (FiA, 2018).

5. Environment

5.1. Pollution

Land-based and ocean-based pollution (from point[4] and non-point[5] sources) are observed in Cambodian coastal area as well as in Kep province.

Population growth and economic development are the main drivers of generated solid and liquid waste. The urbanization, in the last few years, has been also increased throughout Cambodia coastal zone, in particular, Sihanoukville. Infrastructure development (resorts, roads, drainage, tourist facilities, markets, etc.) have been notably built and improved in coastal cities/ municipalities. In 2005, the generated domestic waste was 460.64 tons/day, and the generated market waste was 92.13 tons/day[6] (MoE, 2005c). A high rate of generated waste was observed in Kampot province, i.e. domestic waste was about 292.18 tons/day, and the generated market waste was 58.44 tons/day. The generated domestic waste in Cambodia coastal zone was notably increased to about 1,075 tons/day in 2015 (MoE, 2018b). The shortages of waste dumping sites, poorly managed waste (the deposited waste in water sources and areas close to human residents) are commonly seen throughout coastal areas, and this will cause harm to the environment and human health (MoE, 2005c). The pollution issues from inefficiency waste management in the coastal provinces/municipalities would be emerged also from the challenges of limited budgets, weak legal instrument application, inadequate human resources, and improper management.

Ocean-based pollution: Beside land-based pollution, ocean-based pollution is also an environmental issue in Kep province. This type of pollution results from sea port, floating vessel, coastal tourism facility, and tourist and fishing boats, etc. that can discharge/spill oil or oily-water into the sea, and eventually and gradually damage/change coastal water quality, ecosystem services, and fishery habitats. It has been noted that these impacts could lead to the fragility of the physical coastal ecosystem, coastal water pollution, eutrophication, public health deterioration, decline of ecotourism areas and nearshore fishery resources, etc. Local community reported that oily-water that drains into the sea by above mentioned activities has a high chance of causing marine pollution, thereby damaging coral and sea-grass and eventually the tourism businesses and local fishing (FGD, 2020).

[4] The source of the pollution is identifiable or localized.

[5] The source pollution is caused by broadly disconnected sources of pollution.

[6] It is calculated using total number of populations in 2005 in each district of the coastal province multiplying by 0.5 kg for domestic waste and 0.1 kg for market waste (State of Coastal Environment and Socio-economy in Cambodia)

According to the regulation, any discharge of liquid waste or waste water from any sources of pollution that is not consistent with the standards for effluent discharge shall be strictly prohibited (MoE, 1999)[7]. Protection ocean water quality is absolutely significant. Moreover, regulation and legal framework should be in place to fine who pollute or fail to prepare facilities for waste disposal. Law enforcement measures (fine/penalty), or payment of ecosystem service are ultimately needed to consider and apply to ensure waste management, healthy marine environment, and ecosystem.

Land-based pollution from point sources: Improper managed liquid and solid waste from resident area, construction or dumping sites that can release various harmful pollutants to surrounding environment is observed in Kep province. At present, drainage culverts carry all rainwater (stormwater) and untreated domestic and municipal waste, and other waste generated from interconnected activities such as heavy construction work associated with hotels, resorts marker, buildings, urbanization, and agriculture, to the sea. The provincial authority is considering the installation and rehabilitation of septic tanks, which aim to reduce unwanted factors discharge directly to seawater. Such septic tanks play an important role in the primary treatment of wastewater from major restaurants, hotels, guesthouses, and other large living buildings, before draining wastewater into the wastewater treatment facilities.

There are three wastewater storage facilities set up in Kep town to serves hotels and restaurants near the coastal areas of Kep city. The management of city liquid wastes is found moderately ineffective with the existed wastewater treatment tanks[8]. Due to some technical reasons, wastewater treatment facilities are not well functioned leaving wastewater naturally treated before draining into the sea (FGD, 2020). The generated domestic waste in 2005 was 17.33 tons/day, while generated market waste was 3.47 tons/day (Ibid). In 2018, the amount of collected solid waste in this province was 13,505 tons/year (or 37 tons/day) (MoE 2018b). Environmental pollution is observed in Kep province in particular the area where infrastructure and tourism development are taken place. It is reported that waste management is found as critical environmental problems, especially in Kep city (FGD, 2020).

Land based pollution from non-point sources: In Kep province, along with the growing urbanization and economic development, untreated waste (solid and liquid waste) and agriculture runoffs are sources of pollution on the marine environment, ecosystem, and human wellbeing. The excess fertilizers, herbicides, nutrient from livestock, pet wastes, insecticides, and toxic chemicals can discharge pollutants in the ground, into lakes, rivers, wetlands, coastal waters and ground waters. Beside this, the runoff of waste generated from resident area, coastal resorts, tourist facilities, and infrastructure and construction sites may include oil, oily-water, grease, residue, bacteria and defective septic organisms that can cause harmful effects on drinking water supplies, recreation, fisheries and wildlife.

Gradually, the amount of solid waste generated is increased and this leads to create more pressure and risks on the environment and human health. Currently, solid waste management in Kep city is, somehow, still poor, due to uncontrolled disposal, lack of waste collection efforts and transportation services, and proper dumping sites. In 2015, Sub-decree on garbage and solid waste in urban areas was created to strengthen and delegate the responsibilities of sub-national government on managing garbage and wastes in their municipalities. It details the responsibilities of concerned authorities including the Ministry of Environment, Ministry of Interior, and sub-national governing bodies. Under

[7] MoE (1999). Sub decree on water pollution control 1999. Ministry of Environment. Phnom Penh, Cambodia.

[8] The first treatment tank contains 85m^3/day is located at Phsa Kdam, the second treatment tank is at sand beach in front the Kep Department of Tourism, contains 50m^3/day, and the third treatment tanks is in seaside that is in front of Kep City Hall which capacity of 50m^3/day. However, these three treatment tanks have no longer function.

this sub-decree, sub-national government bodies take responsibility for waste management in their respective cities. Moreover, each sub-national authority is given decision-making power for contracting with private waste collecting companies (MoE, 2015b).
Solid waste management and environmental pollution issues have become the most challenging problems in Kep province. Unlikely to the past that the waste management company has the contractual right to charge households for waste collection fees with the electricity's invoice. At present, the charge for garbage collection system is under the management of provincial authority.

Despite waste management reform was undertaken, i.e. decentralization of responsibility from the provincial department of environment to Kep municipal authority, waste collection, and management, in particular in Kep city, is remaining implicated issue that need further consideration and addressing. There are some difficulties in translating/practicing it (decentralization) and mobilizing support. Some vital challenges to be solved to improve waste management function in Kep city, including a new model of management, inadequate practical legal framework, inappropriate mechanism, lack of law enforcement, and deficient human and financial resources (FGD, 2020). It is noted that individuals often dump garbage at roadsides (FGD, 2020; Kep, 2019).

Therefore, improving solid waste collection facility, treatment, and management capacity (storage or dumping, reuse, reduce, and recycle) is important. The collaboration between government, private sector, and stakeholders regarding urban waste management shall be taken into account.

5.2. Climate Change Risks and Vulnerabilities in Kep Province

The effects of climate change have already been widely observed in Kep province, including changes annual temperature; changes annual volume and pattern of rainfall; increased frequency and severity of climate-related hazards such as droughts, floods, storms, erosion, and saltwater intrusion (CBD, 2016; Kep 2019; NCDM, 2016). For example, in the eastern parts of the province, Damnak Chang'aeur district, is subject to irregular rainfall. In addition, salinity intrusion is confirmed as a main concern affecting water sanitation, hygiene, and health that made people faced with a lack of water for drinking and agricultural activities. It is also reported that, due to country geography (including Kep province) which is prone to vector and water-borne diseases, including malaria and dengue fever, changes in climatic conditions will have a significant influence on the outbreak of these diseases (Watt *et al*., 2012).

In Kep province, about 79.68% of the total population relies on agriculture (Kep, 2019), especially in rice production. However, there is a climate projection which indicates greater uncertainty of weather patterns and the occurrence of more frequent and intensive extreme weather events such as floods and droughts, showing, for example, increases of mean temperature between 0.013^{o}C to 0.036^{o}C per year by 2099, and sea-level rise between 0.18m to 0.56m by 2090. Under this projection of changing climate, rice yield would be more variable than under current conditions due to the increase in flood frequency and intensity (MoE 2016). Salinization of groundwater occurs in low land area which close to the sea in Kep province. Similarly, most streams in coastal areas experience seawater intrusion in the dry season (Watt *et at*. 2012). Coastal fishery communities are amongst the most vulnerable, due to a high dependence on natural resources that are direct exposure to severe storms, sea-level rise, and changing rainfall patterns (NCDM 2016). Poorest families especially children, women, and elderly people are the most vulnerable to climatic hazards, such as drought, salinity intrusion, seasonal storm. Women even have fewer adaptation options as they traditionally have less influence over the decisions, including those related to climate adaptation ((Watt *et at*. 2012; NCDM 2016).
National Committee for Disaster Management (NCDM, 2020) revealed that from 2003 to 2019 Kep province encountered a series of climatic and natural hazards such as floods, lightning and storms

resulted in significant loss of life and considerable economic loss including lightning killing 7 persons, extreme storm injuring 12 persons, destroying 32 houses damaging 13 houses, and affecting 542 people, and floods affecting about 1,735 people and damaging roads of about 5,605m. It is observed that from 2011 to 2016 drought had affected about 414 households (hh) and 1,552 persons (CDB, 2016; NCDM, 2020).

Due to the increased negative impacts of climate change and natural hazards on natural resources and human welfare, at present, fourteen ministries and government institutions have prepared sectoral climate change action plans to reduce, adapt and mitigate climate changes impacts, including the mainstreaming of climate change in national and subnational planning and budgeting processes, environmental protection, biodiversity and conservation of natural resources, and strengthening knowledge management and information systems (MoE, 2016). In Kep province, the climate change adaptation and natural resources management action plans (NRMAP) are prepared in a three-year provincial revolving investment plan and implemented by respective provincial departments such as the department of environment; the department of agriculture, forestry and fishery; and the department of water resources and meteorology, etc.

a) Temperature

During 1960-2003, the mean of the country's annual temperatures have observably increased by 0.8°C since 1960, at a rate of about 0.18°C per decade. The rate of the increase is most rapid in the dry season, increasing from 0.20-0.23°C per decade, and is slower in the rainy season, increasing from 0.13-0.16°C per decade (GFDRR, 2011).

Like other provinces of the country, Kep province is in a tropical monsoon climate with the rainy season from May to October and the dry season from November to April. In the dry season, the temperature of the province is highest in April, and coldest in February. The minimum and maximum temperature is between 17^{o}C to 35^{o}C with the average temperature of 26^{o}C (CDC, 2014). Climate change will likely increase temperatures, rainfall frequency, and pattern, and this will cause soil erosion and change water balance which will have direct impacts on forest productivity. Meanwhile, when the temperatures get high, it will reduce paddy, crops, and other vegetable production. Besides this, animals and children in the village are also vulnerable to diseases related to the changing weather, e.g. poultry and other livestock were died due to the heat. Likewise, higher temperatures promote the growth of pests and insects that cause damage to crops (FGD, 2020).

b) Rainfall

From May to November, the rainy season arrives with the summer monsoon bringing the heaviest rainfall. In Kep province, the rainy season is from May to October during which rainfall mainly comes from the southwest monsoon to inland from the Indian Ocean. The rainfall pattern is bi-modal with peaks in June and September/October. The annual rainfall is about 2,216mm (CDC, 2014). The average annual rainfall in Kep is 1,407mm with the highest level recorded being 2,604mm (ADB, 2014).

A suitable amount of rainfall is usually seen as a benefit to crops and fields. However, if the average rainfall is much lower or higher than the suitable amount, it can lead to significant problems, from drowned crops to lower yields. During the rainy season, rainfall provides water for people living in the area that is far from (or shortage of) water sources. Farmers reported that the groundwater table is high and their ponds and well are full of water.

In rainy season, the prolonged and heavy rain brings a huge amount of water down to the nearby main streams, lakes, reservoirs, wetlands, canals, ponds, paddy fields, and other low land areas of Kep province. This also creates a flush-flood that causes damage to people's homes, assets, and health. For example, the inundated flood caused by a long and heavy rainfall[9] in 2019 had notably damaged homes and property of people. It is noted that, from 2003 to 2019, lightning associated with rainfall and strong wind killed seven people, and severely injured four (NCDM, 2020). People revealed that they are informed to be more cautious about the heavy rainfall and thunderstorms since it would occur more frequently and bring them suffering.

c) Floods

Agriculture activities (including farming and fisheries) are the main economic activities in Kep province wherein 2017 about 80.2 % of the total population are involved in these activities, although Kep is considered as a key tourism destination area. Unpredicted climate change would increase the frequency of extreme storm and heavy rain with sea-level rise that might threaten the low land paddy due to the intrusion of saltwater and unwanted flood.

From 2003 to 2019, Kep province has been affected by a series of climate change related risks and natural hazards, such as floods, lightning and storms resulted in significant loss of life and considerable economic loss.

Table 3: Climate change related risks and natural hazards in Kep (2003-2019)

Event	Deaths	Injured	Houses Destroyed	Houses Damaged	Directly affected	Education centers	Damages in crops (ha)	Lost Cattle	Damages in roads (m)
Flood					1,735		12		5,605
Lightning	7	4						4	
Storm		12	32	130	542	1			
Total	**7**	**16**	**32**	**130**	**2,277**	**1**	**12**	**4**	**5,605**

(NCDM 2020)

The above table 5 shows between 2003 and 2019, flood has severely impacted about 1,735 persons.

People in Kep province recognized floods and droughts as one of the main drivers of poverty. In 2016, several schools in Damnak Chang'aeur district were inundated with flood after a prolonged rain of about 24 hours. People reported that sometimes there is so much rain, which suddenly causes floods damaging rice seedlings and animals (FGD 2020).

During the flash flood, the water runoff from the mountainous areas (such as Kep and Phnom Vor mountains) brought along with rocky and debris on the cropping and low land paddy areas before flowing into the sea. This would gradually make the cropping and paddy areas less fertile. Meanwhile, it would increase erosion that may affect coastal resources as well, e.g. reducing the provisional services of the coastal and marine resources such as coral reefs, seagrasses and coastal water quality changes. While most of the population in the province relies on those resources, such a negative effect will make them particularly vulnerable to the effects of climate change.

d) Droughts

[9] There was a long heavy rain starting from 15-19 September 2019.

Drought is one of the main climate change effects that causes negative impacts to coastal communities and ecosystems in the country's southern coastal provinces. Droughts are a period of abnormally dry weather over a long period of time, resulting in severe hydrological imbalances. In the dry season, drought, sometimes extends from 20 to 30 days and causing serious damage to crops. It was reported that between 2011 and 2016, Kep province faced with harsh drought that severely affected about 414hh and 1,552 persons (CDB, 2016).

In 2012 and 2013 drought occurred in Angkaol and Pong Teuk communes of Damnak Chang'aeur district and severely affected about 277hh and 50hh respectively. In 2014, there was no report on the drought in the province. Between 2015 and 2016, drought brought serious impacts to about 50hh and 37 hh, respectively (Kep, 2019).

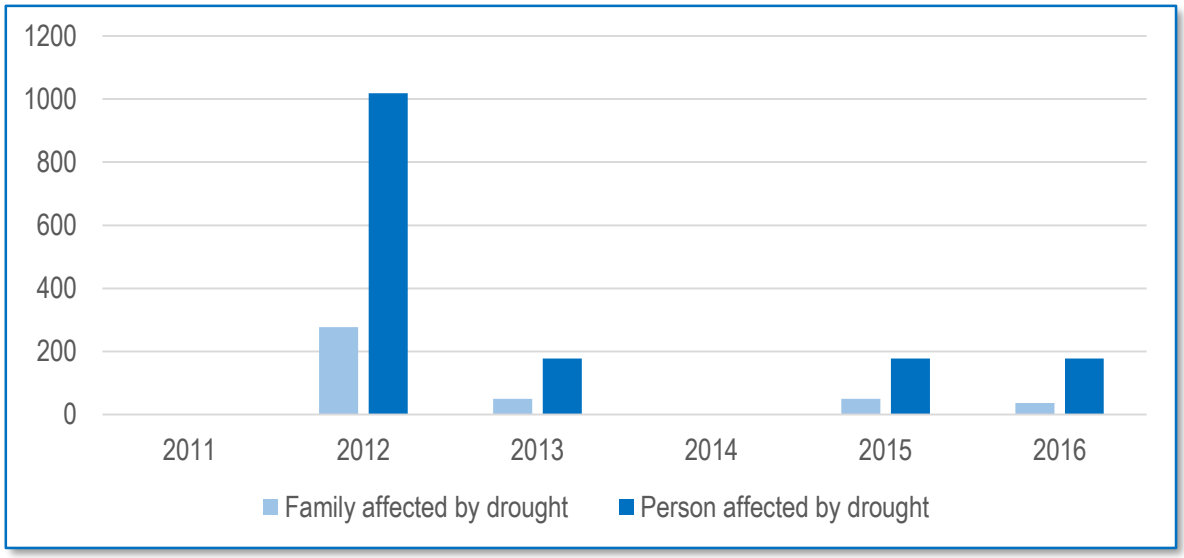

Figure 3: Family and persons affected by drought in Kep (2011-2016)
(CDB, 2016; Kep, 2019)

Similar to floods, drought is recognized by local people as the main driver of poverty. In the last few years, the coastal inhabitants experienced 'extreme hot weather' in the dry season. People who need water for their cropping activities observed that rising temperatures and increasing periods of drought are threatening their livelihoods (FGD, 2020). For example, the paddy area in Damnak Chang'aeur district plays a very important role for people whose income mainly relies on farming and cropping. Those areas had nearly every year encountered severe drought and flood. From 2003 to 2016, Angkaol and Pong Teuk commune of Damnak Chang'aeur district had encountered with severe drought almost every year. There is no major adaptation action in place to minimize the impacts and protect the local resources and community assets (Ibid).

Meanwhile, it is also noted that the agricultural systems applied in Kep province are characterized by medium productivity, e.g. average yield is about 3.7 tons per hectare for dry season rice and about 3.3 tons per hectare for rainy season rice, with insufficient modern technology, financial resources and improved farming practices (Kep 2019; FGD 2020). These agricultural systems can be affected by changing seasonal weather patterns, in particular, delayed drought and increased frequency of rainfall, which leads to poverty and food insecurity in the province. Best practice of water management and smart agriculture (better irrigation, water reservoir, seedling, appropriate cropping techniques) can be applied in those areas to cope with climate change impacts.

e) Extreme Storm

Storms and typhoons occurred almost in all provinces of Cambodia, especially in the lowland or coastal provinces, and seriously damage infrastructures (roads, school buildings, and houses), crops, schools, and public buildings as well as other assets (MoE, 2018b). Extreme storms that came along the very strong winds, and little or heavy rain combined with the sound of thunder (or lightning), had notably destroyed the property of the local community. Storms have affected people living since their daily business was postponed or closed and they could not generate income. For example, during storm and typhoon, the provincial authorities ordered/warned all tourists and local people not to go to the coast or islands to avoid accidents. Fishermen in the province were also informed not to go out to sea.

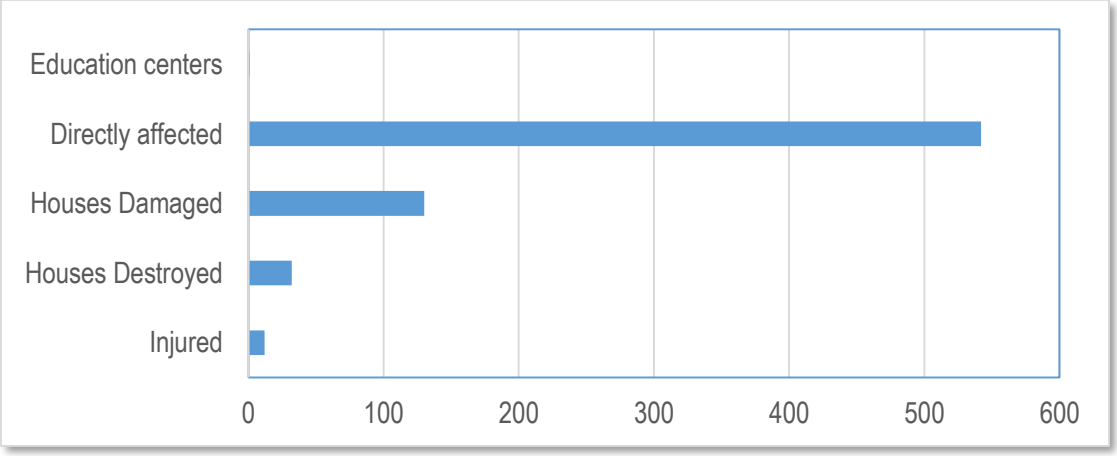

Figure 4: Storm impacts in Kep province between 2003 and 2019
(NCDM, 2020)

As illustrated in the above Table 5, Kep province was notably affected by extreme storm associated with sea-level rise and salinity intrusion, and poorest families especially children, women, and elderly people, were affected (NCDM, 2016; Kep, 2019). For example, between 2003 and 2019, the storm damaged one education center, and injured about 12 persons, destroyed about 32 village houses, damaged about 130 houses, and directly affected about 542 persons. During the field visit to Kep province, people reported that storms and sea-level rise can be seen as the drivers of sever flood and saltwater intrusion that destroyed crops and farms (FGD, 2020).

f) Erosion

Coastal erosion is an environmental issue associated with extreme storm combining with heavy rain, rising sea-levels, and various land-based activities, such as agriculture, and development. The erosion process can be seen as the combination of various influences, including the degradation of mangrove forest that protects the strong wave action, and the run-off from the paddy fields and saltpans that enhance erosion in localized areas contributing to overall erosion process. Commonly, the coastal provincial towns are undergoing some minor erosion and some of them have been protected by seawalls or natural protection in the form of rocky shoreline.

The coastal plain areas at the western and eastern parts of Kep city, which moderately or not protected by mangroves, are experienced with moderate to severe coastal erosion. It is observed that Kep city recreation beach, which is one of the few public recreation bathing beaches of Kep province, is also suffering from some minor erosion (FGD, 2020).

The larger erosion is observed in the stretch of the eastern coast of Kep where mangroves have been replaced or converted to salt farms, paddy fields, and other development. The villagers have been forced to retreat their houses inland (from 1983 to 2013) due to severe erosion. It was informed that during the last 30 years the coast has retreated/swallowed more than 50 m, and the rate of erosion could reach up to about 1.5 m a year (Ibid).

g) Saltwater intrusion

Like other coastal provinces of the country, Kep province had been affected by climate change impacts and extreme weather events including saline water intrusion. In some areas of the province, for example in Damnak Chang'aeur district, had experienced irregular and extended rainfall. People also noted that rising sea levels, storm surges, high tides, beach erosion and salinity intrusion posed a significant threat to coastal areas. In saltwater intrusion areas, the local people faced with a lack of water for drinking and agricultural activities. People in Kep's coastal area considered salinity intrusion as a main factor affecting water sanitation, hygiene, and human health (NCDM, 2016).

In Kep province, salt production is important for income generation of local people. There are about 2,000 ha of saltpans. Yet, the rising sea-level will lead to permanent inundation of coastal areas that is seen as a potential threat to salt production, and this negative effect needs to be considered in future development plans (GSSD, 2015). During the field visit, people reported that storms and rising sea levels are potential threats to the livelihood of communities living along the coastline. (FGD, 2020).

Table 6 is the result of the desk review, consultations, and observations that provides tremendous data and information for understanding and analyzing the critical hazards, climate impacts, the adaptive capacities, as well as adaptation options. The result suggested that communities, ecosystems, and resources have leveraged in the past or currently leverage to respond to climate risks. The following table is prepared to summarize the series of hazards, the observed impacts, and the level of adaptation and vulnerability of the local community in Kep province. These adaptation options are identified, described and discussed in three main contexts: i) retreat or relocate assets and people to safe areas); ii) defend or protect existing and new structures against climate change hazards with structural and physical measures; and iii) co-exist or adapt to the observed climate change conditions by a combination of innovative planning measures.

The observed impacts, in the second column, are developed through the consolidated results of the analysis of past, current, and predicted future effects of climate change and natural disasters. The adaption level, in the third column, are based on the analytical results of the condition of the ecological system and community adaptation capacity, and the consultation with target stakeholders (to revalidate and comment on analytical results) in the province.

Table 4: Climate change vulnerability in Kep province

Hazards	Observed impact on natural resources and livelihood	Adaptation Level			Vulnerability Level			Adaptation Options
		L	M	H	L	M	H	
Temperature (heat) and Droughts	- Heat-related health problems or diseases - Affect to people income, coastal resources/habitats - Increase exposure to sunlight - Lack of water supply							- Education and awareness-raising on increased temperature, diseases outbreak and improve better access to portable and clean drinking water - Reduce exposure to sunlight - Protect coastal resources. Select heat resistant crops

	- Lack of portable/clean water							- Build capacity people (farmer, fishermen, and businessmen) on income diversification and climate-resilient agriculture through better water management and irrigation system - Build canal, reservoir, dam, and irrigation system and maintain natural wetland, lake, pond, and well for rain/stormwater capture and storage
Heavy rainfall, lightning and Flood	- Damage to human life, homes and habitats - Loss of income - Water/vector-borne diseases - Erosion, sedimentation and runoff from hilly ground/mountains - Damage to coastal landscape - Damage to roads and infrastructure							- Set up a warning system and safe location. Raising awareness of people on flood and lightning protection - Disseminate weather forecast information on time - Increase people capacity on livelihood diversification, climate-smart agriculture, increase aquaculture and fish farming, increase fishermen capacity to better understand migratory patterns. - Build a canal/reservoir and maintain natural wetland, lake, pond, and well for rain/stormwater capture and storage - Build and protect infrastructures (road, wall, and dike)
Extreme storm	- Lead to flush flood and saltwater intrusion - Damage to homes/resorts - Increase threat, injure and loss of life due to lightning - Loss of tourist potential - Damage to boats/fishing equipment - Damage to roads and infrastructures							- Warn people and fishermen not to go to sea during the storm - Provide information and set up a warning system and a safe location - Raise awareness of people capacity on storm protection - Increase people capacity on creating/ constructing stormwater protection wall/dike.
Erosion	- Damage to coastal landscape - Lead to salt water intrusion - Damage to homes - Damage to costal habitats - Damage to roads and infrastructures							- Raise awareness on home protection and habitat restoration/ rehabilitation - Build, upgrade and protect infrastructures (road, wall, and dike) to protect coastal landscape
Salt water intrusion and sea level rise	- Damage to crops/farms - Loss of farmland - Damage to homes - Lead to coastal erosion - Damage to roads and infrastructures							- Careful retreat/set back people home and farmlands where it is possible - Consider and plan mangrove and natural coastal defenses. - Increase people capacity on livelihoods diversification. - Pay attention on strengthening, protecting and managing coastal ecosystem services Build, maintain, and upgrade coastal

								infrastructures (road, wall, and dike)

Note: L: Low, M: Medium, H: High

: Low to medium

: Medium to high

As a consequence of the past and current human activities and climate conditions, urban communities in Kep city have already experienced a decline of ecological service and function of natural resources in the province. The decline of both marine and inland resources leads to a decrease of the food chain and water security; insufficient of clean water and sanitation; increased threat to health and spread of diseases such as fever, dengue, typhoid and diarrhea, loss of life, assets and livelihood opportunities, and increased unemployment and migration.

At present, the capacity of biodiversity and ecological systems services to provide non-timber forest products, marine fisheries, clean water, etc. to meet the demands of the socio-economic system is gradually become ineffective. Local communities have been still facing significant capacity challenges that undermine their capability to effectively carry out the climate change adaptation actions. Then, capacity building shall be provided so that local communities/ stakeholders can get rid of vulnerability and other climate-related hazards.

Meanwhile, since climate change capacity building is a crosscutting issue, a guidance mechanism to ensure coherence and coordination among the relevant institutions, and shift capacity-building efforts toward long-term and systemic process is definitely important.

6. Findings

This part of the report is to discuss urban ecosystem-based adaptation (EbA) in Kep city. Geographically, Kep urban area covers only three communes/sangkat, namely Kep, Prey Thom, and Ou Krasar communes. In this context, as the scope of work is only focused on the urban area of Kep city so that biodiversity assessment for the entire Kep province can be targeted/zoomed in to Kep urban area. Therefore, any areas outside Kep urban area are excluded for suggestions/recommendations and further EbA implementation/intervention.

Results from discussions with relevant technical working groups in the context of biodiversity assessments (in terms of terrestrial resources, coastal/marine resources and related environment) within Kep urban area have weighted/justified a significant consideration on terrestrial resources of protected area rather than coastal resources. Why the coastal resources in urban Kep areas are not considered to select/suggest for EbA implementation? There are some reasons as follows:

Firstly, coastal resources, like mangroves, seagrasses, coral reefs and fisheries resources are assessed. Mangroves grow very sparse, and they are degraded/fragmented by human activities. The remained mangroves distribute sparsely and they are found in three communes within urban Kep areas. Furthermore, several patches of mangrove areas are encroached for land reclamation. The observations mainly captured a general status of biodiversity assessment of coastal resources within boundary of Kep urban city. The fragmented mangrove areas are commonly visible with small trails (dikes), fence /poles, and/or signposts indicating that such areas are divided or belong to land grabbers. This mangrove habitat is likely least significant functions of ecosystem services to support fisheries resources and livelihoods.

Secondly, fishing activities in shallow water are almost non-existing where is in front of urban inshore area. Seagrass area where located in front of urban nearshore is found sparsely and in degraded status. This means that seagrasses ecosystem is under degradation and fisheries resources may no longer depend on such degraded habitat and they move to elsewhere habitats. Furthermore, coral reefs where locate off a small archipelago of 13 islands are considered as fishing areas. These coral reefs located about four km southwest of Kep city and they have been established as marine fisheries management area which include some islands of Koh Tounsay archipelago. People are not allowed to settle permanently in those islands except small groups of fisherfolk for temporary landing and/or some businesses for day-trip visitors. As aforementioned, seagrasses and coral reefs are under degradation and fishing activities occur away from urban nearshore. These means that coastal resources do not support for activities within limit of urban area.

Third, almost 50% of urban Kep's shoreline has been constructed as seawall protection. Furthermore, areas located behind the shoreline are the settlement area, agricultural land and other land uses. No mangrove areas remaining behind the concrete shoreline area. This means that ecosystem services of coastal resources have no more function to support community. Therefore, coastal resources located within urban areas are not significantly considered in terms of ecosystem services for conservation value through EbA implementation site.

Meanwhile, terrestrial resources of Kep National Park (KNP) located at center of urban Kep city should be advised/recommended/suggested as project implementation site. Field observation to the park was conducted to capture overall pictures of biodiversity status.

Kep National Park is the only terrestrial evergreen forest in Kep city. The park plays a significant role not only in protecting biodiversity and ecosystems, stabilize the environment (erosion, landslides/avalanches, etc.) but also in making beautiful aesthetics and associated landscape with a small archipelago of islands that can attract more visitors. Furthermore, Kep is the one amongst the 11 most beautiful places to visit in Cambodia as visitors can trek through the park's trails to see sea view and other beautiful landscapes in Kep National Park. However, the park's trails or ranger trails have been deteriorated and need to be improved/rehabilitated.

Also, in response to the threats of climate change and natural hazards (as aforementioned in table 5), adaptation options have identified and discussed in suitable and applicable ways for provincial and local authorities and communities in Kep province, as well for EbA intervention to reduce and minimize climate change threats and vulnerabilities.

Table 5: Status of natural resources vulnerability and adaptation

Key Natural resources and environment	Threats Level			Description	Adaptation Options
	Low	Medium	High		
Mangroves			√	Very degraded/fragmented habitats (most mangroves areas are found in Angkaol where are outside urban Kep area)	- Set up public campaign and community participation in mangrove replantation. - Establish vulnerable and fragmented mangrove areas mapping, management, and rehabilitation planning.
Seagrasses			√	Degraded and sparse Existing and abundant seagrasses are located in Angkaol (outside urban area)	- Establish seagrass area mapping, restoration, rehabilitation and conservation - Set up awareness raising and community involvement in seagrass protection and rehabilitation.

Key Natural resources and environment	Threats Level			Description	Adaptation Options
	Low	Medium	High		
Coral reefs		√	√	Degraded and most coral areas are found around Koh Tonsay archipelago and inlets	- Increase community participation in coral reels management and conservation. - Establish vulnerable coral reels area mapping and protection.
Fisheries		√	√	Fishing activities are almost absence because of no fish (fishing areas are far away and outside urban Kep area)	- Raise awareness of fishermen on livelihood diversification and small-scale aquaculture. - Penalize and prohibit unsustainable and illegal fishing - Encourage and increase community participation in fishery resources protection and conservation.
Terrestrial forest	√	√		Forest area is in Kep National Park and inside urban Kep area.	- Strengthen and protect forest ecosystem services - Prepare public campaign and community participation in forest replantation, protection and conservation. - Enforce law on illegal forest cutting and forestland clearance.
Solid waste		√		Waste management mechanism is an early stage of its effectiveness	- Establish awareness raising on solid waste disposing, reuse, reduce, and recycling. - Manage dumping site and improve waste collection and management techniques - Strengthen collaboration on solid waste management - Deliver garbage facilities. Prohibit and penalty polluter
Sewage		√		Sewage management is an early stage of its effectiveness	- Conduct technical assessment of wastewater management. - Improve existing drainage/sewage and septic system - Provide better management of wastewater prohibit fine and penalize who pollute the sea - Apply polluter pay measures
Costal water quality	√	√		Coastal water quality would be changed. Current untreated wastewater might be critically important challenges in the future on recreational sites	- Improve wastewater management and treatment system - Improve sewage, drainage and culvert system - Raise awareness on coastal water quality protection. - Make better planning to ensure pollution-free on coastal water - Control and monitor coastal water quality - Apply law enforcement and polluter pay measures to protect coastal water quality.

7. Conclusion

Kep province's biodiversity and ecosystem services play important ecological services for urban people and communities, such as providing habitat, spawning, breeding and nursery areas for commercially important fish species and other marine species, and buffering/protecting the communities living in the coastal area from storms, inundation, and floods. Urban people and community livelihoods, however, are prominently vulnerable while these ecosystem services have

been deteriorated due to the negative effects of climate hazards and their capacity to adapt to climate variability is still limited. As aforementioned, extreme temperature, change in rainfall and sea-level rise can cause changes of water temperature and water quality. In addition, storms can create strong wave surge that cause erosion of shoreline and island's shoreline and this brings sedimentation load, especially into the seagrasses bed and coral reefs that affect to ecosystems. Mangroves also affects from sea level rise as certain species of mangroves are hard to tolerance and this can lead to saline water intrusion into areas where are behind the mangroves area. Meanwhile, some negative human activities are still occurring (such as illegal deforestation, fragmentation of mountainous forest, land encroachment, fuelwood collection, improper disposal or discharge of solid or liquid wastes, etc.) that harm to sustainable natural resources management.

The degradation of natural resources has impacts on both women and men. However, men are reported to get more burdens because they travel longer distances to the deep sea for fishing and get more workload for income generation, while women spend more time taking care of kids. Furthermore, men migrate to seek jobs in the city or other provinces or overseas. Other direct impacts include the increased workload for women as they take care of day-to-day food for the family. Female headed-households tend to have more roles to challenge for their subsistence.

Under identified anthropogenic and extreme natural climatic circumstances, rehabilitation and maintenance of the provisioning and regulating services of natural ecosystems are critically important in Kep province. These ecosystems will act as physical buffers against climate-related hazards while generating multiple social and environmental benefits.

Increase local participation is key to sustainably protect, conserve and manage forest resources, for example forest replantation; forest boundary demarcation; forest patrolling. These activities will rehabilitate biodiversity and ecological systems services, income generation and livelihoods improvement, building community resilience, climate and natural hazards mitigation (protection of people in the city from flash floods, extreme storm, intensive rain and stormwater runoff, landslide and erosion). Following the scope of the assignment, Kep National Park is the most suitable site to implement those activities.

This Park covers with evergreen forest and plays a very significant role not only in protecting biodiversity, ecosystem and habitats, stabilizing environment (erosion, landslides, heavy rain and stormwater runoff, water storage, etc.), protecting nearby resident and urban area from severe natural hazards, but also in making beautiful aesthetic and associated landscape that can attract more visitors, and in turn, it can provide a great opportunity to local people and community for employment, services and income generation. Due to its specific features, Kep National Park (KNP) is highly justified and recommended for EbA initiatives implementation site.

Meanwhile, efforts aimed at raising awareness and building the adaptive capacity of urban communities is vitally important. This can be achieved by mainstreaming EbA into development planning (at commune, city and provincial level) to reduce the vulnerability of local communities. This will help increase resilience, maintain essential ecosystem services and reduce the vulnerability of livelihoods of the local people and urban community, and nature in the face of both anthropogenic and climate change.

8. Recommendations

The below recommendation is based on analysis and assessment results and inputs collected from relevant stakeholders, especially the EbA TWG in Kep province. Ideally, this recommendation would

help to support the effective implementation of EbA intervention in Kep city to reduce climate change vulnerability on biodiversity, ecosystem services, and urban community asset and livelihoods. Proposed activities for EbA interventions in Kep province include:

- Conduct ecotourism and environmental awareness raising to local communities in three communes;
- Conduct training to rangers and community people (local guides) on park management, patrolling, environment, ecosystem, biodiversity conservation and protection, and good governance so they are able to protect natural resources and ecosystem effectively and introduce to visitors and/or school students properly;
- Rehabilitate ranger's trail of 6,400m inside the park to:
  - Facilitate patrol activities to prevent illegal activities;
  - Boundary demarcation of 100 signposts; and
  - Enhance access road for visitors to trek inside the part for sightseeing i.e., sea view, islands, and associated beautiful aesthetic of the park and Kep city.
- Conduct regular patrol to prevent illegal activities;
- Prepare seven to eight locations for sightseeing, and camp sites to:
  - Attract visitors and researchers/ students to spend more days in the park and Kep city; and
  - Increase a number of visitors and researchers/ students.
- Create more employment opportunity and income for local community (local guide, selling foods, tourist products and other services);
- Establish nursery station of conservation value plant species to support communities to plant in the public areas of schools, health centers and public gardens and/or roadsides;
- Conduct public plantation activities;
- Enhance environmental education and awareness with targeted groups, for instance, school students and/or service providers on conservation values of biodiversity and ecosystem services;
- Generate income for park management through expansion of sustainable ecotourism development inside the park (after construction trails and sightseeing and campsites);
- Conduct monitoring and evaluation (M&E);
- Conduct training awareness to relevant stakeholders, particularly service providers (such as owners of the guesthouses and hotels), local authorities;
- Conduct public awareness campaign days, create clean campaign day including clean beaches. Encourage school students and service providers to participate in this campaign, and create public forum for providing open public debate on waste management;
- Prepare nursery (with an area of about 1 ha) for mangrove seedlings and mangrove plantation;
- Install 100 signposts for mangrove protection and build five guard-posts for community fisheries to protect mangroves;
- Restore forest in the degraded forestland (with the area of about 10 ha), create man-made beach in the mudflat areas (1000m x 35m) and improve Angkaol's beach (4000m); and
- Continue building ranger's trail of 18,000m in the park to patrol illegal activities and serving tourist to visit more sightseeing and campsites.

The Proposed activities for above mentioned interventions are detailed in Appendix A.

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Appendix A: Proposed activities for intervention

Tentative Urban Kep Action Plan for EbA intervention

#	Sector	Priority actions	Location	Type Investment	Expected outputs	Beneficiaries	Proposed & Implemented by	Period (months)	Timeline			Estimate cost (US$)
									2021	2022	2023	
1	Tourism and environmental education	Conduct ecotourism and environmental awareness raising to local communities in 3 communes.	. Kep . Prey Thom . Ou Krasar	The project is potential for impact on the ground: • Soft: 1) raising awareness to communities; and 2) Pilot on community ecotourism; • Ground Impact: 1000 community peoples	Local community awareness on ecotourism, environmental protection improved.	- Community people - Park rangers - Visitors - Local guides	PDE PDT	6	√	√	√	14,860
2	Protected Area, Environment, Tourism Biodiversity and Ecosystem	Conduct training to rangers and community people (local guides) on park management, patrolling, environment, ecosystem, biodiversity conservation and protection, and good governance so they are able to protect natural resources and ecosystem effectively and introduce to visitors and/or school students properly.	. KNP[10] . Kep City . Prey Thom . Ou Krasar	• Soft: 1) raising awareness to park rangers and local people/ communities; and 2) Enhancing local capacity building on environment, ecosystem, biodiversity conservation and protection; and community ecotourism; • Ground Impact: 1000 community peoples including park rangers and school students.	Rangers and community people (local guides) knowledge on park management, patrolling, environment, ecosystem, biodiversity conservation and protection, and good governance significantly improved.	- Community people, - Park rangers, school students and visitors	PDE	6	√	√	√	14,860
3	Protected Area, Environment, Tourism, Biodiversity and Ecosystem.	Rehabilitate ranger's trail of 6,400m inside the park: 1) Facilitate patrol activities to prevent illegal activities; and 2) Boundary demarcation of 100 signposts Access road for visitors to trek inside the part for sightseeing i.e., sea view, islands, and associated beautiful aesthetic of the park and Kep city.	KNP	• Soft: Improving knowledge on patrol activities to prevent illegal activities • Hard: 1) ranger's trail rehabilitation; and 2) Protected area boundary demarcation; • Ground Impact:	- Rehabilitated 6,400m of ranger's trails inside the park - The number of visitors (tourists, researchers, student camping, etc.) increased.	Local livelihoods improved through created employment opportunity for urban community. Improved natural resource management	PDE	18	√	√	√	597,357

[10] Kep National Park

				6,400m ranger's trail, and 100 s of Protected area signpost								
4	Protected Area and Environment	Conduct regular patrol to prevent illegal activities.	KNP	The project is potential for impact on the ground: • Soft: raising awareness park rangers and communities to prevent illegal activities. • Ground Impact: 1) Community participation in KNP protection and management; 2) climate change impacts reduction.	- Local community participation in forest protection and patrolling increased; - Illegal forest cutting reduced; - Biodiversity and forest ecosystem in the park well protected; - Urban climate risks (flush flood, extreme storm, storm water runoff, etc.) and vulnerability reduced.	- Household assets Protected - Park management Improved - Visitor safety increased	PDE	18	√	√	√	5,000
5	Protected Area, Environment, Tourism, Biodiversity and Ecosystem, and Livelihood Improvement	- Prepare 7-8 locations for sightseeing, and camp sites to: 1. Attract visitors and researchers/ students to spend more days in the park and Kep city; 2. Increase a number of visitors and researchers/ students; - Create more employment opportunity and income for local community (local guide, selling foods, tourist products and other services).	KNP	• Hard: 7-8 locations for sightseeing, and camp sites to be created; • Ground Impact: 7-8 locations for sightseeing, and camp sites created; Visitors and employment opportunities increased;	- About 7-8 locations for sightseeing and campsites inside the park built. - Number of tourist/visitors increased. - Number of homestays increased. - Employment opportunity and income of local communities improved.	- Increase visitors to stay in the park and/or Kep city - Improve local livelihoods	PDE	12	√	√	√	83,680
6	Environment, Tourism, Biodiversity and Ecosystem, and Public Health	Establish nursery station of conservation value plant species to support communities to plant in the public areas of schools, health centers and public gardens and/or roadsides.	KNP	• Soft: Public Health improved; • Hard: nursery station of conservation value plant species created; • Ground Impact: Community peoples and Public Health improved; Visitors increased;	- Nursery station created. - Local participation in forest plantation in public areas of schools, health centers and public gardens and/or roadsides increased.	Community with good environment and tourist attraction	PDE	12	√	√	√	106,700
7	Environment, and Tourism	Conduct public plantation activities	Kep city	• Soft: raising awareness to communities in environment, public health and ecotourism;	Kep city environment quality and tourist attraction better improved.	Community with good environment and tourist attraction	PDE	6	√	√	√	

				• Ground Impact: Public Health improved; Visitors increased								
8	Environment education, Biodiversity, Ecosystem, and Livelihood Improvement	Enhance environmental education and awareness with targeted groups, for instance, school students and/or service providers on conservation values of biodiversity and ecosystem services.	. Kep . Prey Thom . Ou Krasar	• Soft: 1) raising awareness to communities; and 2) Pilot on community ecotourism; • Ground Impact: Ecosystem rehabilitated; and Community capacity and knowledge improved	Awareness and capacity of school students and/or service providers on conservation values of biodiversity and ecosystem services improved.	Local employment increased Tourist understanding on environmental value	PDE	6	√	√	√	8,470
9	Protected area, Environment, Ecotourism, and Income generation	Generate income for park management through expansion of sustainable ecotourism development inside the park (after construction trails and sightseeing and campsites).	KNP	• Soft: raising awareness to communities on income generation and livelihood diversification; and 2) ensuring community ecotourism; • Ground Impact: Community income better generated	Additional budget for park protection and management better improved	Local employment increased Tourist understanding on environmental value	PDE	6	√	√	√	5,000
10	Protected area management	Conduct monitoring and evaluation (M&E)	KNP	• Soft: 1) raising community awareness, park manager on M&E; and 2) Enhance the management and conservation of protected area; • Ground Impact: KNP well managed	Park M&E regularly and effectively conducted.	KNP better managed and protected	PDE	3	√	√	√	7,830
11	Environment education, waste management, and Tourism	Conduct training awareness to relevant stakeholders, particularly service providers (such as owners of the guesthouses and hotels), local authorities.	KNP	The project is potential for impact on the ground: • Soft: 1) raising awareness to communities; and 2) Pilot on community ecotourism; • Ground Impact: 1000 community peoples	Training for awareness raising to relevant stakeholders, service providers and local authorities conducted as planned.	Stakeholders get more understands and take part in solid waste and sewage management	PDE	6	√	√	√	37,750
12	Environment education and	Conduct public awareness campaign days	. Kep . Prey Thom . Ou Krasar	• Soft: raising awareness to communities on	Public Awareness Raising Campaign Day conducted.	Stakeholders get more understands and take part in	PDE	36	√	√	√	21,750

	Waste management			Environment and Waste management; • Ground Impact: Community awareness improved		solid waste and sewage management						
13	Environment education and Waste management	Create clean campaign day including clean beaches. Encourage school students and service providers to participate in this campaign.	Kep city	• Soft: raising awareness to communities and public on Environment and Waste management; • Ground Impact: 1000 Public and community participation; Clean beaches;	Students and service provider involvement in Public Beaches Clean-up Day/Campaign increased.	Attract more visitors and environmental protection improved	PDE	36	√	√	√	27,950
14	Environment education and Waste management	Open public debate on waste management	Kep city	• Soft: raising awareness to public and communities on Environment and Waste management; • Ground Impact: 500 Public and community participation;	Public Debate Forum on Effective waste management well conducted.	Community people and/or visitors get more understanding on waste management and environmental protection	PDE	36	√	√	√	21,750
15	Coastal resource management, Climate knowledge and Climate change adaptation	Prepare nursery (with an area of about 1 ha) for mangrove seedlings and mangrove plantation.	. Angkaol . Prey Thom . Ou Krasar	• Soft: 1) raising awareness to communities on coastal protection and climate change adaptation; and 2) Pilot on community mangrove plantation; • Hard: nursery for mangrove seedlings • Ground Impact: 1 ha mangrove nursery	At least 30,000 seedlings are planted and survived in next few following years	- Reduce damages of household assets from climate risk and natural disasters; and - Improve coastal habitats and fisheries	PDE & PDA	36	√	√	√	26,800
16	Coastal resource management, Climate knowledge and Climate change adaptation	Install 100 signposts for mangrove protection. Build 5 guard-posts for community fisheries to protect mangroves	. Angkaol . Prey Thom . Ou Krasar	• Soft: raising awareness to communities on coastal protection and climate change adaptation; and • Hard: 1) installation of signposts for mangrove protection; 2) Build 5 guard-posts for community fisheries • Ground Impact: 100 signposts; 5 guard-posts;	100 signposts and 5 guard-posts are built to prevent land speculation in the mangrove areas and preventing land encroachment into mangrove area. Community people to protect mangroves	Livelihood improvement through mangrove areas protection	PDA	12				7500

17	Coastal resource management, Climate knowledge and Climate change adaptation	Restore forest in the degraded forestland (with the area of about 10 ha)	. Angkaol . Pong Toek	• Soft: 1) raising awareness on forest protection values and climate change adaptation to communities; and 2) Pilot on Community forest plantation; • Hard: Community forest replantation area. • Ground Impact: 10 ha forest replantation	More forest plantation and environmental protection improved Climate risk reduced	Local communities and tourist understanding of forest protection values	PDA	36				7,300
18	Coastal resource management, Tourism, Climate knowledge and Climate change adaptation	Create man-made beach in the mudflat areas (1000m length and 35m width)	Prey Thom	• Soft: 1) raising awareness on forest protection values and climate change adaptation to communities; and 2) Pilot on Costal tourism; • Hard: Community forest replantation area. • Ground Impact: 10 ha forest replantation	Sand beach developed. Tourist attraction increased More jobs on service providers created	Livelihoods of communities improved. Mangroves in Prey Thom protected	PDT	36				3,000k
19	Coastal resource protection, Tourism, Climate knowledge and Climate change adaptation	Improve Angkaol's beach (4000m)	Angkaol	• Hard: Beach improvement to attract visitors and coastal resources protection. • Ground Impact: 4000 m beach improved	Tourist attraction increased Local employment increased	Livelihood alternatives created and more visitors to visit Kep province.	PDT	12				10,000
20	Protected Area, Environment, Ecosystem, Tourism. Livelihood, Climate knowledge and Climate change adaptation.	Continue building ranger's trail of 18,000m in the park to patrol illegal activities and serving tourist to visit more sightseeing and campsites.	KNP	• Soft: 1) raising awareness on environment, ecosystem, tourism and climate change adaptation to communities; and 2) Pilot on Costal ecotourism; • Hard: building ranger's trail in KNP. • Ground Impact: 18,000m ranger's trail;	Ranger's trail of 18,000m length built. Visitors increased Local employment increased	Community people, ranger and visitors	PDE	60				2,000k
21	Restoration of Por He dam to	- Restoration of damaged dam	Phum Tmey				- Kep city authorities	36	✓	✓	✓	N/A

	enhance ecosystem based adaptation and promotion of ecosystem based tourism	- Promotion of the conservation and management of natural resource for ecotourism - Awareness raising for dam management and participatory natural resource management					- Kep Environmental department - Kep Tourism Department					

Appendix B: Questionnaires

I. Questionnaires on climate change risks, vulnerability and needs

Questions are prepared to identify, to understand and collect data/information about climate change impacts in Kep province to design interventions aimed at reducing climate change risks and vulnerabilities.

1. Climate change risks and vulnerabilities:

- What are the main climate stressors that contribute to vulnerability?
    - Changes of rainfall
    - Changes of temperature
    - Frequent floods
    - Frequent drought
    - Extreme storms/cyclones
    - Sea level rise
    - Saltwater intrusion
    - Coastal erosion
    - Others (specify)
- What kind of natural resources below are vulnerable to climate change, and which one is the most vulnerable?
    - Terrestrial forest
    - Coastal resources (i.e., mangroves, seagrasses, and coral reefs)
    - Water resources
    - Fisheries resources
    - Wildlife
    - Coastline/shoreline (i.e. sand beaches, geomorphology)
    - Others (i.e. agriculture, infrastructures including coastal infrastructures)
- What community/groups are vulnerable to climate change, and which one is the most vulnerable?
    - Forestry community
    - Fishery communities
    - Farmer and water user groups
    - Gender and other social groups
    - Livelihoods
    - Employment
    - Others …
- Where are vulnerable natural resources and communities/groups located?
- What extend are they (natural resources and communities/groups) vulnerable?
    - High
    - Medium
    - Low
- Which month or season (raining or dry) of the year that natural resources and communities/groups are (most) vulnerable?

2. Environment:

- What are the main sources of pollution (solid and liquid waste)?
    - Agriculture
    - Land-use change
    - Salt farming
    - Shrimp farming
    - Domestic

    - Tourist infrastructure
    - Coastal infrastructure
    - Other marine and land-based activities…
- Where are most polluted areas located?
- What are the direct and indirect impacts of this pollution on natural resources and communities/groups?
- What factors (internal and external) cause this pollution?
- What natural resources and communities/groups are most effected from this pollution?
- What extend are they (natural resources and communities/groups) polluted?
    - High
    - Medium
    - Low
- What people and communities/groups need to reduce pollution?
- What actions are taken to protect the environment from this pollution?
- What options, plans, and strategies are available to manage this pollution?
- What capacity do people and communities/groups have and need to adapt to the identified pollution?

3. Needs and options:

- Who are working on reducing and adapting to climate change vulnerabilities?
    - National and provincial authorities,
    - Competitive institutions
    - Local communities
    - Gender and other social groups
    - Private sectors
    - Others…
- What are they (national and provincial authorities, competent institutions, etc.) doing to reduce vulnerabilities?
    - Adaptation
    - Mitigation
    - Capacity building
    - Others…
- Which actions are they well working to reduce vulnerabilities? Why?
- Which actions are they working hard/slow to reduce vulnerabilities? Why?
- What are the main barriers/challenges to reduce vulnerability?
- What are the most needed actions to help people/communities adapt to or reduce the effects of climate change? Why?
- What are the most needed interventions to protect and restore natural resources to help people/communities adapt to (or resilience) the effects of climate change? Why?
- What options, plan, and strategies are available to help people and communities adapt to the effects of climate variability and change?

II. Questions to discuss with relevant provincial departments and stakeholders

1. Provincial Department of Environment (PDE): Discussion on the challenges/constraints and opportunities on natural resources and protected area management (including finance, human resources, collaboration, legal mechanisms, magnitude of resource degradation). Environment-related issues environmental management i.e., land-based pollution, natural (Household wastewater, urban wastewater, garbage and solid waste, poor water quality discharge from factory?), stormwater and

culvert/drainage management, and agricultural effluent- excess fertilizers or pesticides. disasters, erosion, saltwater intrusion, etc

Threats from human settlements or other land use	High	Medium	Low	N/A
Housing and settlement				
Tourism and recreation infrastructure				
Roads and trails				
Fruit tree farms (Chamkar)				
Hunting and collecting terrestrial animals				
Collecting NTFPs and charcoal kilns				
Human disturbance				
Environment-related activities (Plantation, fire suppression)				
Increased fragmentation within PA				

a) Geographical event (landslide/avalanches, erosion and siltation/deposition (e.g., shoreline or riverbed change), sea-level rise and saline water intrusion and land use conversion
b) Climate change and vulnerability (Change of rainfall? Droughts/floods (frequency, the magnitude of damage and other help intervention?), extreme storms (frequency, magnitude of damage and help intervention?), extreme temperature (frequency?)

2. PDWRM (Provincial Department of Water Resource Management and Meteorology):
Discussion on challenges/constraints of water resource management (reservoirs, catchment, water bodies and infrastructure), emergency structures (spillway, embankments and sluice gates), rainfall and natural disasters (drought, flood and extreme storm/cyclones, and extreme temperature as well as frequency, magnitude of damage and intervention).

3. PDA (Provincial Department of Agriculture): Discussion on (i) agriculture (cultivated areas, crop varieties and chemical fertilizers etc.), land use varieties including saltpan and challenges for cultivation (water availability, irrigation water, groundwater, soil fertility etc.) as well as environment-related issues. (ii) Climate change risk and vulnerability (change of rainfall, droughts, flood and extreme storms (frequency, magnitude of damage and intervention) and extreme temperature, saline water intrusion (saltpan expansion, land-use conversion for settlement)

4. FiA (Kep Fisheries Administration): Discussion on challenges/constraints and opportunities on coastal fisheries management (fish refugia and coastal resources), resource depletion, number of fishing, annual catch, catch per unit, fish size and community management and livelihoods. Environment-related issues: water quality change (land-based pollution), conversion of mangroves into other land use, destructive fishing gear practices in seagrass and coral areas? Coastal land reclamation (minimize fishing area for poor fisherfolks), coastal erosion, conversion of mudflat into other land use (sand beach? land reclamation etc) and habitat loss

5. FA (Kep Forestry Administration): Discussion on constraints/challenges and opportunities on forest management (including forest plantation area), environment-related issues (topsoil runoff, soil/rock mining, alien invasion), Forest management? Plantation? Forestry communities? Livelihoods? Agricultural expansion (diminishing forest area)? Opportunities (used as esthetic/landscape for ecotourism activities)?
6. PDLMUPC (Provincial Department of Land Management, Urban Planning and Construction):

Discussion to get understanding of current development including registration of land tenure, legal mechanism, constraints and challenges of settlements, urbanization, infrastructure, and environment-related issues.

7. PDT (Provincial Department of Tourism): Discussion on challenges/constraints and opportunities and/or ecotourism developments, potential areas for ecotourism development sites.

- #Recreation sites (Sand beach, islands, mountains, and cultural sites)
- Increase the number of tourists?
- Challenges and constraints (including seasonal peak, solid waste, etc.
- Opportunity for development (including artificial sand beach?)
- Environment-related issues- Garbage management, solid waste from guesthouse/hotel, and water consumption (shortage of freshwater).

8. PDISTI (Provincial Department of Industry, Science, Technology and Innovation): Discussion to get understanding of current development including constraints and challenges on handicraft and industrial sites and environment-related issues

- Handicraft/industrial sites (including types of handicraft/industries)
- Challenges and constraints
- Environment-related issues (Septic tanks, discharge of waster)

9. PDRD (Provincial Department of Rural Development): Discussion to get understanding of constraints/challenges of current infrastructure development including clean water consumption)

- Infrastructures (i.e., Village roads, and wells,)
- Challenges and constraints
- Environment-related issues- Water pollution for water consumption, damaged infrastructures resulting from natural disasters

10. PDPWT (Provincial Department of Public Work and Transportation): Discussion on challenges/constraints to get understanding of infrastructure development, especially sewage system, drainage culverts, water treatment sites, dumping site, and other environment-related issues, waste management.

11. Communities and local authorities: Discussion on the status of natural resources management (on mangroves, seagrasses, coral reef and coastal Fishery Resources as well as terrestrial forest, water for household consumption, gender roles and so on), land use varieties, environment-related issues (agricultural runoff, fertilizer/pesticide/herbicide and pollution. Climate change risk, vulnerability and adaption, and so on.