Biodiversity and Ecosystem Management for Sustainable Development in North Tonle Sap Region, Cambodia

2020

SOMALY CHAN

Doctoral Dissertation

Biodiversity and Ecosystem Management for Sustainable Development in North Tonle Sap Region, Cambodia

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20 February 2020

Summary

1. Background and Objectives

Cambodia is situated in the region of Southeast Asia and its territory consists of a mixture of low-lying plains, mountains, the Mekong Delta and the Gulf of Thailand. The country has a total land area of 181,035 kilometers squared, a 443-kilometer coastline along the Gulf of Thailand and a population estimated at over 16 million in 2018. The largest area of the country falls within the Mekong River Basin, which is crossed by the Mekong River and its tributaries, including the Tonle Sap River, which joins the Tonle Sap Great Lake.

Cambodia's current record of biodiversity in relation to the inventory lists of all species known is 6,149 species in the major groups of mammals, birds, reptiles, amphibians, fish, plants and invertebrates. Cambodia is predominantly dependent on its rich biodiversity and other natural resources for its socio-economic development and for the population's food, livelihoods and well-being.

As Cambodia emerged from civil war, and during the rapid development process that the country went into thereafter, a great deal of pressure was put on the use and management of natural resources and the ecosystem, in many sensitive areas of high value in terms of biodiversity. In response to these pressures, twenty-three Protected Areas were established under a Royal Decree in 1993 to protect areas of environmental and cultural importance. These were classified into four categories: Natural Parks, Wildlife Sanctuaries, Protected Landscapes and Multiple Use Areas. Each of these types of Protected Area has a different nature and is submitted to different controls. Within the Royal Government of Cambodia's reform process related to environmental management, the number of Protected Areas has increased dramatically, to cover 41 per cent of the total land area of the country. This represents a very major commitment to the protection of biodiversity, along with associated environmental services and cultural values, by the Royal Government of Cambodia.

By definition, a Protected Area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. However, Cambodia has defined Protected Areas not only for conservation purposes but also for the

sustainable use of natural resources, which contribute to socio-economic development and cultural preservation. Further detailed guidelines on the management of Cambodia's Protected Areas are set out in the Protected Areas Act of 2008 of the Royal Government of Cambodia. In 2018, the Ministry of Environment defined the country's Protected Area management zones based on the ecosystems and geographical characters that these contained. The North Tonle Sap Region represents a unique ecosystem in that it interlinks between nature and cultural heritage through its interaction between three different ecosystems – those of mountain, plateau and wetland. Conservation and management of this region are of great value and significance.

Unfortunately, the North Tonle Sap Region has suffered from over-exploitation of natural resources as a consequence of unsustainable development, population growth, migration and climate change, as well as invasions of alien species. These threats are affecting not only the region's biodiversity and ecosystem but also its population's livelihoods, the local economy and its cultural heritage.

This study discusses the effectiveness of the system of management of biodiversity and ecosystem in the North Tonle Sap Region by exploring relevant environmental issues; assesses the value of biodiversity and ecosystem services in the region, by means of the review of a number of examples; and presents effective strategies and measures to use in working with natural resources for sustainable socio-economic development and human well-being.

2. Cambodia's Biodiversity and Ecosystem Services

Cambodia is rich in biodiversity, in terms of its ecosystem and species and genetic levels, including plants, animals and microorganisms. The country contains one of the world's largest natural freshwater lakes, in the shape of the Tonle Sap Great Lake. Large forested landscapes and grasslands support a rich biodiversity, including endangered and rare large mammals, birds, reptiles, insects and plants species. Freshwater wetlands are of great importance for a diversity of fish (estimated at more than 850 species), amphibians, regionally significant water-bird colonies and river dolphins. Coastal and marine habitats support major areas of seagrass, coral reefs, fish nurseries and turtles. The number of species by category is presented the following section.

Biodiversity supports human societies from an ecological, economic, cultural and spiritual perspective. Ecosystems provide a habitat for plants, animals and microorganisms that we can use or that perform useful functions.

Economically, the biodiversity and its ecosystem services contribute to the local economy through ecotourism and through the provision of natural resources, including medicinal and non-timber forest products, for either subsistence use or commercial purposes. Millions of people, particularly in rural areas, depend directly on the natural environment for their daily food, water and energy needs and their livelihoods. Cambodian biodiversity and ecosystem services are intimately linked to maintain the sustainability and productivity of agriculture and inland fisheries.

Based on the characteristics of the Tonle Sap ecosystems and their relative contributions, production of freshwater fish for the year 2011 is estimated at 37,000 tons for fresh water cage farming, with gross revenue generated from the Pangasius and Snakehead fish species at more than US$ 35 and US$ 15 million, respectively. Moreover, the total annual contribution of Veun Sai-Siem Pang National Park was US$ 129.84 million. In one study, Dr. John Talberth, Ph.D., Senior Economist of the United States Agency for International Development, shows that the value of non-timber forest products such as wild tree fruits to local villagers in the Cardamom Mountains is estimated at around US$ 350 per household per year. In addition to this, total annual revenue to the community from service provision to Kulen Promtep Wildlife Sanctuary reached to US$ 18,523 in 2016.

In order to protect the ecosystems of the country for further sustainable use, since 2016 the Royal Government Cambodia has been putting in place reforms to the management structure of the Protected Areas System, through zoning it as follows: East Mekong River Zone, North Tonle Sap Zone, South Tonle Sap Zone, Wetland Zone and Marine and Costal Zone.

3. Biodiversity and Ecosystem Management in the North Tonle Sap Region

The North Tonle Sap Region is composed of mountains, plateaus, plains and wetlands, which all coexist in a complex ecosystem landscape that sees harmonization between the region’s natural and cultural heritage. This, of course, means that the region

represents a unique ecosystem of very significant value for the country's social and economic development and for the conservation of its natural and cultural heritage.

There are sixteen Protected Areas in the region, including four Protected Landscapes, one National Park, six Wildlife Sanctuaries, two Multiple Use Areas, one Natural Heritage Park, one Ramsar site and one Biodiversity Corridor.

3.1. Environmental Issues Facing the Region

Natural resources in the region have been subject to severe over-exploitation, through illegal and uncontrolled logging, land encroachment and pollution, and have been adversely affected by climate change and the invasion of alien species. These factors have led to habitat loss, land degradation, ecosystem fragmentation and the decline and extinction of a number of species and the region's genetic diversity.

The rapid industrialization of the region, the expansion of agricultural farms and increased production have had a number of consequences of significance. These have included the clearing of natural habitats; an increase in the size of settlements as a result of migration, leading to a need for more resources for consumption; and intensive logging and deforestation. These have all affected the quality of soil and of watercourses by increasing the levels of chemical pesticides in rivers and the volume of sediment washed loose from degraded and bare soils towards the Tonle Sap River and river basins. This has resulted in negative impacts on the ecosystem's functioning and a reduction in the presence of species and in the region's genetic diversity.

Meanwhile, alien species are the second major cause of biodiversity loss and habitat destruction. Invasive species can cause great damage to native species by competing with them for food, eating them, spreading diseases, causing genetic changes through inter-breeding with them and disrupting various aspects of the food web and the physical environment. Two critical invasive alien species have been reported in the region: the giant mimosa (*Mimosa pigra*), a thorny plant from the Amazon, which has proliferated in the Tonle Sap area, threatening agriculture, fishing and flooded forests; and the golden apple snail (*Pomacea canaliculata*), introduced from South America, which has become an important pest in rice fields and invaded some freshwater systems, where it competes with native snails for food and causes the destruction of native aquatic vegetation.

To go into greater detail on *Mimosa pigra* (*M. pigra*), this is a thorny invasive alien plant that originates from tropical South and Central America and that has spread into Cambodia since 1980 around the Tonle Sap Great Lake and especially along the Mekong River, where it occupies thousands of hectares of flooded wetlands and abandoned fields. This weed has resulted in negative impacts on biodiversity, ecosystems, agriculture, health and socio-economic structures.

A study has been conducted on the emergence of *M. pigra* in the region and on its negative impacts on local livelihoods and ecosystems in Stung Sen Core Area. The results show that *M. pigra* has the most significant impact (60 per cent) on fisheries yields of all negative factors (it is followed by illegal fishing at 20 per cent and climate change and fish poisoning at 20 per cent) (see Figure 3 in the main text). Figure 4 in the main text indicates that, when *M. pigra* is present, fishers take more than seven hours to earn their daily income of US$ 17; the same amount can be earned in only two to five hours in the absence of *M. pigra*. Figure 5 in the main text shows daily local incomes from fisheries received as being between US$ 15 and US$ 25 in the absence of *M. pigra*; the amount decreases dramatically to between US$ 5 and US$ 10 when *M. pigra* is present. This represents evidence that *M. pigra* has disturbed the fish habitat and ecosystems in the area, leading to fish stock shortages.

The negative impact of the invasion of *M. pigra* is the loss of local income in the Stung Sen Core Area. Statistics show a local daily income in Stung Sen Core Area (1,164 families) of US$ 27,936; unfortunately, this income decreases by more than 50 per cent, to US$ 12,804, when *M. pigra* is present. Each family has seen an overall loss of US$ 4,745 in their annual income, and the total profit loss for Stung Sen Core Area has been huge, at more than US$ 5.5 million annually.

The results of this study imply that the value of ecosystem services in the Stung Sen Core Area, from the aspect of fisheries stocks alone, is more than US$ 5.5 million annually.

3.2. Measures Taken

To control the invasion of *M. pigra* in particular, several methods can be applied, including physical controls, chemical controls, revegetation and biological controls. Each

method has its pros and cons. In Cambodia, three methods have been applied; biological control is currently under assessment.

At the national level, Cambodia has developed several policies and pieces of legislation to enable sustainable development through protection of the environment, conservation, management and restoration of biodiversity and the ecosystem. The policies are listed in the following section.

Aside from the policies listed in Table 3 in the main text, nine relevant laws have been adopted to address the environment, biodiversity and ecosystem conservation and management issues. These are as follows:

1. The Law on Environmental Protection and Natural Resource Management (1996);
2. The Land Law (2001);
3. The Law on Forestry (2002);
4. The Law on Fisheries (2006);
5. The Law on Water Resources Management (2007);
6. The Protected Area Law (2008);
7. The Law on Biosafety (2008);
8. The Law on Seed Management and Plant Breeders' Rights (2008);
9. The Law on Tourism (2009).

To achieve effective management of Protected Areas, several factors need to be considered. Budgeting is one of the most important. In order to be able to assess the effectiveness of current Protected Areas management, the author analyzed financing and the fiscal gap in some Protected Areas in the Stung Sen Core Area.

As summarized in Figures 6 and 7 in the main text, an analysis of financing and of the fiscal gap in relation to Cambodia's Protected Areas has been conducted to identify resource gaps in the management of the twenty-three Protected Areas of Cambodia. The North Tonle Sap Region contains only sixteen Protected Areas, and only seven Protected Areas were selected for this study. This study set up a benchmark for full-time staff per 1,000 hectares and operational expenditure per hectare.

This study found that, for better management of Protected Areas, the budget for their operations should be doubled – that is, increasing it to US$ 2.5 million per year, required from external sources.

The recent expansion of the Protected Area system is part of an initiative of the Royal Government of Cambodia to implement its environmental governance reforms. The current Protected Area system contains 56 Protected Areas, covering 7.4 million hectares – that is, 40.9 per cent of the country's territory. In the North Tonle Sap Region in particular, fifteen Protected Areas and one Biodiversity Corridor have been established. However, as we have already seen through the result of the financing and fiscal gap analysis, the budget for the operations and management of Protected Areas should be doubled.

3.2.1. Strategy development for the sustainable management of biodiversity and the ecosystem in the North Tonle Sap Region

Limitations on financial resources for the effective management of natural resources remain a critical challenge. Payment for Ecosystem Services represents an important resource mobilization mechanism and is an approach that has been widely implemented with respect to environmental protection, biodiversity conservation, Protected Area management and sustainable development.

The North Tonle Sap Region is characterized by the co-existence of cultural heritage and nature, which provides for a unique ecosystem and an attractive destination for both national and international tourism. Within the 11 months of 2018 up to November of that year, approximately 2.46 million international tourists had visited the temples of Angkor Wat near Siem Reap. The proximity of the cultural heritage and natural sites in the North Tonle Sap Region represents a very good opportunity for tourists after they visit the temples.

This study presents recommendations on strategy for the future within and outside these Protected Areas, based on environmental issues, geographical location and socio-economic opportunities in the North Tonle Sap Region. For effective management of biodiversity and ecosystems within and outside of the region's Protected Areas, the study recommends the approaches of Ecotourism Development, Ex-Situ Conservation and Payment for Ecosystem Services.

The Royal Government of Cambodia has established the Orchid Research and Conservation Center near Phnom Kulen National Park to enhance scientific research and conservation of native species, promote public awareness and promote tourism. Strengthened operation of this center is necessary to enable the better management of biodiversity within the Protected Areas System in the North Tonle Sap Region.

Given its cultural heritage and its unique ecosystem, the North Tonle Sap Region has high potential to implement the Payment for Ecosystem Services mechanism. As such, this study conducted an initial feasibility study for potential implementation of Payment for Ecosystem Services in Phnom Kulen National Park. The feasibility study found that, in 2014, underground and aboveground water in Siem Reap City, which is sourced mainly in Phnom Kulen National Park, was extracted to a substantial degree (approximately 6.8 million meters cubed) and sold at an estimated value of US$ 1.9 million. The rate of annual underground water exploitation increased slowly from 1995 to 2005 but accelerated abruptly after 2005 and again from 2016 onward.

Given the high rate of water exploitation in Siem Reap City, Payment for Water Ecosystem Services must be implemented immediately.

A highly increasing trend of tourists and business establishments in Siem Reap City is predicted, with the number of international tourists projected to reach 2.68 million in 2025 (Figure 8 in the main text). This dramatic increase in tourism represents high potential for Payment for Water Ecosystem Services.

Based on analysis of the current situation, annual revenue from Payments for Ecosystem Water Services to a value of US$ 2.9 million to US$ 3.9 million can be generated in Phnom Kulen National Park.

3.2.2. Coordination mechanism and participation

Aware that biodiversity management is a cross-cutting issue; the Royal Government of Cambodia established the National Council for Sustainable Development with the vision of “Promoting Sustainable Development aimed at ensuring economic, environmental, social and cultural balance within the country” (Royal Decree No. NS/RKT/0515/403). This Council is composed of the Prime Minister of the Kingdom of Cambodia as the Honorary Chair, the Minister of Environment as the Chair, a Secretary of State of the Council of Ministers as the First Deputy, a Secretary of State of the Environment as the

Second Deputy, various Secretaries of State of the line ministries, the Secretary General of the National Committees and twenty-five Municipal/Provincial Governors of the Royal Government of Cambodia.

The National Council for Sustainable Development has the mandate of coordination and cooperation with line ministries and institutions to develop and implement policies and legislation and create strategies, programs and projects related to biodiversity, climate change, the green economy and science and technology for sustainable development.

The Biodiversity Department, one of the technical departments of the General Secretariat of the National Council for Sustainable Development, has the mandate of coordinating and performing day-to-day work in accordance with the instructions and decisions of the National Council for Sustainable Development to ensure achievement of the vision of the latter on biodiversity conservation and ecosystem management.

To ensure the full participation of relevant stakeholders, especially from indigenous and local communities, in the Royal Government of Cambodia's biodiversity and ecosystem conservation programming, the latter had established 168 Community Protected Areas by July 2019. In the North Tonle Sap Region, seventy-seven Community Protected Areas have been established and are functioning well.

4. Conclusion and Recommendations

The North Tonle Sap Region has a rich biodiversity with a unique ecosystem. The landscape of this region covers mountains and plateaus; it is the home of many species and many temples; and it also has wetland areas, including the Tonle Sap Great Lake, which provides the largest freshwater fish yields in the world.

However, this region has suffered from over-exploitation of natural resources in many forms, mainly illegal logging, land encroachment, soil and water pollution, overfishing, population growth and settlement expansion, as well as the negative impacts of climate change and invasive alien species. These factors have led to habitat loss, land degradation, ecosystem fragmentation and the decline and extinction of species and genetic diversity.

The Royal Government of Cambodia is taking serious actions and measures to deal with these challenges, including institutional capacity development, legislation development and enforcement, setting-up and operation of a coordination mechanism,

participatory engagement and livelihood improvement, to reduce the unsustainable use of natural resources.

This study has analyzed the effective management of biodiversity and ecosystem in the North Tonle Sap Region focusing on four core aspects: legislation development and enforcement; human and financial resources; measures taken for strategic development; and effective coordination.

In conclusion, the study has found that:

1. Two relevant policies (land and forestry) have been developed and implemented, and nine laws relevant to biodiversity and natural resource management were developed between 1996 and 2006, although implementation of these is still limited and challenges remain as a result of overlapping jurisdictions and lack of clarity in some provisions.
2. Both human and financial resources need to be increased for effective management of Protected Areas, according to the result of our fiscal gap analysis. At least 153 additional full-time staff must be employed and an additional budget in the amount of US$ 662,000 must be mobilized for seven Protected Areas in the North Tonle Sap Region established by Royal Decree in 1993.
3. Realistic incentive approaches, such as ecosystem services, including the REDD+ program, ecotourism and value change produce, etc., should be considered and applied.
4. Payment for Ecosystem Services, especially water ecosystem services, in the studied area (Phnom Kulen National Park) could be a good solution for sustainable Protected Areas financing as well as the ecosystem and biodiversity conservation in the Stung Sen Core Area.
5. The results of the assessment of the value of the Stung Sen Core Area in terms of fisheries stock – at US$ 5.5 million/year – should be used as evidence for decision-making on the profits received from ecosystem services in terms of contributing to the local household and national economy.
6. A participatory approach and partnership are very important to ensure the ful participation of all stakeholders in conserving and managing biological resources for sustainable development.

Finally, this study recommends a few approaches, including Ecotourism Development, Ex-Situ Conservation and Payment for Ecosystem Services, to overcome conservation challenges, enable better effective management of the Protected Areas system and enhance local livelihoods as well as conserving the spiritual and cultural heritage in the North Tonle Sap Region.

Acknowledgements

The Kingdom of Cambodia is recognized as one of the richest biodiversity hotspots within Southeast Asia. Biodiversity and ecosystems whose natural processes are deeply interconnected provide many services, resources and functions important for the livelihoods and well-being of the people of Cambodia, the country's wildlife, the economy and the mitigation of climate hazards.

While biodiversity provides the fundamental goods and services upon which all life depends, it is particularly important to the most vulnerable groups of our society. Numerous Cambodians, especially indigenous groups and remote communities depend heavily on biodiversity for their basic necessities, such as food, water, shelter, medicine and a livelihood.

Given this importance, Cambodia has developed a series of policies, strategies and action plans aiming at conserving and sustaining these biological resources. To deal with the environmental issues that confront us in the current situation, this study presents strategic recommendations for biodiversity and ecosystem management that will contribute to poverty reduction and sustainable development in Cambodia.

This study has been carried out with strong support from professional experts, colleagues, friends and communities, with respect to advice, data collection and information-sharing. Particularly useful has been advice from the study's supervisor, Professor Dr. Mihara Machito, who has given strong support and valuable pointers throughout the process of developing the study.

The author would like to thank the General Secretariat of the National Council for Sustainable Development of the Ministry of Environment for encouragement and for the provision of legal documents for this study. Thanks also go to colleagues from the Biodiversity Department for their support in collecting information/data to help in conducting this study. Thanks also to research colleagues and interns from the Royal University of Phnom Penh for their support during the field study.

Finally, the author would like to give sincere thanks to Professor Dr. Mihara Machito, Professor of Tokyo University of Agriculture and President of the Institute of Environmental Rehabilitation and Conservation, for his support and professional guidance

as supervisor on this Ph.D. study. Also, thanks go to Professor Dr. Fumio Watanabe and Professor Dr. Keishiro Itagaki, Professors of Tokyo University of Agriculture, and His Excellency Dr. Sinisa Berjan, Ambassador of Bosnia and Herzegovina based in Tokyo, for their valuable advice in the whole process of the development of this dissertation.

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List of Acronyms

BC	Biodiversity Corridor
EDGE	Evolutionally Distinct and Globally Endangered
EEPSEA	Economy and Environmental Program for Southeast Asia
FTS	Full-Time Staff
GC	Genetic Conservation Area
GSSD	General Secretariat for Sustainable Development
IUCN	International Union for Conservation of Nature
MP	Marine National Park
MU	Multiple Use Area
NBSAP	National Biodiversity Strategy and Action Plan
NFP	National Forestry Program
NCSD	National Council for Sustainable Development
NH	National Heritage Park
NP	National Park
NRM	Natural Resource Management
NTFP	Non-Timber Forest Produce
NTSR	North Tonle Sap Region
OpEx	Operational Expenditure
PA	Protected Area
PES	Payment for Ecosystem Services
PKNP	Phnom Kulen National Park
PL	Protected Landscape
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks
RGC	Royal Government of Cambodia
RS	Ramsar Site
RUPP	Royal University of Phnom Penh
SMART	Spatial Monitoring and Reporting Tool
SSCA	Stung Sen Core Area
WS	Wildlife Sanctuary

Chapter 1: Background, Objectives and Methodology

1.1. Background

Cambodia is situated in Southeast Asia, and consists of low-lying plains, mountains, the Mekong Delta and the Gulf of Thailand. It covers a total land area of 181,035 square kilometers and has a 443-kilometer coastline along the Gulf of Thailand. The country's population is estimated at having been over 16 million in 2018, and to be growing at an average annual rate of 1.46 per cent – among the highest rates in Southeast Asia. Cambodia's low-lying plains are in the central part of the country, surrounded by mountainous and highland regions in the northern, eastern and western parts (6NR, 2019). The largest area of the country falls within the Mekong River Basin, crossed by the Mekong River and its tributaries, including the Tonle Sap River, which joins the Tonle Sap Great Lake.

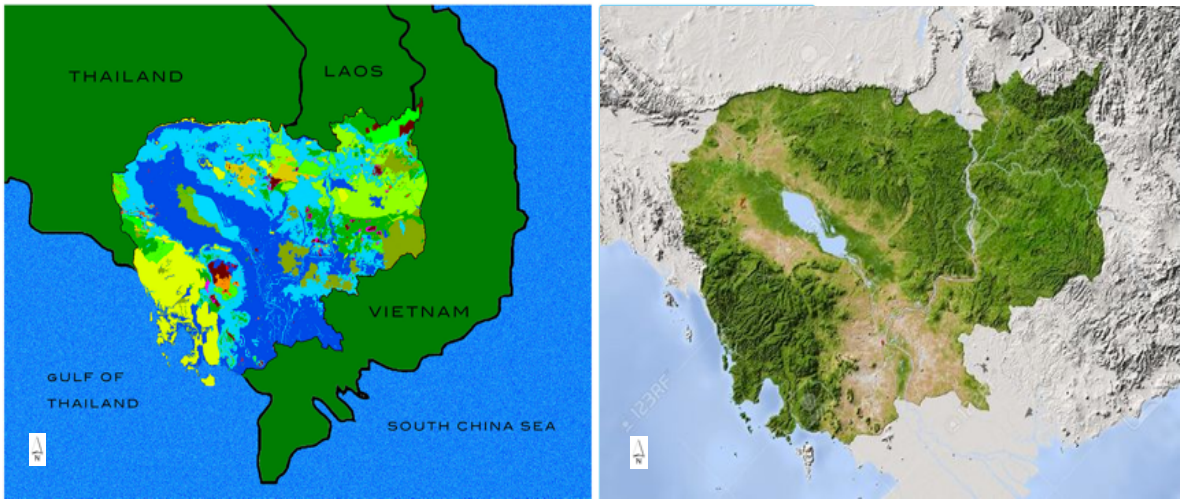


Fig. 1. Meteorological Map of Cambodia and its location

1.1.1. Country Profile

Cambodia, which comes under the monsoon climate, can be divided into four ecological regions:

1. The Annamite Range hosts moist forests, which are home to 134 species of both endemic and near-endemic mammals, 525 bird species and several species of reptiles. More than 50 per cent of these dense forests have been cleared for timber and firewood.

2. The Cardamom Mountain moist forests are considered to be one of the most species-rich ecoregions of Cambodia. This ecoregion is composed of evergreen forest plant species and is home to over 100 mammals, with elephants the most important, and in the area of 450 species of birds and several reptiles. The ecoregion is generally protected and intact but cases of illegal logging are being reported.
3. The Central Indochina dry forests in the arid plains of Cambodia represent an ecoregion consisting of sparse woodland communities dominated by deciduous trees. It has 167 species of mammals, with the majority made up of threatened megaherbivores and over 500 species of birds. The ecoregion is threatened essentially by land clearing for settlement.
4. The Mekong freshwater ecoregion is characterized by a high diversity of habitats including deciduous forests, grasslands, wetlands and riparian environments. It hosts an exceptionally high species diversity.

Large forested landscapes and grasslands support a rich biodiversity including endangered large mammals and rare birds, reptiles, insects and plants species. Freshwater wetlands are of great importance for a diversity of fish (estimated at more than 850 species), amphibians, regionally significant water-bird colonies, and river dolphins. Coastal and marine habitats support major areas of seagrass, coral reefs, fish nurseries and turtles.

Cambodia has a unique environment, with one of the world's largest natural freshwater lake fish,[1] the Greater Mekong forests and river complex and the largest contiguous block of natural forest remaining on the Asian continent's mainland – which altogether mean the country represents an important biodiversity hotspot. In addition, five of nine high-priority biodiversity conservation corridors in the Greater Mekong Sub-Region are in Cambodia (ICBD, 2014). The Ministry of Agriculture, Forestry and Fisheries classifies wildlife species into three categories: near extinct, rare and common. The near extinct species include ten mammal species and six bird species. The rare category includes twenty-seven mammal species, forty-five bird species, five reptile species and many endangered plant species. Twenty-three species of wildlife in Cambodia

[1] The Mekong giant catfish.

are on the International Union for Conservation of Nature Red List as globally endangered species.

Biodiversity is considered to comprise the ecosystem, species and genetic levels, and includes plants, animals and microorganisms, although there is a large discrepancy with regard to the availability of data for each component. The current record of biodiversity on Cambodia in relation to the inventory lists of all known species is 6,149 species in the major groups of mammals, birds, reptiles, amphibians, fish, plants and invertebrates (NCSD, 2016). Plant and animal genetic resources and ecosystem diversity are considered an important group.

Cambodia is predominantly dependent on its rich biodiversity and other natural resources for country's socio-economic development and for the food, livelihoods and well-being of the majority of the population. Biodiversity is key to food security and nutrition, and contributes to the achievement of Sustainable Development Goal 1 on poverty eradication and Sustainable Development Goal 2 on zero hunger. Food systems depend on biodiversity and the ecosystem services that support agricultural productivity, soil fertility and water quality and supply. For example, pollination is one of the most important mechanisms in the maintenance and promotion of biodiversity and life on Earth. Pollinators and pollination are critical for food production and human livelihoods, and directly link wild ecosystems with agricultural production systems.

1.1.2. Culture and the Relationship between Humans and Biodiversity

Biodiversity is a major source of cultural and spiritual enrichment for human beings. Species, genetic diversity and the diversity of ecosystems are frequently integral to religious, cultural and national identities. For example, all major religions include elements that are related to natural aspects, and many countries around the world use species found within them as national symbols. The special relationship that exists between indigenous peoples and nature has in many cases enabled them to conserve a great proportion of the Earth's biodiversity. Meanwhile, in other cases, the relationship between humans and nature exists in urban areas. Ecosystems such as parks and other effective area-based conservation measures provide recreation and a source of knowledge for visitors, such as in educational centers that connect people with nature, and biodiversity is a frequent source of inspiration for artists and designers.

1.1.3. Socio-Economic and Population Factors in Cambodia

This section provides brief information on the Cambodian socio-economic, poverty and income situation, as well as reviewing the Cambodian population, to enable us to understand and identify the environmental issues in the country as well as those related to biodiversity conservation and management.

1.1.3.1. Socio-economic factors

Cambodia's economic growth is estimated to have remained strong in 2018 and 2019, underpinned by tourism and fiscal expansion. Economic diversification, good quality public governance, environmental sustainability and human capital development are key priorities for the country if it is to sustain growth and achieve inclusive development in the future.

The social economy in Cambodia is still in its infancy but, with increasing interest from social investors and intermediaries, the country has significant growth potential in this regard. While institutional philanthropy is a recent phenomenon in Cambodia, partnerships between foundations and other stakeholders in the social economy are proliferating. Cambodia is also experiencing a burgeoning impact investing scene, having attracted 45 per cent of all private impact investment capital deployed in Southeast Asia between 2007 and 2017.

For this study, in terms of socio-economic aspects, this study focuses only on aspects related to the environment and natural resource management, such as water quality, energy sources for cooking, land management, agricultural systems, health, income and poverty, among others.

Water quality

Water is fundamental for life and health. Water, like health, is an essential element in achieving other human rights, especially the rights to adequate food and nutrition, housing and education.

Drinking water for Cambodia relates to access to water supply services, defined as "availability of an improved water source". The main sources of drinking water in the country are improved and unimproved water sources. Improved water sources include piped water in the dwelling or on the premises; public taps; tube/piped wells or boreholes;

protected dug wells; and improved rainwater collection. Meanwhile, unimproved water sources include unprotected dug wells; ponds, rivers or streams; unimproved rainwater collection; vendor-provided water/tanker truck provision of water; and bottled water. An improved water source is not necessarily safe but is more likely to provide safe water.

According to the Cambodia Socio-Economic Survey 2017, piped water in the dwelling or on the premises is defined as piped water that is connected to the in-house plumbing through one or more taps; a public tap/stand pipe is defined as a public water point from which community members may collect water; a tube well or borehole is defined as a deep hole that has been driven, bored or drilled with the purposes of reaching groundwater supplies; and a protected dug well is defined as a dug well that is protected from runoff water. Rainwater collection is also considered an improved water source if the rainwater catchments tank is completely closed, has a tap for use in withdrawing water and has a capacity of at least 3,000 liters (CSES, 2017).

Energy sources for cooking

In all Cambodia, about 67 per cent of households use firewood for cooking, 24 per cent use liquefied petroleum gas and 7 per cent use charcoal. The main sources of cooking fuel include firewood, charcoal, liquefied petroleum gas, kerosene, household generators and publicly provided electricity/city power.

Land management

Land in Cambodia is divided into three classifications: private property, state private property and state public property. An understanding of the distinction between state private property and state public property is essential to determining how state land is to be used.

Private property is property owned by a person or collectively by individuals or companies. Private land is immovable property that is the property, under the ownership or right of ownership, individually or jointly, of persons or companies.

State private property is all immovable property belonging to the state but not of public interest. This type of land is designated as “non-state public land” and is also open to ownership by private individuals or collectives under the 2001 Land Law. Basically, any land that is not private or that does not serve the public interest is privately held state land under the 2001 Land Law. State private land is all that which belongs to the state but does

not serve the public interest. Land in this category can be sold or rented, including through long-term leases and concessions, but those involved must follow the correct legal procedures. State private land may be the subject of sale, exchange, transfer and leasing as a long-term land concession. If state public land loses its public interest value, it may be reclassified as private land, so it is possible to rent concessions to swap or sell.

State public property is land that is of significant interest to the public. State public land is protected by the laws of Cambodia for the purpose of maintaining its value for the public benefit. As such, the use of such land is restricted and cannot be granted. This system does not represent a form of economic land concession but rather is in place to maintain the benefits of the land. In any case, a great deal of state public lands has been categorized as state private land, for use in carrying out business with private legal entities (CCHR, 2013). State public land refers to all land that serves the public interest. This type of land thus includes natural resources (such as rivers, lakes and mountains) that are developed specifically for general use (such as ports, railroads and airports); real estate that is for public use (such as roads, trails and parks); and public real estate that is divided up to provide public services (such as schools, local hospitals and administrative buildings). Designation of state public land has as its aim the protection of the heritage, history and official property of the kingdom of Cambodia.

Public land cannot be sold or transferred and cannot be used for social or economic land concessions. However, state public land, including land in Protected Areas, has often nevertheless been classified as state private land and been used to provide concessions to private entities.

Economic land concessions are long-term leases that allow private companies to clear land for agribusiness development. They may be granted for a number of activities, such as large-scale plantations, animal husbandry and the construction of agricultural processing plants.

Agricultural land refers to the land that households own or operate, rent in, rent out or use freely for vegetable gardening, agriculture or farming activities, such as crop cultivation, livestock-raising, fishing and fish breeding and private forestry. This excludes land under permanent pasture, wood or forest and all other non-agricultural land brought under residential use or for other enterprise activities. Private ownership of land was recognized in 1989. Farming households were then invited to apply for title to the land

they cultivated. Around 4 million such applications were made, and the intention was that the central cadastral authorities would process these as quickly as possible. Households with agriculture as their main occupation received land according to their household size and other household characteristics. However, since then, there have been significant socio-economic changes (refugee repatriation, urbanization, growth in the economy and population) that have placed a number of new demands on the land. This has led to complications in the cadastral process.

Based on a survey report by the National Institute of Statistics, about 1.9 million hectares of agricultural land is used in the wet season, of which 367,000 hectares is used by households that are headed by women and 1,560,000 hectares is used by households that are headed by men. In the dry season, the share of agricultural land used is much smaller, at 22,000 hectares used by households headed by women and 268,000 hectares used by households headed by men.

The second most common type of land is land for kitchen gardens, with 512,000 hectares for both genders of household heads.

If we compare all agricultural land in the five zones, the Tonle Sap zone has the largest area, at 777,000 hectares, followed by the Plains zone, with 568,000 hectares, and the Plateau/Mountain zone, with 473,000 hectares, all added up for households, whether headed by women and or headed by men.

The most common type of land tenure in Cambodia is share of owned agricultural parcels by all households. Out of the total area of agricultural land, about 88 per cent is owned and 7 per cent is owned and rented out. Altogether, about 84 per cent of agricultural land was owned in 2017. About 59 per cent of the total area of agricultural land in 2017 was used during the wet season. In the dry season, the share of agricultural land area used is approximately 9 per cent. The second most common type of agricultural land area is land for chamkar, which constitutes about 16 per cent of the total.

Statistics from the National Institute of Statistics indicate that about 42 per cent of the total area of agricultural land in 2017 had irrigation facilities. In the wet season, about 20 per cent of agricultural land was irrigated to grow crops and plants.

Crop production

In 2016, the number of household for crop planting was estimated to be 2,541,000 in the wet season and 815,000 in the dry season. The total number of household activities for crop planting in 2017 is higher, estimated at 3,627,000 in the wet season and 978,000 in the dry season. The most common crop coming under production in Cambodia comprises cereals, which are harvested for their grains and accounted for 73 per cent of all household activities for crop planting in 2016; the corresponding proportion in 2017 was lower, at about 71 per cent. The second most important crop produced comprises fruits and nuts, which accounted for about 10 per cent of crop production in 2016 and 11 per cent in 2017.

Fish cultivation

A large number of households in Cambodia are participating in fish cultivation and fishery activities. Out of 3.4 million households in Cambodia, about 1,352,000 are engaged in fishing activities, equivalent to 39 per cent. The share of households involved in fishing activities is highest in the Plateau/Mountain zone, at 48 per cent; this is followed by the Coast zone, at 47 per cent, the Tonle Sap zone, at 44 per cent and the Plain zone, at 43 per cent.

Forestry and hunting

In 2017, the number of households participating in forestry and hunting activities was 2,321,000, which is equivalent to about 68 per cent of all households in Cambodia. The most common activity was collecting root crops, fruit, vegetables and firewood, at 41 per cent of all households.

Health statistics

The average life expectancy of Cambodians increased by 25 years between 1980 and 2012 (UNDP, 2015). The average life expectancy in 2012 was 71.9 years (UNDP, 2014). The United Nations Children's Fund estimated the maternal mortality rate at 170 per 100,000 in 2013. In 1990, the maternal mortality rate in Cambodia was 1,200. This therefore represents a drop of 86 per cent (UNICEF, 2015).

1.1.3.2. Population

The provisional population totals of the General Population Census of Cambodia 2019 show that the total ***de facto*** population of Cambodia on March 3, 2019 stood at 15,288,489.

This includes only those who spent the night at the place of enumeration, thereby excluding those who were abroad, even if only briefly. The total population has increased from 13,395,682 in the 2008 Census. Thus, the population has grown by 1,892,807 persons, which represents 14.1 per cent, over the period of eleven years from 2008 to 2019. The male population was 7,418,577 (48.5 per cent) and the female population stood at 7,869,912 (51.5 per cent). The average size of households has been stable since 2008, at 4.6 persons.

A Demographic and Health Survey conducted in 1979–1980 estimated the total population of Cambodia at approximately 6.6 million. Later, the 1994 Socio-Economic Survey estimated the total population of Cambodia at 9.9 million. In March 1996, the National Institute of Statistics conducted another Demographic and Health Survey, covering 20,000 households, which estimated the total population of Cambodia at 10.7 million. Next, the total population determined by the 1998 Census was 11.4 million. The National Institute of Statistics also undertook an Inter-Censal Survey in 2004 and found the population to have increased to 12.8 million. Following a pattern of steady increases, the 2008 Census obtained a result of 13.4 million; after an update by the Inter-Censal Survey of 2013, this figure rose to 14.7 million. Now, the provisional result of the 2019 Census sets the total ***de facto*** population at 15.3 million (Annex 1). Obviously, the final result may differ slightly from this figure (NIS, 2019).

1.1.3.3. Poverty and income

Over the past two decades, Cambodia has undergone a significant transition, reaching lower-middle-income country status in 2015; it now aspires to attain upper middle-income country status by 2030. Driven by garment exports and tourism, Cambodia's economy sustained an average growth rate of 8 per cent between 1998 and 2018, making it one of the fastest-growing economies in the world. While easing slightly, growth remains strong, projected to reach 7 per cent in 2019, after the better-than-expected growth rate of 7.5 per cent in 2018.

Poverty rates continue to fall in Cambodia. According to official estimates by the World Bank, the poverty rate in 2014 was 13.5 per cent, compared with 47.8 per cent in 2007. About 90 per cent of the poor live in the countryside. While Cambodia achieved the Millennium Development Goal of halving poverty in 2009, the vast majority of families

that escaped poverty did so by a small margin. Around 4.5 million people remain near-poor, vulnerable to falling back into poverty when exposed to economic and other external shocks.

Cambodia has exceeded the poverty reduction targets set out in the Millennium Development Goals. The proportion of people living in extreme poverty is less than US$ 1.15 per day, down from 53.0 per cent to 20.5 per cent between 2004 and 2011. The nearly half-year improvement is attributed to higher prices for rice and production, which increased incomes for farm workers and growers. However, a large number of people still live near the poverty line and are vulnerable. The number of people earning less than US$ 2.30 per person per day increased from 4.6 million in 2004 to 8.1 million in 2011 (Ulrich, 2014).

Income inequality in Cambodia is similar to that in the West and lower than in the United States, according to various developmental standards. For example, the Gini coefficient (for measuring income inequality, with 0 representing perfect equality and 100 representing extreme inequality) was 31.8 in 2011, whereas Ireland scored 32.1 in 2010 and Germany 30.6. The score for the United States in 2010 was 41.1. Income inequality is declining in Cambodia, according to the World Bank and the United Nations (World Bank, 2015).

1.1.4. Cambodia's Protected Areas System

A Protected Area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN, 2008). However, Cambodia's defined Protected Areas are not only for conservation but also intended for the sustainable use of natural resources, to enhance their contribution to the country's socio-economic development and cultural preservation.

Cambodia was the first country in Southeast Asia to put in place a Protected Areas system. It did so in 1925, first by surrounding the culturally significant Angkor complex of temples, which is now designated as a World Heritage Site. In 1957, 173 forest reserves, comprising 3.9 million hectares, and 6 wildlife reserves, comprising 2.2 million hectares, or 12 per cent of the total area, were designated for the protection of wildlife, in particular large mammals.

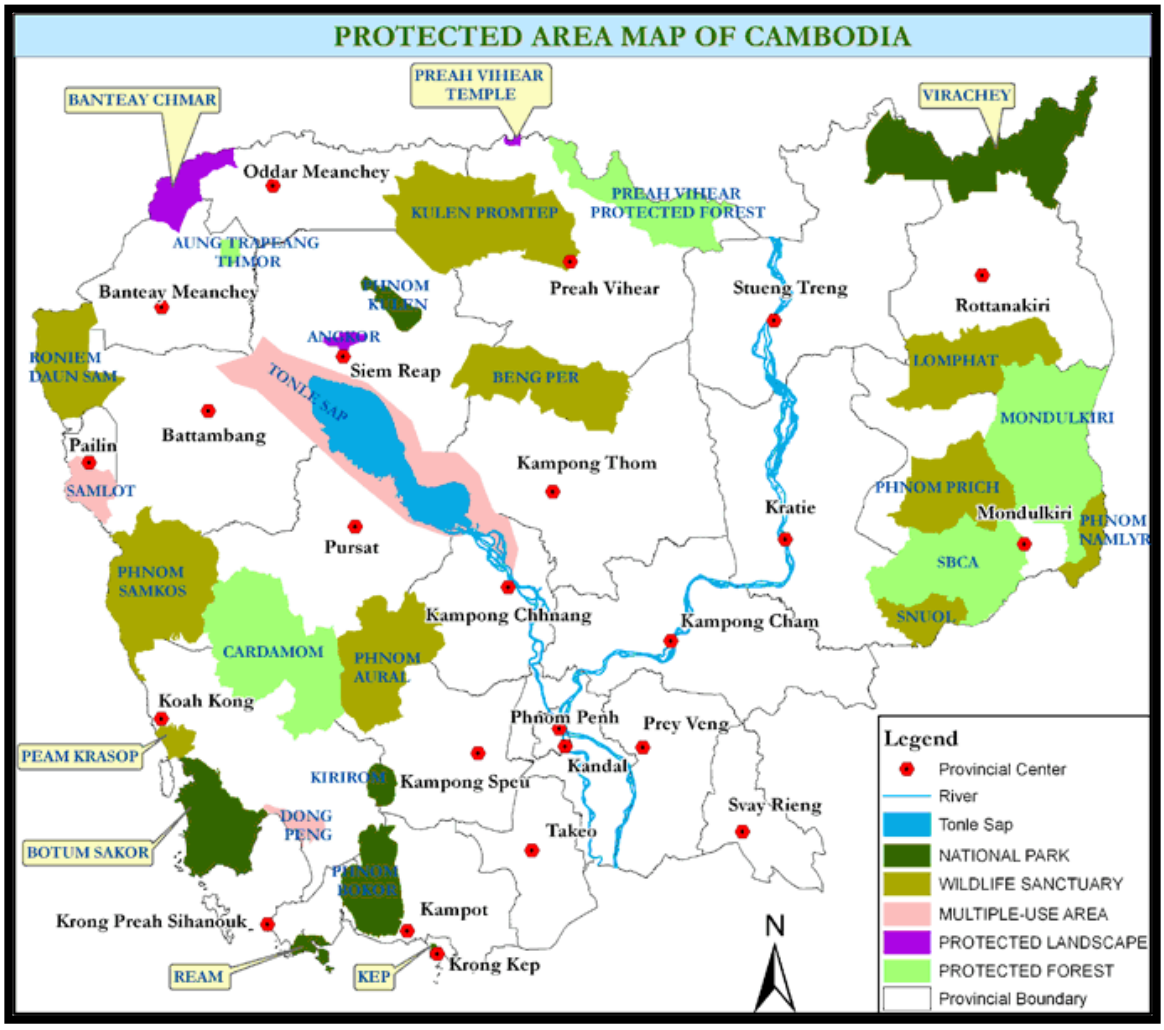


Fig. 2. Cambodian Protected Areas Map (Royal Decree 1993)

The Protected Areas System was ahead of its time but unfortunately, it effectively collapsed during the years of internal conflict within Cambodia after this. However, over the past decade, efforts to ensure the conservation of the country's biodiversity through Protected Areas have recommenced and intensified.

In 1993, twenty-three Protected Areas were established by Royal Decree to protect areas of environmental and cultural importance, with areas classified under four categories: Natural Parks, Wildlife Sanctuaries, Protected Landscape and Multiple Use Areas. These cover about 3,273,300 hectares, equal to 18 per cent of the country's territory. They come under the authority of the Ministry of Environment. Each of these types of Protected Areas has a different nature and control (Figure 2).

In addition, the Royal Government of Cambodia has designated an additional ten Protected Forest areas, administered by the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries. These cover 1.63 million hectares. Alongisde this are fifty-eight fish sanctuaries supported by the Ministry's Fisheries Administration (ICBD, 2014).

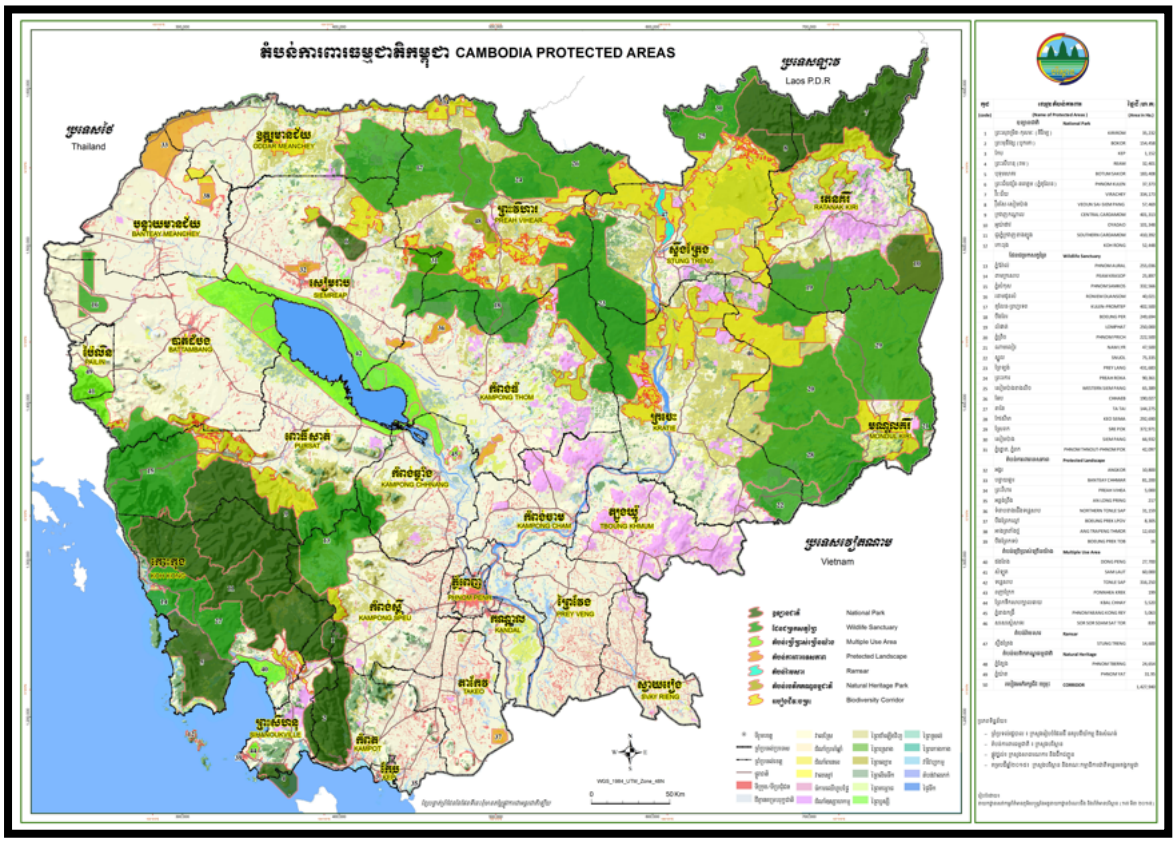


Fig. 3. Cambodian Protected Areas Map (2018)

The recent transfer of conservation areas from the Ministry of Agriculture, Forestry and Fisheries to the Ministry of Environment has more than doubled the Protected Area estate under the jurisdiction of the latter – this now covers almost 40 per cent of the entire country. Within the government reform process related to environmental management, the number of Protected Areas has continued to increase, reaching 41 per cent of the total country land area by 2018 (Figure 3). This represents a very major commitment to the protection of biodiversity, along with associated environmental services and cultural values, by the Royal Government of Cambodia.

Further detailed guidelines on the management of Cambodia's Protected Areas are set out in the Protected Areas Act of 2008. In 2018, the Ministry of Environment defined Protected Area Management Zones based on the respective ecosystems and geographical characters. The North Tonle Sap Region has a unique ecosystem, interlinking between nature and cultural heritage, with three different ecosystems interacting: mountain, plateau and wetland. These characteristics are of great importance and value with regard to the conservation and management of the region.

In recent years, Cambodia has been increasing its capacity for *ex-situ* conservation. For example, the National Council for Sustainable Development (NCSD) has established Orchid Research and Conservation Center, which has the objective of enhancing scientific research, native species conservation, education and entertainment. The Royal University of Phnom Penh (RUPP) has embarked on genetic studies, including, for example, the use of DNA sampling for the identification of crocodiles in captivity, and the use of fecal DNA to study populations of wild elephants. There are plans to develop a database of native orchids based on their DNA.

1.2. Objectives

Cambodia's natural resources and ecosystem are facing a range of significant threats, both as a result of actions in the immediate vicinity and as a consequence of pressures originating further away from activities related to human development. Despite the existence of management systems, these pressures on natural resources and biodiversity, especially within the Protected Areas themselves, are so great that they are continuing to degrade, and the ecosystem is becoming extremely fragile. The threats are affecting not only the biodiversity and the ecosystem of the country but also the livelihoods, economy and cultural life of the human population.

In particular, the North Tonle Sap Region, a unique region that is characterized by the co-existence of nature and culture and the ecosystem, is coming under great pressures from the over-exploitation of natural resources. Driving factors behind this phenomenon have been increasing population density and ever-higher demands from a more globalized market, as well as by unsustainable development activities. Specifically, this region has suffered from habitat degradation, illegal logging, land encroachment, population growth,

migration movement and settlement and climate change impacts, as well as invasions of alien species.

Responding to such pressures is an urgent matter if the values of biodiversity and ecosystem functions are to be maintained and conserved for sustainable use. However, this will be challenging. In this endeavor, the effective management of natural and biological resources and ecosystem functions is crucial and of priority. There are many practical reasons for obtaining a good understanding of ways to effectively manage these important resources.

This study discusses the effectiveness of the management of biodiversity and the ecosystem in the North Tonle Sap Region by exploring environmental issues; assessing the value of biodiversity and ecosystem services in the region, giving some examples; and defining effective strategies and measures to ensure the rational use of natural resources for sustainable socio-economic development and human well-being.

Effective management of biodiversity and the ecosystem in this study refers to adequate funding and human resources and sufficient support from policies, strategies and tools to respond to pressures and other conservation challenges. The results of this study represent evidence to orientate decision-makers towards promoting better management policies and best practices. Stakeholders will hopefully be able to use the results of this study to improve their own performance and to set priorities for the future.

1.3. Methodology

This study applies several data collection, analysis, evaluation and exploratory tools to assess how to better conserve and manage biodiversity and ecosystem services for sustainable development in Cambodia.

1.3.1. Stocktaking

The study has collected primary and secondary data related to natural resources, biodiversity, the ecosystem, the environment, climate change, societies, development and economics. A number of documents, including academic papers, journals, national legislation, technical reports, strategies and filed work reports, as well as results emerging from interviews with key experts and park managers, have been reviewed and analyzed.

Simple questionnaires were designed in Khmer language for data collection in the selected targets areas and Protected Areas. The first questionnaire was developed to gather information on social, economic and environmental issues, pressures on natural/biological resource conservation and possible actions to deal with challenges in the field. The second questionnaire was designed for a research paper on the impact of *M. pigra* in the Stung Sen Core Area. The third questionnaire was given to park managers, rangers and key biodiversity experts to collect information on human and financial resources for biodiversity, expenditure and income generation from ecotourism and strategy implementation.

1.3.2. Data Analysis

This study examines environmental issues, assesses biodiversity value and ecosystem functions and reviews status and biodiversity, genetic and ecosystem status and trends. It also reviews and analyzes conservation challenges, the relevant management structure, strategy and existing policies related to natural resources and environmental management. In addition, it examines the most relevant policies and specific laws and their provisions, to identify overlaps in jurisdictions, provisional gaps and unclear provisions.

In addition, other means, tools, methodologies, strategies, best practices and good examples from previous studies have been assessed, to identify learning that is applicable to respond to the specific natural resource pressures in our target areas.

This study reviews general data/information but focuses in particular on biodiversity issues in the North Tonle Sap Region, especially on measures taken to respond to biodiversity pressures; on the impact of climate change; on population, living conditions and local livelihoods; on the potential and opportunities for ecotourism development; and other approaches, such as Payment for Ecosystem Services within the region.

This paper also presents and explains special maps on land use and forest cover changes from 2016 to 2018.

1.3.3. Content Identification

This study describes biodiversity and ecosystem conservation in general inside and outside the Protected Areas System, where biodiversity is key to conservation. However, the analysis narrows down to the target area of North Tonle Sar Region only. Strategy

development and recommendations for the effective management of biodiversity and the ecosystem for sustainable development are key in this area. The study identifies the key aspects related to the effective management of natural resources in the region.

1.3.4. Research Papers and Case Study

Three pieces of research have been conducted, and their results have been used as evidence for the strategic orientation of and recommendations for biodiversity and ecosystem conservation for sustainable development. These research papers are as follows:

1. Policy Analysis for Biodiversity Conservation in Cambodia: The Protected Areas System;
2. Analysis of Fiscal Gap and Financing of Cambodia's Protected Areas; and
3. The Impact of *Mimosa pigra* on Local Livelihoods in the Stung Sen Core Area, Tonle Sap Biosphere Reserve.

Chapter 2: Cambodia's Biodiversity and Ecosystem Services

2.1. Cambodia's Biodiversity and Ecosystem Services

Biodiversity is the core of human well-being and socio-economic development, but its value is often underestimated. In line with the modern concept of the triple bottom line, benefits arising from biodiversity can be considered as categorized into three groups: environmental, economic and social benefits. Biodiversity plays an important role, providing many services such as food security, health, clean air, water, livelihoods and economic development, in pursuit of the Sustainable Development Goals as well as poverty reduction (ICBD, 2013).

Greater diversity of life provides increased opportunity and potential for environmental, economic and social benefits, to the benefit of all people. It is estimated that at least 40 per cent of the world's economy, and 80 per cent of the needs of the poor, is derived from biological resources, and that the same biodiversity enhances our ability to adapt to new challenges such as climate change (GBI, 2017). Compared with Cambodia, few places on Earth demonstrate so dramatically the fundamental link between people and nature: biodiversity supports Cambodians ecologically, economically, culturally and spiritually.

2.2. Biodiversity in Cambodia

Cambodia's rich biodiversity consists of the ecosystem, species and genetic levels, and includes plants, animals and microorganisms.

The country is unique, given the presence of one of the world's largest natural freshwater lake fish, in the Tonle Sap Great Lake. Large forested landscapes and grasslands support a rich biodiversity, including endangered and rare large mammals, birds, reptiles, insects and plants species. Freshwater wetlands are of great importance for a large range of fish, amphibians, regionally significant water-bird colonies and river dolphins. Coastal and marine habitats support major areas of seagrass, coral reefs, fish nurseries and turtles.

2.2.1. Genetic Diversity

The National Biodiversity Status Report of the Royal Government of Cambodia (RGC, 2016) provides a very broad overview of genetic diversity in Cambodia and

highlights the potential significance of genetics in agricultural diversity for domestic plants and animals, and also for wild relatives of some domesticated plants and animals. There is a positive trend towards increased understanding of genetic diversity and the importance of this for conservation. However, implementation is still limited with regard to domestic and commercial plants and animals.

The status of biodiversity presented in the Royal Government of Cambodia report was drawn from the Cambodian Agricultural Research Development Institute report, "Conservation and Utilization of Plant Genetic Resources for Food and Agriculture in Cambodia" (2011), under the Environmental Animal Health Monitoring Initiative. Significantly, this report shows that there are now *ex-situ* resources in the country, including 3,313 accessions (*ex-situ* at the Institute) and Kbal Koh Vegetable Research Station, which also has some *in-situ* conservation. There are also plans for herbaria and botanical gardens.

The previous status of animal genetic diversity derived from the Food and Agricultural Organization Domestic Animal Diversity Information System (1998) and a report on domestic livestock by Maclean in 1998 (see 6NR, 2016), which showed the presence of four cattle species and three pig species, alongside buffalo, horses, goats, chickens, ducks, geese and turkeys. Wild relatives were also identified, including wild cattle, water buffalo, boars and the red jungle fowl – the wild chicken.

The Environmental Animal Health Monitoring Initiative (2011) reinforced some of the previous status information on domestic animals.

With regard to conservation, DNA sampling of sixty-nine crocodiles in captivity to identify the pure fish-eating hill crocodile (*C. siamensis*) has had positive results: thirty-four Siamese, thirty-two hybrid with estuarine and three hybrids with Cuban. Fecal DNA studies of wild elephants have been used to estimate a population of 400–600 elephants in Cambodia.

2.2.2. Species Diversity

Few actual species lists exist and/or are available in Cambodia, thus it is difficult to make comparisons in this regard. Significant increases in species knowledge will be possible with increased capacity and research. The major gaps relate to knowledge on invertebrate species and endemism in species. Meanwhile, new species are still being

found. Overall, there is a positive trend towards increased species numbers and knowledge about these, but alongside this there are also potential extinctions becoming apparent.

Little is known about the status of plant species, but Siamese rosewood and other luxury timbers have been heavily targeted for commerce and are likely to be in decline. There is a positive trend towards increasing plant knowledge; there are 3,113 plant species currently listed for Cambodia.

The current status of invertebrates, while still weak, is an improvement on the past. The trend is towards an increasing understanding of invertebrate species; however, this remains the most significant gap area in terms of species knowledge. There are 671 invertebrates currently listed for Cambodia.

Experts from the Ministry of Environment have carried out research on amphibians and reptiles. The trend towards understanding reptile and amphibian species is positive. There are 72 amphibians and 173 reptiles currently listed for Cambodia.

No distinction has been made between freshwater and marine species, but it is noteworthy that more data is available for freshwater fish species. There are growing concerns that the trend towards a reduction in fish species diversity is a sign of an unsustainable harvest and potentially a tipping point for the fisheries industry. Furthermore, there is a trend towards increased damming of the Mekong and its tributaries, which could have further impacted on fish species diversity, as stream flows and migration routes are altered. As highlighted in Cambodia's Fifth National Report to the Convention on Biological Diversity, the Royal Government of Cambodia has taken quite strong action in this regard, by removing fishing concessions on the Tonle Sap Great Lake while also promoting aquaculture and community fisheries. The Royal Government has also acknowledged the significance of fisheries to people's livelihoods and is acting to better manage this resource. Across both fresh and saltwater systems, there are currently 1,357 species listed for Cambodia.

The following information on bird species is based on and updated from "The Birds of Cambodia: An Annotated Checklist" (Goes, 2013), which is a significant biodiversity resource for Cambodia. Protection of breeding colonies and nests has been part of the country's successful approach to conservation as used at Prek Toal and in the northern plains. In addition to these setbacks, bird conservation actions are also increasingly

encountering new challenges. Rapid development has shifted threats from merely local and species-focused issues to include those associated with landscape-level changes.

Birds seem to be the most well researched of the species lists, although a new species was identified in Phnom Penh only recently. There are 601 bird species currently listed for Cambodia, with seven on the new global Evolutionally Distinct and Globally Endangered (EDGE) list.

Previous mammal data placed the greatest importance on setting an agreed national mammal list. New mammal species are still being uncovered in Cambodia, however, for which seventy-two species have now been identified – which is more than the total for mammals in 2001. There have been significant mammal finds since 2001, which seem likely to continue, albeit with fewer new mammal species expected. In 2008, a survey of Seima Protected Areas identified previously unknown and internationally significant populations of black-shanked doucs and yellow-cheeked crested gibbons.

While there has been important mammal research, data has not been systematically collected and has not been effectively shared among relevant stakeholders. The respective declines in dugongs and river dolphins are concerning indicators for marine mammals in Cambodia. There is a need for classification standards and national discussions around the mammal list, including potential extinctions such as of the kouprey and rhinoceros. Mammal diversity in Cambodia, across both terrestrial and marine systems includes 162 species.

Table 1 presents the number of individual species by category.

Table 1. Inventory List of Cambodian Species (NCSD, 2016)

No.	Species by category	Data (species)	Proportion (%)
1	Plants	3,113	50.5
2	Invertebrates	671	11
3	Amphibians	72	1
4	Reptiles	173	3
5	Fishes	1357	22
6	Birds	601	10
7	Mammals	162	2.5
	Total species	6,149	100

2.3. Status, Trends and Future Dynamics of Biodiversity

The status and trends of biodiversity in Cambodia reflect the country's geography, history and awareness of the value of this natural asset. Across the country, biodiversity is considered at the ecosystem, species and genetic levels, and includes plants animals and microorganisms. However, as we have seen, there is a large discrepancy with regard to the availability of data for each component. The National Forestry Program 2010–2029 (NFP) sets out a plan for the long-term management of Cambodian forests. Figure 3 above presented the structural condition of forests in Cambodia. In many parts of the country (e.g. in Koh Kong, Pursat, Ratanakiri, Stung Treng, Kampong Thom and Preah Vihear provinces), forests are generally still dense and have seen relatively little or no disturbance. They are home to a rich biodiversity and are thus expected to be more resilient to climate change.

The Forestry Administration targets under the NFP include 2 million hectares of community forests (up from about 400,000 hectares); 3 million hectares of protection forests (up from c.1.5 million hectares); 2.6 million hectares of production forests under sustainable forest management; and 3 million hectares of Protected Areas managed by the General Department of Administration for Nature Protection under the Ministry of Environment. This could provide significant gains for biodiversity conservation as well as significant climate change benefits through emission reductions under the framework of REDD+ (Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks). Large proportions of forested land are within Protected Areas, and as such carbon stored in the forest is protected. Cambodia has one of the highest levels of forest cover in Southeast Asia, with approximately 10.1 million hectares of forest in 2010, which makes it the 13th most forested country by percentage of land area. Forest ecosystems are home to many flora and fauna, and thus serve as a gene pool for biodiversity conservation. Forests play a significant role in rural livelihoods, providing construction wood, fuelwood, food and medicine, as well as ensuring ecosystem functions such as watersheds, storm and coastline protection.

Forests in the northern plain of Cambodia, for example, which the Royal Government of Cambodia recognizes as the Northern Plain Dry Forest Priority Corridor, harbor a unique assemblage of threatened vertebrates, including the banteng, gaur, Eld's deer, Asian

elephant, dhole, clouded leopard, giant ibis, white-shouldered ibis, sarus crane, greater adjutant and green peafowl, and the world's only stable populations of three critically endangered vultures. In addition, the northern plain forests supply both underground and surface freshwater in the catchment. They prevent siltation from erosion in the rivers and Tonle Sap Great Lake.

Total forest cover is declining at a fast rate in Cambodia. It decreased from approximately 72 per cent in 1973 to 48 per cent in 2014. Meanwhile, alongside this, dense forest decreased from 42 per cent to 16 per cent over the same period, and the level of mixed forest cover (inclusive of some plantations) stayed relatively stable, going from 30 per cent in 1973 to 31 per cent in 2014. Since 2000, 45 per cent of the remaining primary forest loss has occurred in and around Protected Areas. In a great majority of these cases, the forests have been cleared primarily to make way for rubber plantations and timber felling (6NR, 2019).

Human development and well-being depend on healthy natural systems. Globally, nature provides services worth around US$ 125 trillion a year (WWF, 2018). However, the situation of nature is declining at a rate unprecedented in human history, with major impacts on ecosystems and societies around the world. Any delay in addressing the current biodiversity crisis will increase the cost of reversing this decline in the natural world and will threaten past development gains. In addition, the collapse of ecosystems will lead to unpredictable tipping points, with even higher societal and economic impacts. Reversing biodiversity loss is therefore urgent – but it is also doable: biodiversity can be restored while achieving other socio-economic goals (IPBES, 2019).

2.4. Biodiversity Value and Its Ecosystem Service Benefits to People

Biodiversity supports human societies from a wide variety of perspectives, including the ecological, economic, cultural and spiritual. Every ecosystem has the ability to provide a habitat for plants, animals and microorganisms that we can use, or that perform useful functions.

Economically speaking, biodiversity and its ecosystem services contribute to the local economy through ecotourism and the provision of natural resources, including medicinal resources and non-timber forest products, for either subsistence use or commercial

purposes. Cambodian biodiversity and ecosystem services are intimately linked to and maintain the sustainability and productivity of agriculture and inland fisheries. Forest resources are also still important sources of energy for Cambodian households, many of which still rely on fuelwood for cooking. Almost half of rural dwellers depend on forests for 20–50 per cent of their total income, whereas 15 per cent of them earn more than 50 per cent of their income from the forests. The forests are also known to mitigate droughts and floods. Forests and their products are used to respond to many demands within and outside the country. The value of biodiversity components is generally well perceived in Cambodia. Economic studies have been carried out to provide decision-makers at every level with opportunities to ensure the country's development.

There exist a number of economic valuation studies related to forest, fishery and mountain ecosystems, as well as on Protected Areas and corridors that link Protected Areas and/or other conservation areas in Cambodia. Not all ecosystems are covered equally, however.

2.4.1. Agro-Ecosystems and Agro-Biodiversity

Agriculture (including crop and livestock production and fisheries) is the dominant livelihood in Cambodia. It contributed close to 30 per cent of gross domestic product in 2015. Rice is by far the most important crop, and the country has achieved food security with respect to the production of this. The production of other food crops, such as soybeans, mung beans, maize, sesame, peanuts, chili, sweet potatoes, cassava and cowpea, is expanding rapidly, particularly in areas poorly suitable to lowland rice. Industrial crops include rubber, sugarcane, cotton, tobacco and jute.

Cambodia also has a wealth of local knowledge regarding so-called "neglected and underutilized plant species". These plants, including a long list of native cereals, roots and tubers, pulses, fruits, vegetables, nuts, seeds and spices, can be grown on marginal and degraded lands while contributing to increased agricultural production, crop diversification and a better environment. In addition, they are usually nutrition-dense, climate-resilient, economically viable, locally available and/or adaptable as "Future Smart Food". As such, they are attracting more and more interest in relation to research and mainstreaming into plans for the implementation of the Sustainable Development Goals.

Noting that, since 2012, growth in agriculture has started to slow down, essentially because the expansion of cultivated lands that determined agricultural growth in the past has reached its limits, Cambodia is paying more attention to ways and means to enhance sustainable agriculture and thus grow more food on existing land, using fewer resources and in an ecologically friendly manner. Various projects and the application of best/good practices are under way in various parts of the country. These include relevant cropping/farming systems and integrated management of pests and waste. Cambodia has developed lists and worked on the collection of weeds, insect pests and plant pathogens as well as carrying out projects to address them as part of sustainable agriculture. Work on soil agro-biodiversity is still in its infancy but its importance has been mainstreamed in sectoral plans, bearing in mind that Cambodian soils are relatively low in fertility and that conventional rice cultivation destroys its structure.

Animal husbandry has always been an essential part of Cambodian economic life. Traditionally, draft animals, such as oxen and water buffalo, have been used intensively for land preparation for cultivation.

With a view to propelling its green growth, Cambodia is investing in ways and means to cope, in a holistic manner, with declining agricultural yields, the emergence of pests and diseases and the occurrence of abiotic stresses like drought, floods and pollution. It is doing this by considering traditional knowledge and crops, experiences from other countries and new technologies including biotechnology.

In line with the Rectangular Strategy Phase III and the National Development Plan, Cambodia will continue giving precedence to the agriculture sector, with an strong emphasis on agricultural productivity, diversification and commercialization, the promotion of livestock-raising and aquaculture, land reform and the sustainable management of forestry and fishery resources. All of these factors represent key elements in the development of the national economy and in poverty reduction, while at the same time reducing the contribution of agricultural systems to greenhouse gas emission and other degradation.

2.4.2. Mountain Ecosystems

Cambodia has three major mountain ranges: the Dangrek Range on the northern border with Thailand, the Cardamom Range in the west and the Eastern Highlands along

the border with Laos. Apart from the mountains in the Cardamom Range, all of these mountains have a relatively low elevation. Many Protected Areas have been established along these mountain ranges. Biodiversity in the mountains is still relatively poorly researched in Cambodia. Meanwhile, there is not much wildlife in the Dangrek Mountains in the north.

Mountains offer vital ecosystem services. For example, the annual value of the goods and services provided by the Cardamom Mountains, including timber, crops, carbon storage, non-timber forest products (e.g. game animals, nuts, seeds, berries, medicinal plants), water and recreation, is estimated to be more than US$ 1 billion.

The mountains of Cambodia have been severely exploited. Illegal and uncontrolled logging is taking place both within and outside the mountainous Protected Areas. Hunting for game meat has significantly affected the population of wildlife as well. Meanwhile, many agricultural activities are also taking place on the mountain slopes. The Cardamom Mountains are becoming increasingly vulnerable to illegal logging, hunting, forest clearing and land encroachment.

2.4.3. Urban Ecosystems

There is little information available on biodiversity in urban ecosystems in Cambodia. However, we do know that, as Cambodia is experiencing rapid industrialization and economic growth, this is being accompanied by migration of rural populations to the cities, which is resulting in poorly controlled expansions of urban areas, in disconnection with urban planning and the development of basic infrastructure. Sewage and domestic waste, in addition to industrial effluents, is contaminating the air as well as both surface and ground water in many urban areas. Urban expansion and infrastructural development that is poorly planned or not planned at all is leading to ecosystem degradation and the loss of biodiversity and its contribution to people's well-being. Urbanization, infrastructural development and rapid economic growth are also modifying consumption and production patterns, lifestyles and dietary habits. There is some evidence that some invasive species have been introduced primarily in urban areas.

2.4.4. Grasslands and Savannas

A savanna is a rolling grassland scattered with shrubs and isolated trees.

In Cambodia savanna grassland predominate in the central lowland region, in the transitional plains and in the Eastern Highlands, where the high plateaus are covered with grasses and deciduous forests. Grasslands and savannas are home to many grazing animals; a few of them are endemic. Habitat loss and excessive hunting have significantly reduced their numbers. The number of bird species is estimated at 500, some of which are endemic. Reptiles and amphibians require more study. Large areas of this region are protected, including for example Kulen Promptep Wildlife Sanctuary and Beng Per Wildlife Sanctuary.

2.4.5. Inland Freshwaters and Wetlands

Water resources are an essential component of the nation's environment and natural resource base. A long dry season and pollution from various sources limit the amount and quality of water available for human consumption, agriculture and other uses, and aquatic life. Wetlands cover more than 30 per cent of Cambodia. They include streams, ponds, freshwater swamps, marshes, the Mekong River and its floodplain, the Tonle Sap (the Great Lake) and its floodplain, the Stung Sen River and the coastal estuaries of Stung Koh Pao and Stung Kep.

2.4.6. Rivers, Lakes and Other Inland Waters

The Tonle Sap Great Lake, the Tonle Sap River and the Mekong River dominate the Cambodian landscape. The Mekong River is the longest river in Southeast Asia, and approximately 500 km of its length is through Cambodia. Nearly 500 of the 1,200 fish species found in the Mekong River are in Cambodia, with a high degree of endemism, particularly in the upland areas of the northeast and in the mountains bordering Thailand. A total of 106 of the 435 bird species found in Cambodia are water birds, and the wetlands of the Lower Mekong Basin support 15 globally threatened species, including the critically endangered giant ibis (*Pseudibis gigantean*). Over twenty species of turtles live in the Lower Mekong Basin, ten of which are listed on the International Union for Conservation of Nature (IUCN) Red List. Of the 160 mollusks identified in the Mekong River and its Mun tributary, about 70 per cent of species are endemic.

The Mekong River provides a wide range of benefits at both national and community levels. It serves as a migratory channel for fish between rivers, tributaries and lakes. The

Mekong River swells during the wet season (May to October) and its waters flow into the Tonle Sap River, forcing it to reverse its course and flow back into the Tonle Sap Great Lake. The lake expands from 2,500 square kilometers in the dry season to 13,000 square kilometers in the wet season, creating a vast wetland area rich in biodiversity. The wet season flow reversal brings into the lake sediments, nutrients and an abundance of fish from the Mekong River. Cambodian fishers and farmers have used the seasonal relationship between the Tonle Sap River and the Mekong River to develop dependable cultural and economic practices for their livelihoods.

The Tonle Sap Great Lake is the largest inland freshwater body in Southeast Asia. It is drained by the Tonle Sap River into the Mekong River. A complex of mountain forest watersheds regulates a system of river tributaries to the Tonle Sap Great Lake and thus plays an important role in the survival of the lake's rich biodiversity and fisheries. The Tonle Sap ecosystem is a unique ecological phenomenon believed to be one of the most productive inland waters and one of the most fish-abundant lakes in the world. The lake and its floodplains serve as migratory routes as well as spawning and nursery grounds for various aquatic animals. They provide directly or indirectly to the benefit of the livelihoods and food security of about half of the population in Cambodia. The Tonle Sap Great Lake is a Ramsar site (under the Ramsar Convention on Wetlands of International Importance) and the whole ecosystem has been nominated as a biosphere reserve.

There are many other lakes, streams and ponds, some of which are seasonal, throughout Cambodia. These have not been studied as much as the large wetlands have. They are important for domestic, agricultural and industrial water supply; for agriculture and fisheries; as wildlife habitats; or for the conservation of genetic resources. They can also serve for use in aquaculture.

Wetland products harvested by local communities include water, fish, water birds, edible plants, medicines and firewood. However, Cambodian freshwater wetlands are under threat from various pressures, including unsustainable fishing methods; excessive harvesting of biological materials (e.g. the collection of migratory birds' eggs and the overharvesting of medicinal plants); water pollution from domestic waste, agricultural run-off and mining, as well as other industrial activities; invasive alien species, such as *Mimosa pigra*; land conversion; and infrastructure development, including of hydropower dams.

In Cambodia, fish is an important diet staple, accounting for 61 per cent of households' animal protein intake, and represents the second most consumed food after rice. Fishing and fisheries, both freshwater (mainly from the Tonle Sap, the Mekong and the Bassac Rivers) and marine, make up another cornerstone of Cambodia's rural economy.

2.4.7. Aquaculture

Fisheries play a significant role in supplying Cambodians with food, as well as in supporting the national economy. However, fisheries in the Mekong, Tonle Sap and Brassac Rivers and their associated floodplains are under a significant amount of anthropogenic pressure, which is leading to a projected decline in fish stocks and in the volume of fish caught. In 2014, the annual yield of all fisheries, including fish and other aquatic organisms, was estimated at 745,065 tonnes. Aquaculture contributed around 120,055 tonnes, and its relative contribution is increasing annually. Aquaculture production in Cambodia is still predominantly small in scale. It grew from around 26,000 tonnes in 2005 to 120,055 tonnes in 2014 with a value estimated at US$ 240 million. Mariculture gives lower yields than freshwater aquaculture in terms of both volume and value.

2.4.8. Marine and Coastal Areas

Cambodia has a 435 kilometer coastline, along which can be found a number of closely interrelated ecosystems, consisting of beach forests, strand vegetation, mangroves, estuarine ecosystems, seagrass beds and coral reefs. These complex coastal and marine ecosystems maintain a rich biodiversity of ecological and economic significance. These ecosystems, which have remained relatively isolated, are now being explored for research. Preliminary biodiversity studies have identified more than 60,000 ha of some 30 species of mangroves; seagrass beds, of which 8 species have been identified; some 70 species of corals belonging to 33 genera and 11 families; 4 species of marine turtles; 435 fish species from 97 families, with an estimated stock of marine fish of 50,000 metric tonnes; and a number of marine mammals, including whales and dolphins, as well as crustaceans and mollusks.

In the coastal zone, mangroves provide important spawning grounds for fish and protection from floods, and there are vast mudflats and estuaries, which are very productive systems and are rich feeding grounds for many vertebrates. Coastal wetlands also act as barriers against storm surges and protect the coastline from erosion. Using United Nations Environment Programme estimates of the annual net economic value of seagrasses (US$ 1,186/hectare) and mangrove forest (US$ 882.35/hectare), Mangroves for Future estimated the total net economic value of mangroves (78,405 hectares) and seagrasses (33,814 hectares) at approximately US$ 69.2 million/year and US$ 40.1 million/year, respectively, in Cambodia. According to a coastal study undertaken by the Asian Development Bank in 2000, the benefits of the coastal and marine biodiversity to the local communities is an estimated US$ 12 million annually, together with an economic value of US$ 100 million annually for fisheries exports (Strategic Planning Framework for Fisheries 2010–2019).

Marine areas and coastal wetlands are threatened by various activities, including tree felling for charcoal production; mangrove clearing for shrimp; finfish and crustacean farming; and destructive fishing practices, including trawling and motorized push nets in shallow waters that destroy the seagrass beds. Establishment of national parks and other conservation areas has been used as a way to address these threats. As an example, between 2000 and 2010, the area of mangroves declined from about 85,100 hectares to 78,405 hectares owing to their unmanaged exploitation (e.g. for charcoal production) and conversion to other land uses (e.g. shrimp farms and settlement in response to population growth).

2.5. Natural Resources Management Arrangement

In line with the objectives of the National Biodiversity Strategy and Action Plan and the NFP, natural resource management and the conservation of biodiversity focus on the implementation of existing and emerging sustainable natural resource management models, and assessing the values of biodiversity and the functions the ecosystem provides to human well-being, to increase the contribution of biodiversity to poverty alleviation, enhanced livelihoods and economic development, while safeguarding environmental services. All this is occurring through the National Protected Area Strategic Management Plan; updating and implementation of the National Biodiversity Strategy and Action Plan (NBSAP) and

management of production forests; monitoring, assessment and reporting for sustainable natural resources management, biodiversity and wildlife conservation; conservation and development of genetic resources and seed sources; tree planting and development of forest plantations; development of forest product and market promotion; wood technology development and forest product processing; and forest certification.

Cambodia recognizes that Protected Areas are integral parts of broader landscapes managed by agencies, organizations and individuals, to which these areas also provide ecological goods and services. Protected Areas System Management is one of the highest priorities for the Royal Government of Cambodia, to ensure natural resources and cultural values are conserved and well managed throughout the country. As recorded in Royal Government's Sixth National Report to the Convention on Biological Diversity, more than 40 per cent of the country is now classified as Protected Areas under different categories, in zones ranging from strict conservation areas to multiple use areas and corridors for connectivity.

From 2016, Cambodia designated thirty-four new Protected Areas, including Koh Rong Marine National Park, and declassified two Protected Areas. As compared with the situation before 2016, Cambodia has added 23.3 per cent of its territory to the country's Protected Area System. Most of the new Protected Areas contain a great deal of forested areas. Together with the protected forests transferred to the Ministry of Environment in 2016, the area of forests under protection has exceeded the 3 million hectares targeted for 2029.

As of December 2018, Cambodia's Protected Area System counted fifty-six Protected Areas covering 7.4 million hectares – or 40.9 per cent of the territory. These are in the following categories: National Parks (twelve), Wildlife Sanctuaries (twenty), Protected Landscapes (ten), Multiple Use Areas (eight), Ramsar Sites (one), Natural Heritage Sites (two), Marine National Parks (one), Genetic Conservation Areas (one) and Biodiversity Corridors (counted as one, but also considered as subdivided into three, the North-East Corridor, the North-West Corridor and the Cardamom Corridor). Protected Areas cover a large portion of forests and thus areas containing large amounts of aboveground biomass carbon as well as belowground carbon. They also contribute to storing carbon and reducing deforestation, forest degradation and, as a result, greenhouse gas emission from biomass (climate change mitigation) while conserving biodiversity (a requirement for adaptation).

Many key biodiversity areas have now been included in the Protected Areas system (including the corridors).

The Protected Areaad Law 2008 provides the legal foundation for the management, conservation and development of the country's Protected Areas. Specifically, the Protected Area Law promotes the use of global IUCN categories for designating Protected Areas and stipulates the use of management zoning systems for each Protected Area to ensure adequate protection of areas of high conservation value; appropriate development of areas of high economic value; and inclusive participation and benefits for local communities and indigenous ethnic minorities.

Article 11 of the Protected Area Law declares that each Protected Area shall be divided into four management zoning systems:

1. A core zone for the management of what is of high conservation value, containing threatened and critically endangered species and fragile ecosystems;
2. A conservation zone for the management of what is of high conservation value, containing natural resources, ecosystems, watershed areas and natural landscapes located adjacent to the core zone;
3. A sustainable use zone for the management of what is of high economic value, for national economic development and management, and the conservation of the Protected Area(s) itself, thus contributing to the local community and indigenous ethnic minorities' livelihood improvement;
4. A community zone for management for the socio-economic development of the local communities and indigenous ethnic minorities; this may contain existing residential lands, paddy fields and field gardens or swidden (chamkar).

Since 2016, the Protected Area System has been classified into five clusters (zoning regions):

1. The East Mekong River Zone;
2. The North Tonle Sap Zone;
3. The South Tonle Sap Zone;

4. The Wetland Zone; and
5. The Marine and Costal Zone.

Cambodia is very conscious that designation alone is not sufficient, and there is a need to continue strengthening law enforcement and apply adequate management. Cambodian rangers have been using effective tools in their patrolling of Protected Areas, such as the Spatial Monitoring & Reporting Tool, with encouraging successes.

The integration of Protected Areas in national development goals and strategies is evident in the Rectangular Strategy Phase IV, which defines the framework for all strategies, plans and programs that Cambodia is implementing. Protected Areas are also well integrated into strategies and action plans for climate change and land degradation. The jurisdictional reform of the natural resource management sector, undertaken by the Royal Government of Cambodia in 2016, reflects the latter's commitment to ensuring the best management and conservation of the country's natural resources. The place given to Protected Areas in the draft Environment and Natural Resources Code of Cambodia is also a clear indication that everyone and all sectors are required to contribute to the success of the Protected Area System in Cambodia for the benefit of all Cambodian citizens.

Respect for and integration of indigenous and local knowledge is key. The Royal Government of Cambodia is engaging local communities and indigenous ethnic minorities, so they are involved in and stay involved in consultations on Payment For Ecosystem Services, the REDD+ program, the zoning of Protected Areas, the mapping and valuing of ecosystem services and management plan development. Researchers are studying their perceptions of some of the measures taken to protect biodiversity and ecosystem services to inform policy- and decision-makers. However, there remains still a need to document and learn more about indigenous and local knowledge, practices and innovations, and to find ways to integrate these into strategies, plans, and programs for natural resources management.

Most of the Cambodian national Protected Areas now under the authority of the national Ministry of Environment were originally created under the Royal Decree Concerning the Creation and Designation of Protected Areas 1993. The Nature Protection Areas (Protected Area) Law of 2008 provides the legal foundation for the management, conservation and development of the country's Protected Areas under the Ministry of Environment.

Under the Forestry Administration, the NFP has the following targets: 2 million hectares of community forests (up from about 400,000 hectares); 3 million hectares of protection forests (up from c.1.5 million hectares); 2.6 million hectares of production forests under sustainable forest management; and 3 million hectares of Protected Areas managed by the General Department of Administration for Nature Protection under the Ministry of Environment.

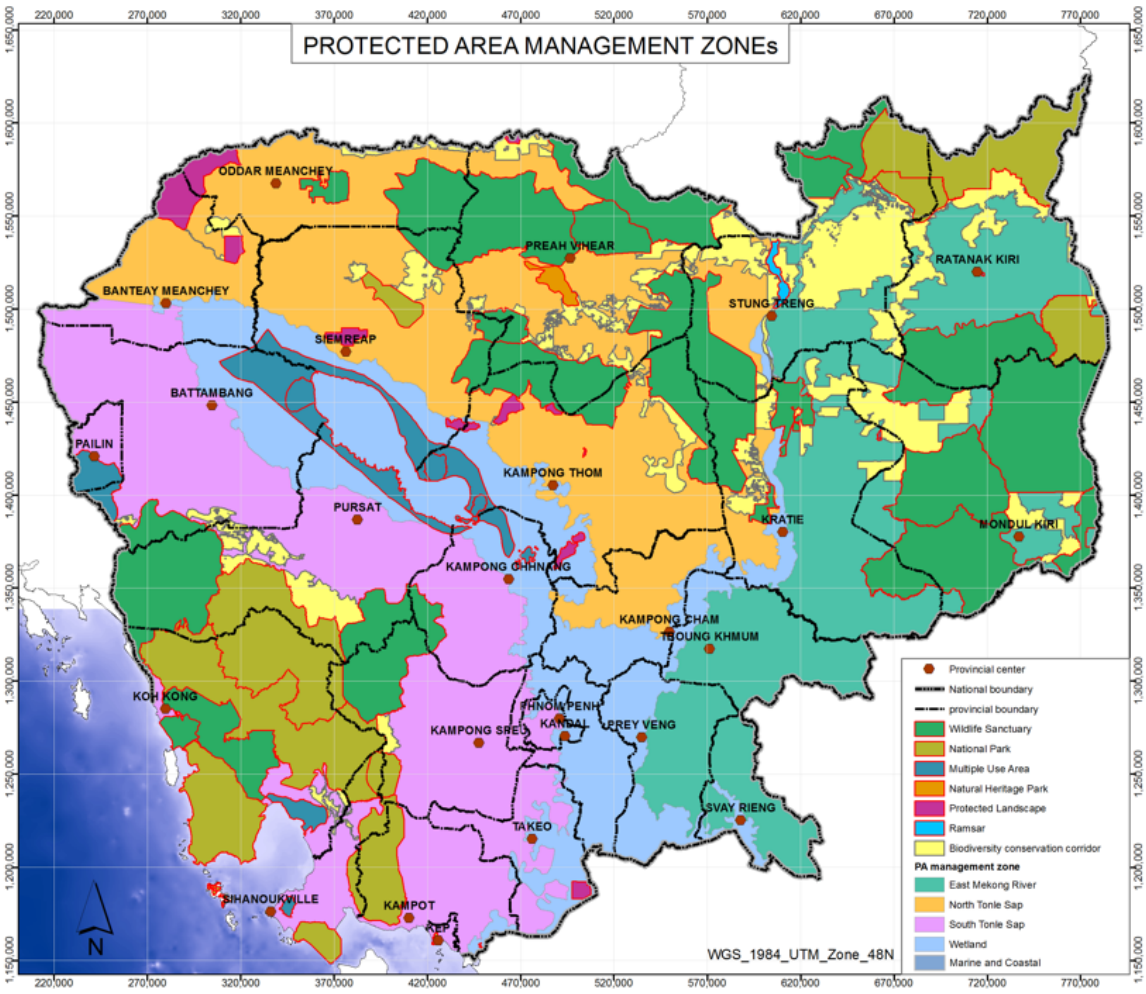


Fig. 4. Protected Area Management Zones

This will provide significant gains for biodiversity conservation as well as significant climate change benefits through emission reductions in the framework of REDD^{+}. Large proportions of forested land are within Protected Areas, and as such carbon stored in the forest is protected.

Chapter 3: Biodiversity and Ecosystem Management in the North Tonle Sap Region

3.1. The North Tonle Sap Region

The North Tonle Sap Region is located (fully and partially) in eight provinces: Banteay Meanchey, Kampong Chhnang, Kampong Thom, Kratie, Preah Vihear, Siem Reap, Stung Treng, and Otdar Meanchey. The total land area of this region is approximately 78,445 square kilometers (Annex 5) and it is composed of mountains, plateaus, plains and wetlands, in a complex landscape ecosystem that represents a harmonization between natural and cultural heritage. The North Tonle Sap Region offers a very significant value and unique ecosystem, which can make a huge contribution to social and economic development and the conservation of natural and cultural heritage.

This region is rich in biodiversity and home to many species, including rare, endangered and near extinction species. However, as we saw in the previous section, there remain many species to be identified and classified, given limitations within the country in relation to research and technical experts.

The North Tonle Sap Region is a cultural and natural heritage site with a beautiful landscape, that contains a mixture of places of interest that have the potential to attract many national and international tourists to visit the region. Angkor Wat and the plethora of ancient temples around the Tonle Sap Great Lake represent a center for economic, social, and cultural activities. This site also attracts migration from other provinces, promising employment and growth in the ecotourism, handicrafts and vocational education sectors. The area has population density of sixty persons per square kilometer, while the population in the eight provinces was around 4,114,243 people in 2019 (Annex 5).

The North Tonle Sap Region has been selected for this study because of its unique ecosystem, and its high value for conservation, especially with regard to the watershed system in Phnom Kulen National Park, which provides clean water to cover daily consumption in nine towns in the surrounding area, including Siem Reap City itself. It also represents a significant source of water supply to fill the Tonle Sap Basin, the Angkor temples canals and the Baray Reservoir.

People living within the North Tonle Sap Region have very few income-generating possibilities beyond natural resources, and are economically almost fully dependent on ecotourism, agriculture, forestry and fisheries.

The region's inland fisheries support a thriving industry of great economic and social importance and has a potentially bright future. Cambodia's freshwater capture fisheries' production of over 400,000 tonnes per year is large, even by world standards. The country may even be among the world's ten largest producers. The most recent estimates of the National Institute of Statistics in Cambodia indicate that fisheries contribute 16 per cent to national gross domestic product.

When the Tonle Sap Great Lake was formed some 5,000 to 6,000 years ago (Rainboth, 1996), it is likely to have abounded with fish. The rise of the Khmer Angkor Empire may, to a large extent, have been possible as a result of the availability of a rich fishery resource and well-developed rice irrigation schemes. The abundance of fish pictured on the reliefs of the Bayon and Angkor Wat temples and the proximity of the temple complex to the Tonle Sap Great Lake in Siem Reap province are testimony to this. Currently, the Tonle Sap is one of the biggest fresh-water fish suppliers in the world and it is an important habitat for many water birds, including migratory birds that travel across Southeast Asia. The Tonle Sap contributes over half of the fish produced in the country. More than 1.2 million people in the Tonle Sap area alone depend on fishing for their livelihoods.

3.2. Biodiversity and Ecosystem Management in the North Tonle Sap Region

The North Tonle Sap Region has sixteen Protected Areas, including four Protected Landscapes, one National Park, six Wildlife Sanctuaries, two Multiple Use Areas, one Natural Heritage Park, one Ramsar site and one Biodiversity Corridor, covering 1,635,562.41 hectares (Annex 6).

Since this region represent the co-existence of human culture and nature, the management system is focused mainly on participation and engorgement from all relevant stakeholders to conserve the area. In this regard, the Royal Government of Cambodia has established a coordination mechanism among relevant sectors, including private and academic institutions. There exist seventy-seven Community Protected Areas within the sixteen Protected Areas that have been established, of various types and operating by means of various functions (Annex 2).

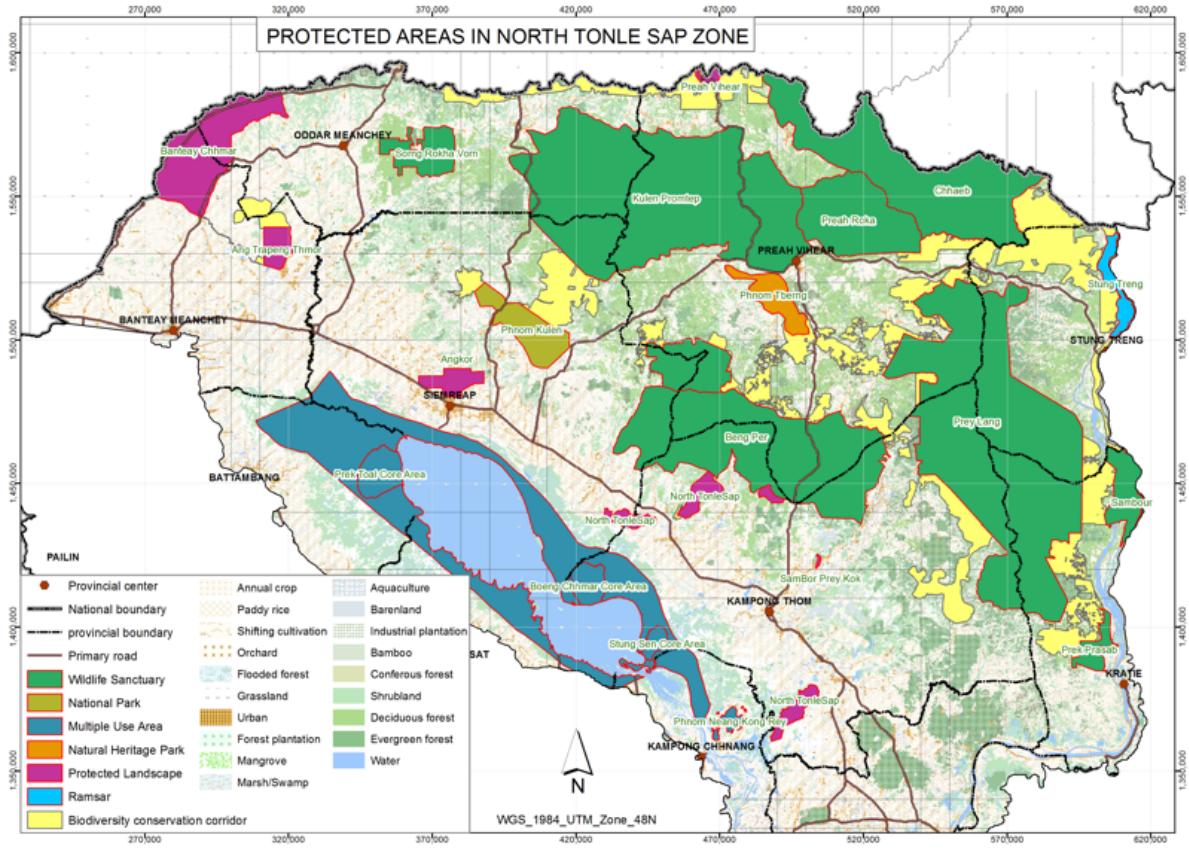


Fig. 5. Map of the North Tonle Sap Region

Management of these important resources in the North Tonle Sap Region is a crucial matter. It requires an understanding of the issues at stake and the identification of rational and relevant means to enable appropriate action.

3.2.1. Environmental Issues Faced

Natural resources, agriculture and tourism are mainstays of Cambodia's economy, but in recent history many of Cambodia's natural resources have been heavily exploited and they are consequently being rapidly degraded.

Cambodia's forest cover declined from 49.48 per cent in 2014 to 48.14 per cent in 2016, owing to clearance for agriculture, settlement expansion, infrastructure development, illegal logging and the unsustainable harvesting of wood fuel. This deforestation is closely linked to other key environmental issues such as land degradation, soil erosion, extinction of wildlife

and general loss of biodiversity and ecosystem services, which have resulted in reduced resilience to disasters and climate change.

The North Tonle Sap Region has been severely exploited through illegal and uncontrolled logging, land encroachment and pollution, and affected by climate change and invasive alien species. These consequences have led to habitat loss, land degradation, ecosystem fragmentation and to the decline and in some cases extinction of species and genetic diversity.

The rapid industrialization of the region; the expansion of agricultural farms and of production that requires the clearing of natural habitats; the growth in settlements as a result of an increasing population and higher migration, and the consequent need for increased resource consumption; and intensive logging and deforestation are all affecting the quality of soil and water streams. They are increasing the levels of chemical pesticides and of sediment washed loose from degraded and bare soils towards the Tonle Sap River and its basins, resulting in a loss of the ecosystem functioning and a reduction in species and genetic diversity.

Cambodia is among the countries in Southeast Asia that are the most vulnerable to climate change. The country's economy and the livelihood of the majority of its population depend on climate-sensitive sectors, including agriculture, forestry, fisheries and tourism, which threaten their resilience.

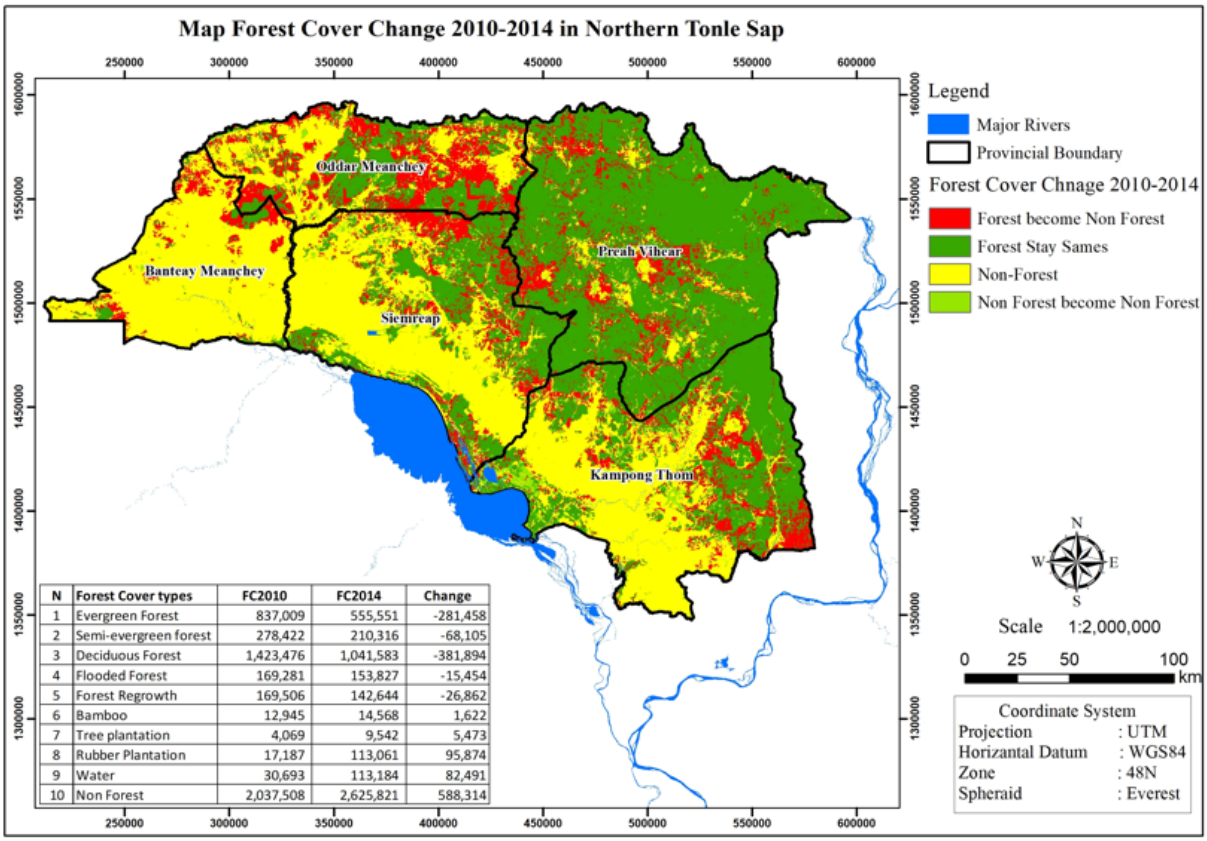
Cambodia's terrestrial, marine and coastal ecosystems face a great deal of direct threats and indirect pressures. These are described below. The following section captures the main pressures on and drivers of change with regard to biodiversity (direct and indirect), in particular.

3.2.1.1. Direct drivers of natural resources pressure

3.2.1.1.1. Land use and land cover changes

Between 1964 and 2014, Cambodia lost 20 per cent of its forest cover. The deforestation rate increased by almost 3 per cent annually between 2010 and 2014. This is one of the highest such rates globally. Cambodia's ecosystem conversion and degradation were driven mainly by:

1. Extensive land use changes for industrial agriculture, aquaculture, rubber, sugar cane, cassava and other commodities, both legal and illegal;
2. Economic land concessions granted for agro-industrial plantations, including some granted within Protected Areas. Their number increased steeply in the 2000s. In-migration of people to formerly remote forested areas as a result of economic land concessions and infrastructure development led to increased clearance for settlement;
3. Hydropower dam construction and development of roads and other infrastructure, particularly towards mining sites;

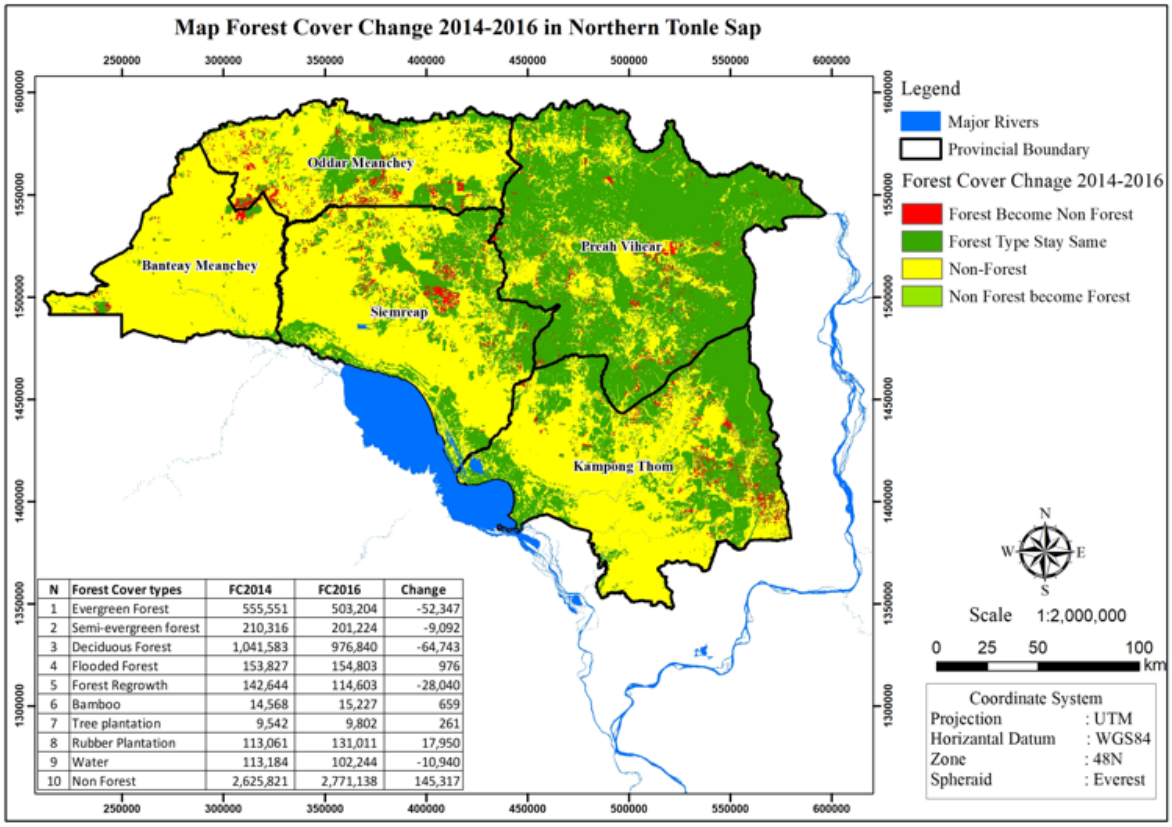


N	Forest Cover types	FC2010	FC2014	Change
1	Evergreen Forest	837,009	555,551	-281,458
2	Semi-evergreen forest	278,422	210,316	-68,105
3	Deciduous Forest	1,423,476	1,041,583	-381,894
4	Flooded Forest	169,281	153,827	-15,454
5	Forest Regrowth	169,506	142,644	-26,862
6	Bamboo	12,945	14,568	1,622
7	Tree plantation	4,069	9,542	5,473
8	Rubber Plantation	17,187	113,061	95,874
9	Water	30,693	113,184	82,491
10	Non Forest	2,037,508	2,625,821	588,314

Fig. 6. Forest Cover Change from 2010 to 2014 in the North Tonle Sap Region

4. Unsustainable agricultural practices that reduce soil fertility and crop productivity in the long term. These include continual use of chemicals (pesticides and inorganic fertilizers); slash-and-burn tillage systems that remove a

great deal of soil nutrients and soil cover, resulting in a high risk of soil erosion. A total of 60 per cent of the soils covered by Cambodia's soil database (mainly agricultural lowland areas) are very low in total N, about 88 per cent are low in extractable P and about 86 per cent are low in organic C.



N	Forest Cover types	FC2014	FC2016	Change
1	Evergreen Forest	555,551	503,204	-52,347
2	Semi-evergreen forest	210,316	201,224	-9,092
3	Deciduous Forest	1,041,583	976,840	-64,743
4	Flooded Forest	153,827	154,803	976
5	Forest Regrowth	142,644	114,603	-28,040
6	Bamboo	14,568	15,227	659
7	Tree plantation	9,542	9,802	261
8	Rubber Plantation	113,061	131,011	17,950
9	Water	113,184	102,244	-10,940
10	Non Forest	2,625,821	2,771,138	145,317

Fig. 7. Forest Cover Change from 2014 to 2016 in the North Tonle Sap Region

Forest ecosystem fragmentation, degradation and conversion to other uses mean that trees are being cut down and replaced with cash crops like cashew nuts, oil palm and cassava. It is largely actors who are not long-term members of local communities that carry out forest conversion to other land uses (particularly agriculture).

Access to forests made possible by development projects, such as the building of roads, alongside poor governance, as well as limited and lack of awareness of the value of all types of forests, is the main factor underlying forest fragmentation or conversion to other land uses. Decrease in forest cover contributes to erosion, flooding and siltation of streams, which compromises fisheries and water currents that directly support the livelihoods of the Cambodian people.

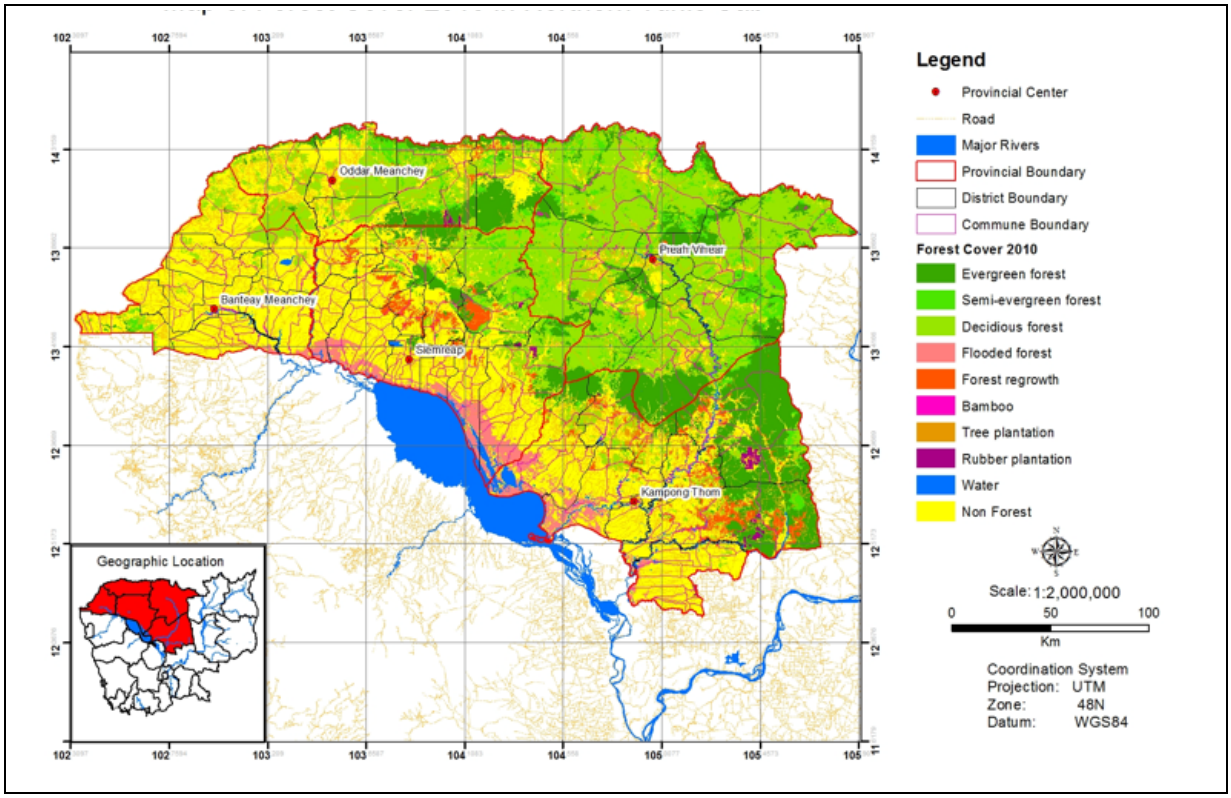


Fig. 8. Land Use in the North Tonle Sap Region in 2010

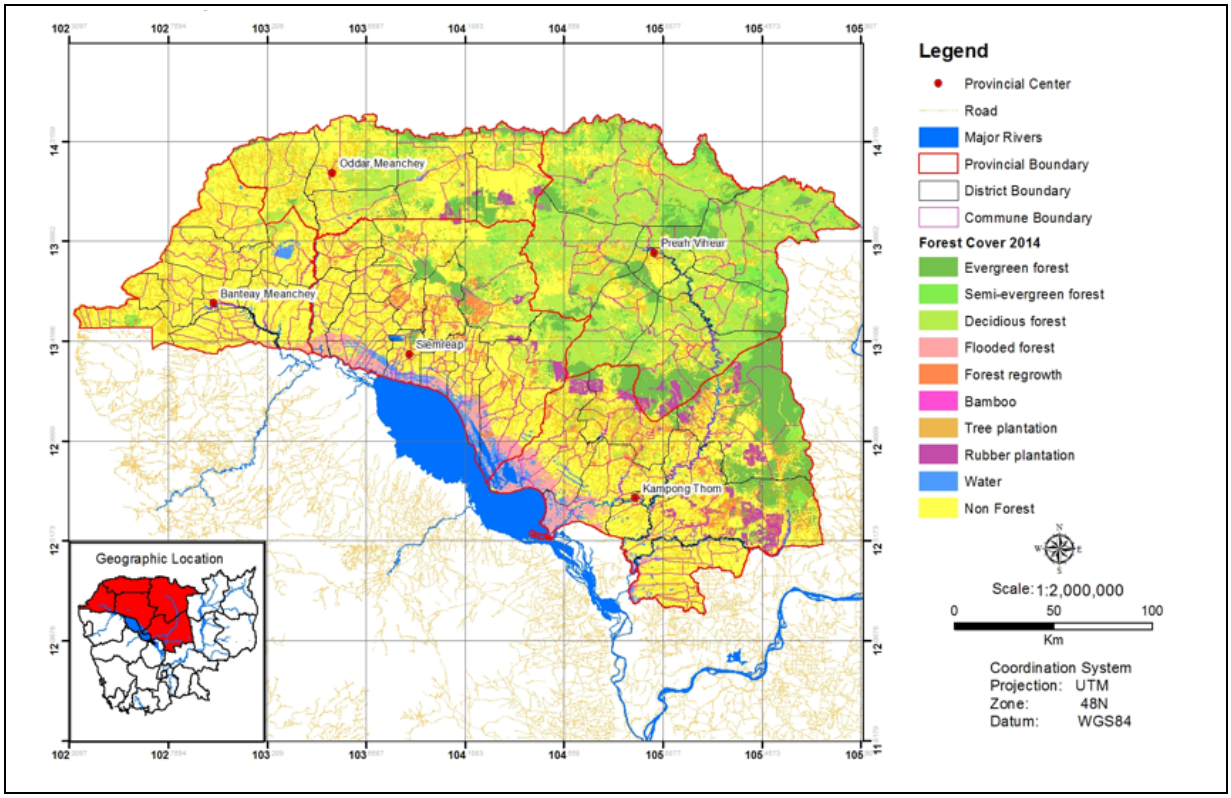


Fig. 9. Land use in the North Tonle Sap Region in 2014

Habitat fragmentation and conversion are one the main drivers of biodiversity loss in Cambodia.

Loss of natural habitats has considerable impacts on biodiversity, on the provision of ecosystem services and on the livelihoods of forest-dependent communities.

Forest degradation has reduced forest quality and its regeneration capacity, which in turn reduces the ability of the forest to provide socio-economic and environmental services.

Degradation of habitat and biodiversity severely diminishes the richness of the ecosystem and reduces its future use value.

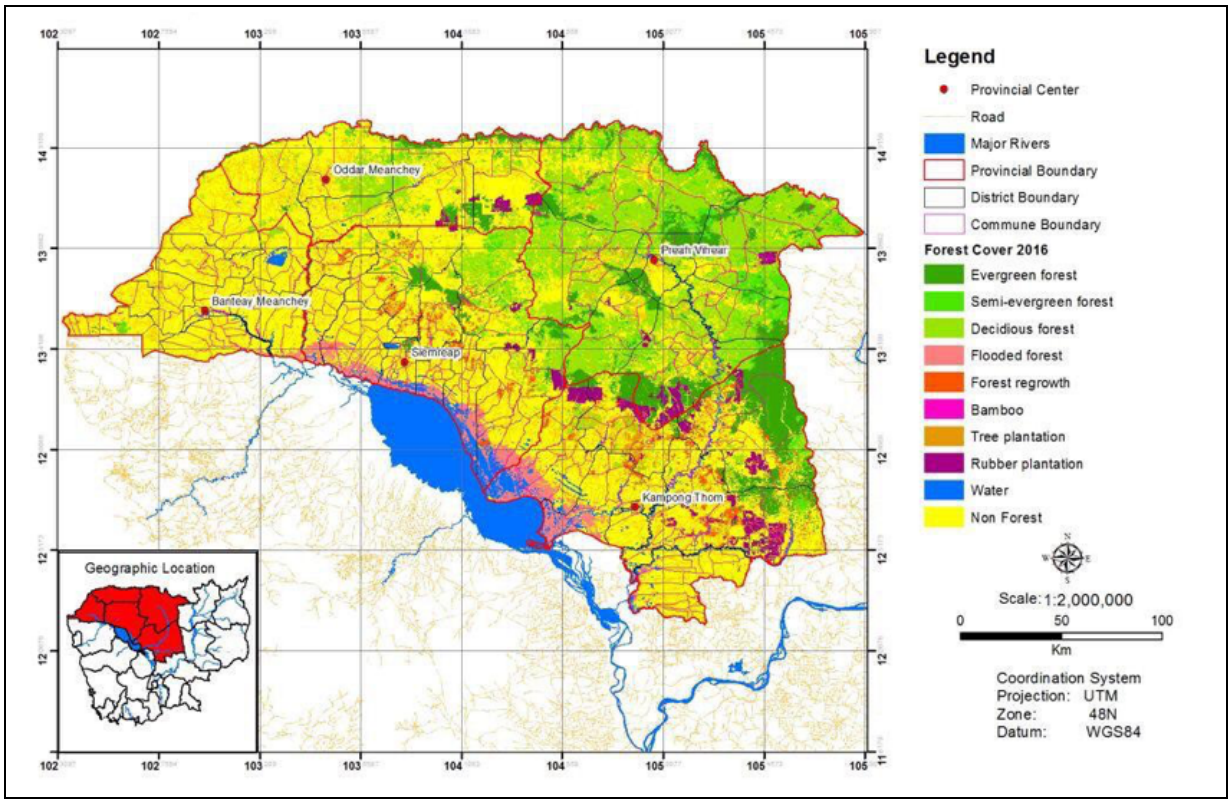


Fig. 10. Land use in the North Tonle Sap Region in 2016

Land degradation poses serious direct threats to food and water security in Cambodia. It affects agricultural productivity and the water retention capacity of the country's watersheds. The Royal Government of Cambodia's primary response to land degradation is detailed in the 2018 National Action Program to Combat Land Degradation.

Figures 6 and 7 above show forest cover change in the North Tonle Sap Region over time.

Figures 8, 9 and 10 show land use changes from 2010 to 2016 in the North Tonle Sap Region.

3.2.1.1.2. Over-exploitation of natural resources (over-fishing, over-harvesting, unsustainable use)

The most significant threat to key wildlife species is over-hunting, which has probably already eliminated some of the major species living in Cambodia, in particular tigers (*Panthera tigris*) and kouprey (*Bos sauvelii*). More recently, populations of ungulates, pangolins, turtles and other taxa have been drastically reduced as a result of over-hunting or hunting using very destructive practices. Most hunting with serious conservation impacts is for domestic market or to supply international trade. Species of high commercial value, such as turtles and tortoises, pangolins, bears, deer and wild cattle, are commonly targeted in this regard.

In addition, the exploitation of wildlife in the region is high, particularly through the collection of eggs and chicks of migratory birds and destructive harvesting methods that eliminate non-target fish or plant species. Over-harvesting of plants for traditional medicine and food is also threatening the ecosystems.

The mountains of Cambodia have been severely exploited. Illegal and uncontrolled logging is taking place both within and outside the Protected Areas in these zones. Hunting for game meat has significantly affected the population of wildlife. Many agricultural activities are also taking place on the mountain slopes.

The Cardamom Mountains in particular are increasingly vulnerable to illegal logging, hunting, forest clearing and land encroachment.

3.2.1.1.3. Pollution

The rapid industrialization of the Lower Mekong Basin; the expansion of agricultural production, which requires the clearing of natural habitats; the extension of mining activities; and intensive logging and deforestation are all affecting the quality of water streams in the

area. They are doing this by increasing the levels of pesticides and/or chemical waste from rubber and palm oil industries and from sediment washed loose from degraded and bare soils towards rivers or coastal areas downstream. This is resulting in losses with regard to ecosystem functioning.

Research results confirm that increased application of chemical inputs is resulting in soil acidification, reduced soil biological activity and low soil fertility.

3.2.1.1.4. Invasive alien species

Alien species are the second major cause of biodiversity loss and habitat destruction. Two invasive alien species have been reported in the Lower Mekong Basin:

1. The giant mimosa (*Mimosa pigra*), a thorny plant from the Amazon, which has proliferated in the Tonle Sap area, threatening agriculture, fishing and flooded forests;
2. The golden apple snail (*Pomacea canaliculata*), from South America, which has become an important pest in rice fields and invaded some freshwater systems, competing with native snails for food and causing the destruction of native aquatic vegetation.

Mimosa pigra (*M. pigra*) is a thorny invasive alien plant that originates from tropical South and Central America and spread into Cambodia from 1980 around the Tonle Sap Great Lake and especially along the Mekong River, where it occupied thousands of hectares of flooded wetlands and abandoned fields. This weed has resulted in negative impacts on biodiversity, ecosystems, agriculture and socio-economic, health and other economic activities.

M. pigra has been encroaching into Cambodia for decades, arriving from its neighboring countries. It was originally considered a wild plant and was introduced from Indonesia to Thailand to control riverbank erosion, cover tobacco crops and produce natural fertilizer (Napompeth and Wara, 1983).

In 1949, *M. pigra* was found in northern Thailand, and it then spread into Vietnam, most likely before 1970 (Thi et al., 2004); it continued its advance into Long An province, where it was found by 1979 (Triet et al., 2004).

Fig. 11. The giant mimosa (*M. pigra*) in Tonle Sap Great Lake

The weed spread into Cambodia from 1980 around the Tonle Sap Great Lake and especially along the Mekong River, where it occupied thousands of hectares of flooded wetlands and abandoned fields (Samouth, 2004).

Around 1997, *M. pigra* encroached into many provinces of Cambodia, including Steung Treng, Kratie, Kampong Cham, Kandal, Kampong Chhnang, Kampong Thom, Pursat, Battambang, Siem Reap, Prey Veng, Svay Rieng, Takeo and some parts of Kampong Speu (GSSD, 2013).

Figure 12 shows the distribution of *M. pigra* within the Stung Sen Core Area; however, the target site for this study is Phat Sonday Commune in Kampong Thom Province, which has a high density of *M. pigra*.

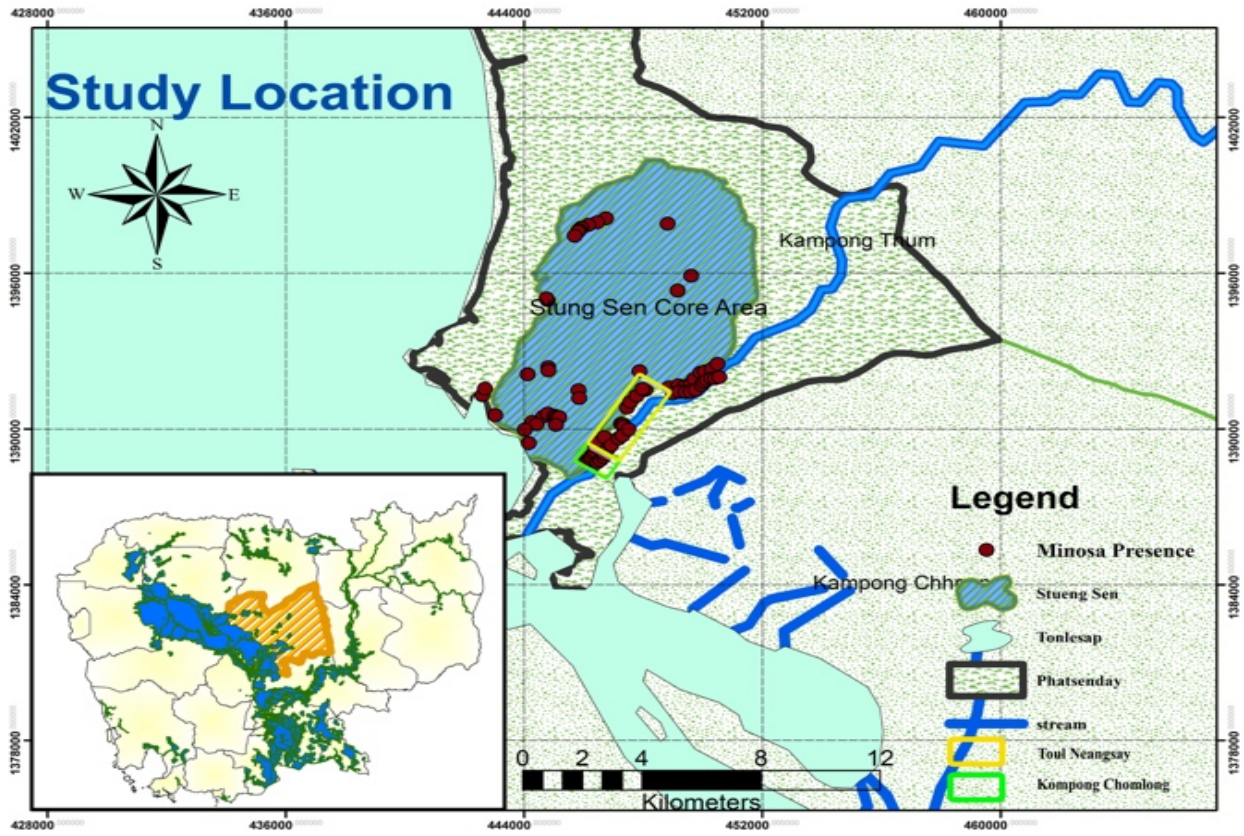


Fig. 12. *M. pigra* distribution map in the Stung Sen Core Area

Socio-economics and income generation in the Stung Sen Core Area

According to field interviews with 80 families in the Stung Sen Core Area and 90 families in Phat Sonday Commune, their major income is earned from the fisheries sector. Their secondary income is based on farming the surrounding area (see Table 2).

Table 2. Occupations and income generation in Phat Sonday, Stung Sen Core Area

Major Income			Occupations		
Source	No. of families	Percent (%)	Occupation	No. of families	Percent (%)
Fisheries	53	66	Fisherman	48	53
Farming	17	21	Farming	34	38
Animal husbandry	3	4	Animal husbandry	5	6
Other	7	9	Other	3	3
Total	80	100	Total	90	100

Impact analysis of *M. pigra*

Table 2 shows that more than 50 per cent of local income generation depends on fishing activities, while the second main source of income is farming. Four major factors have been identified as reasons for the negative impact on fisheries yields: invasive species (*M. pigra*), climate change, illegal fishing and poisoning as a result of chemical usage in agriculture. The results of our survey suggest that *M. pigra* has the most significant impact (60 per cent); illegal fishing is the second most significant factor (20 per cent) and climate change and poisoning present around 20 per cent of the impact together. Therefore, this section analyses the impact of *M. pigra* on local livelihoods, especially in relation to incomes earned from fishing activities.

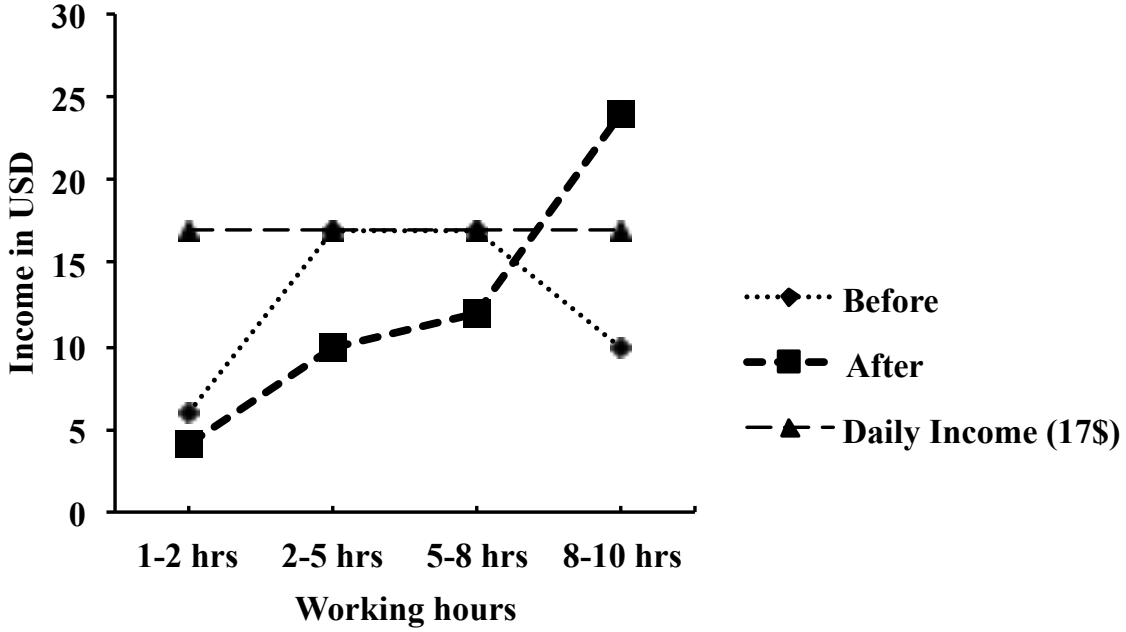


Fig. 13. Change in time spent on fishing

Two indicators, "time spent" and "income" earned from fisheries, have been identified to measure the impact of *M. pigra* on local income generation. Data on both indicators "before" and "after" presentation of *M. pigra* has been collected by category. As shown in Figures 13 and 14, "time spent" on fishing is classified into four categories (G_1 = 1–2 hrs, G_2 = 2–5 hrs, G_3 = 5–8 hrs and G_4 = 8–10 hrs); "income" received from fishing is grouped into five categories: C_1 = US$ 2.5–5, C_2 = US$ 5–10, C_3 = US$ 10–20, C_4 = US$ 20–30 and C_5 > US$

30. The average income "benchmark" is set at US$ 17 per day per fisher in accordance with the data received from the interviews with 50 fishers as shown in Table 2.

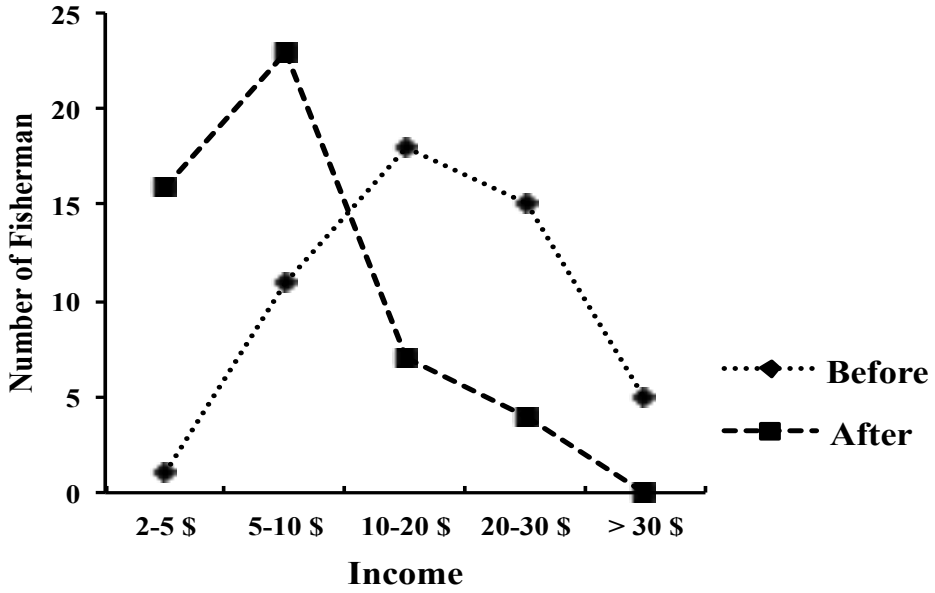


Fig. 14. Change in income from fishing

The results in Fig. 13 clearly indicate that, as *M. pigra* has continued to spread, fishers have had to engage in fishing activities for at least seven hours per day to earn an income at the benchmark level. Previously, they needed to fish for only two to five hours to achieve this benchmark figure. This result represents evidence that *M. pigra* has disturbed the fish habitat and its ecosystems and has led to fish stock shortages.

Figure 15 shows the trend of local incomes from fisheries before and after *M. pigra* presented in the area. The "before" line represents incomes received from fisheries before *M. pigra* presented and the "after" line represents the post-*M. pigra* situation.

The "before" line shows a high proportion of fishers received a good daily income of between US$ 15 and US$ 25, whereas the "after" line clearly shows quite dramatic reductions in fishers' incomes to between just US$ 5 and US$ 10 per day.

Table 3 shows daily and annual incomes from the fisheries sector and the profit loss of the 1,164 families in the Stung Sen Core Area. This figure is based on the results of interviews with 50 selected families in the target area.

Table 3. Daily and Annual Profit Loss after Presentation of M. pigra in Stung Sen Core Area

Description	Income earned from fisheries by category					Total family		Income	
	C_1 = 5$	C_2 = 10$	C_3 = 20$	C_4 = 30$	C_5 = 50$	Survey	Area	Family	Area
Before (family)	1	11	18	15	5	50	1,164		
After (family)	16	23	7	4	0	50	1,164		
Daily income									
Income before	$5	$110	$360	$450	$250	$1,175		$24	$27,936
Income after	$80	$230	$140	$120	0	$570		$11	$12,804
Daily and annual profit loss									
Daily income loss								$13	$15,132
Annual income loss								$4,745	$5,523,180

$$DI=\frac{Nf_1x+Nf_2xC_2+Nf_xC_3+Nf_4C_4+Nf_{x5}C_5}{TNf} \quad \text{Eq. (1)}$$

Where, DI = daily income; Nf = number of family/category, C = value/category; TNf = total number of family for survey

This assignment has used Equation 1 to estimate local incomes in each category identified in Table 2. According to this calculation, when *M. pigra* had not yet presented, around 30–35% of the total population was able to generate a daily income of between US$ 20 and US$ 30; after *M. pigra* had presented, nearly half of the total population was able to earn only US$ 10 per day. Therefore, they experienced a loss of more than 50 per cent of their income to a rate of US$ 13 per day and an overall loss of US$ 4,745 annually as a result of the fish habitat being interrupted by *M. pigra.* In addition, the total profit loss for the Stung Sen Core Area among 1,164 families has been a huge amount, at more than US$ 5.5 million annually.

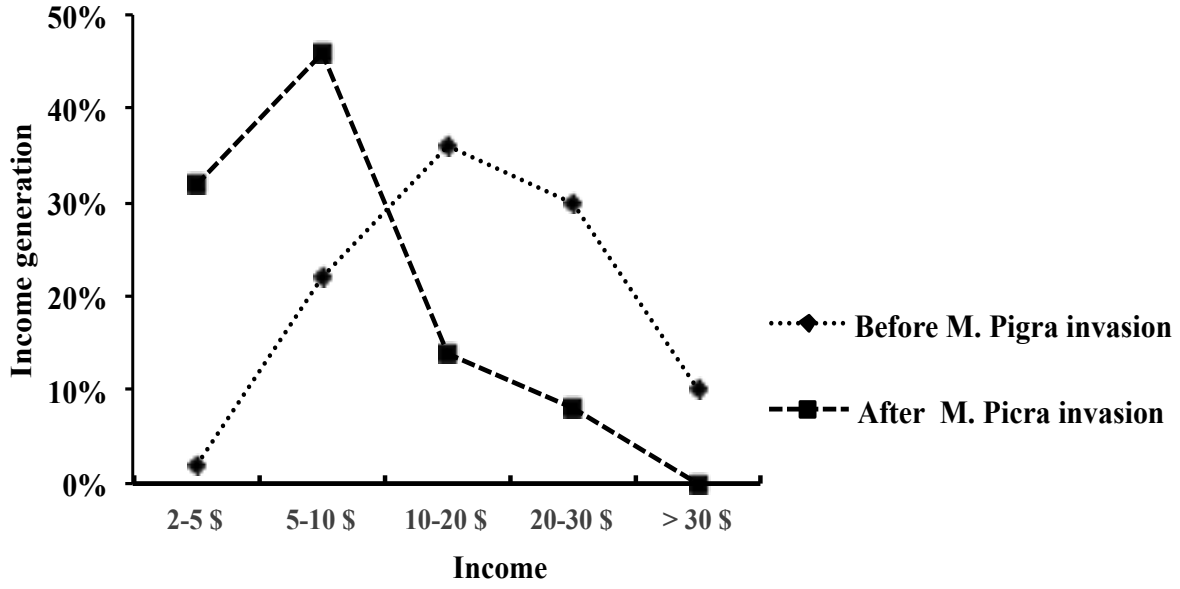


Fig. 15. Change in daily income from fishing

3.2.1.1.5. Climate change and variability, and land degradation

Cambodia is among the countries most vulnerable to climate change in Southeast Asia. Its economy and the livelihood of the great majority of its population depend on climate-sensitive sectors such as agriculture, water resources, forestry, fisheries and tourism. These sectors are impacted by climate change primarily through the increased intensity and frequency of floods and droughts. According to the National Communication to the United Nations Framework Convention on Climate Change, the vulnerabilities of communities living around the Tonle Sap in particular have increased significantly as a result of the threats posed by the increased frequency of heavy rainfalls during the wet season combined with the annual flooding of the Mekong River, which is destructive to crops and infrastructure around the Tonle Sap plain. In addition, unpredictable rains are making rain-fed crop-growing riskier. Floods coupled with droughts have resulted in significant economic losses. Under extreme climate conditions, populations of some pests, such as rice bugs, armyworms and rats, alongside disease, will likely increase. Although on aggregate the land-use change and forestry sectors were reported in 2015, Cambodia is paying attention to the contribution of greenhouse gas emissions of its agriculture and land-use sectors.

3.2.1.1.6. Natural disasters

Natural disasters (in particular floods) that have occurred in recent years in Cambodia have caused serious damage to infrastructure and ecosystems, especially agro-ecosystems. IN this regard, they have disrupted social and economic activities.

3.2.1.2. Indirect drivers of natural resources pressure

Cambodia recognizes the need to identify, assess and address indirect drivers of biodiversity loss if its actions to control and/or eliminate direct drivers are to succeed.

The most visible indirect drivers of biodiversity loss in Cambodia consist of:

1. An increasing human population, alongside related urban expansion, is increasing demand for natural resources and leading to changes in consumption and production patterns; large-scale development projects are having impacts on natural ecosystems, in particular as a result of improved roads facilitating access to all areas, including those that were previously protected because they were isolated from core human activities.
2. The human population in Cambodia has been growing steadily (at a rate of 1.51 per cent), as has average income per capita and thus the purchasing power of the population. The poverty rate has fallen sharply, from 53.2 per cent in 2004 to 16 per cent in 2013, but the majority of the population remains highly vulnerable. A total of 80 per cent of the population lives in the countryside and is highly dependent on natural resources. Cambodia also has a strong tourism sector, with more than 4.5 million international visitors recorded in 2014 and an estimated income of US$ 2,700 million from these.
3. Cambodia's economy is based largely on agriculture, with livestock production on the increase. In order to respond to high and ever-increasing food demands in the country, while avoiding further conversion of forestland to agriculture, the Royal Government of Cambodia is taking environmentally friendly measures to increase agricultural productivity and efficiency, food processing and marketing, in line with the laws, strategies and plans adopted since 2002 relating to agriculture and animal production. However, Cambodia is facing major

challenges related to harmonizing economic development with forest and biodiversity conservation goals.

4. Over 84 per cent of Cambodian households meet their energy needs through fuelwood, which accounts for approximately 70 per cent of the total national energy demand. The domestic use of fuelwood and charcoal commonly requires heavy forest logging, which generates indoor/outdoor air pollution and leads to severe environmental problems. Energy supply in Cambodia also relies heavily on imported fuels. The country is exploring new sources of energy, including hydropower, offshore and onshore oil and gas, and renewable energy to respond to its increasing energy demand.
5. Cambodia is also making efforts to strengthen its institutional and human capacities to take responsibility for and address all aspects of natural resource management.

3.2.2. Measures Taken

Many measures have been taken to reduce biodiversity loss and to protect, manage and restore natural and cultural resources for sustainable development in Cambodia. These include the expansion of the Protected Areas System; establishment of a Biodiversity Corridor; building institutional capacity; development and enforcement of a framework of legislation and relevant strategies; and mobilizing resources for conservation, among others.

Recently, biodiversity and ecosystems are being degraded and species and genetic diversity are being reduced at a concerning rate, which is pointing to a need for immediate actions.

Natural resources, agriculture and tourism are mainstays of Cambodia's economy but, in recent history, many of Cambodia's natural resources have been heavily exploited and are being rapidly degraded (NCSD, 2016).

Despite their importance, ecosystems are being degraded and species and genetic diversity are reducing at an alarming rate, as a result of the impact of our growing human population and increasing resource consumption rates (NCSD, 2016)

In recent decades, high population growth and the increasing economic demands of this growing population have often led to the conversion of natural forests to agriculture, with adverse effects on the environment; to land degradation and pollution resulting from unsustainable agriculture and industrial activity; to habitat fragmentation as a consequence of public works and urbanization; and to the over-harvesting and over-exploitation of resources, particularly in forests and in freshwater, marine and coastal areas. These pressures on biodiversity and its associated ecosystem services are often exacerbated by the impacts of climate change and more frequent natural disasters.

The Royal Government of Cambodia is finalizing the development of the Environment and Natural Resources Code of Cambodia, which represents the legal framework for the management of the country's environment and natural resources. Its purpose is 'to enable the sustainable development of the Kingdom of Cambodia, by protecting the environment and conserving, managing, and restoring natural and cultural resources'. The drafting of the Code started in 2015; the tenth draft was being considered in 2018.

Measures taken to implement the United Nations Framework Convention on Climate Change are in line with the provisions of each article of the Convention to ensure the conservation of our natural assets and their sustainable use and management to ensure the well-being of all the persons living in the country and to try as much as possible to ensure that all stakeholders benefit from the use and commercialization of genetic resources. Cambodia recognizes the benefits from cooperation in the region – South–South as well as South–North cooperation. Cambodia is also particularly promoting the synergistic implementation of the Rio Conventions.

Cambodia has taken a number of measures to reduce biodiversity loss, in particular the designation of a wide network of Protected Areas. However, limited financial resources and issues related to insufficient capacity in general (including management capacity at institutional level and technical capacity at operational level), combined with poor awareness of the value and vulnerability of ecosystems, limited knowledge and data and lack of positive incentives, have not allowed for effective control of the drivers of biodiversity loss. This, of course, has detrimental consequences for the country's sustainable development in the long term.

Building on the findings of the National Capacity Self-Assessment and follow-up capacity development monitoring, Cambodia is continuing to strengthen its human capacity for research, information management and communication, and at the science–policy interface. There are plans in particular to develop capacities to enable the synergistic implementation of the three Rio Conventions.

In the past decade, the Royal Government of Cambodia has adopted a great many laws and strategies of relevance to the objectives of the United Nations Framework Convention on Climate Change. These provide safeguards to ensure the implementation of the Convention at the local, national and regional levels.

Cambodia is maintaining strong collaboration with a few international environmental non-governmental organizations that support its programming, especially in areas where technology is still lacking. Cambodia is also fostering collaboration among line ministries identified in the NBSAP.

In addition to using its national budget, Cambodia has been applying to the international financial mechanism and mobilizing partners to fund some of the actions listed in the NBSAP.

3.2.2.1. National policy and legislation related to biodiversity management

This section gives an overview of national policies, laws and strategic plans that are relevant to natural resources and biodiversity conservation in Cambodia.

The Royal Government of Cambodia has developed a number of policies and pieces of legislation to enable sustainable development through the protection of the environment and through conserving, managing and restoring the country's biodiversity and ecosystem. The Royal Government is endeavoring to implement a coordinated set of laws, programs, action plans and institutional arrangements regarding natural resources, all of which are directed toward enabling the achievement of national goals on environmental protection, biodiversity conservation, poverty reduction, socio-economic development and good governance, as described in Table 4.

The Royal Government of Cambodia has set national goals directed towards the sustainable development of the nation that represent an overall development framework for the conservation and management of Cambodian natural resources, and that consider the

ecologically, socially and economically viable conservation and management of biological resources as a major pillar for public welfare. The aim is that this will directly contribute to environmental protection, poverty reduction and socio-economic development throughout the Kingdom of Cambodia.

Table 4. National Policy Related to Biodiversity Conservation

Date	Policy
2001	**Declaration on Land Policy** Focuses on three sub-sectors: land administration, land management and land distribution, under the responsibility of the Ministry of Land Management, Urban Planning and Construction
2002	**National Forest Sector Policy** To conserve and sustainably manage the country's forest resources for sustainable socio-economic development and to ensure that the management and exploitation of forests generate benefits for government entities, local communities, the private sector and individuals
2010	**National Forest Program 2010–2029** Developed to replace and implement the National Forest Sector Policy. This identifies REDD+ as an important source of sustainable forest financing in targeting the registration of 1,000 community forestry groups nationally and the establishment of community forest programs to cover 2 million hectares by 2030
2010	**Strategic Planning Framework for Fisheries 2010–2019** To support the achievement of Cambodia's Millennium Development Goals and implement the National Strategic Development Plan with compliance with the Law on Fisheries to the benefit of the Cambodian people

National policy

This study selected policies related to land, forestry and fisheries to review in the context of biodiversity conservation for sustainable management.

The *Land Policy 2001* has the objective of ensuring the management, protection and use of land and natural resources with transparency and efficiency in order to preserve environmental sustainability and equitable socio-economic development in rural and urban areas. It also aims to prevent disputes over land use by regulating land development, land conversion, land readjustment, construction and resettlement.

The *National Forest Sector Policy 2002* provides a mandate to the Forestry Administration of Ministry of Agriculture Forestry and Fisheries to conserve and manage forest resources under five objectives:

1. To conserve and sustainably manage the country's forest resources for sustainable socio-economic development;
2. To consider the remaining forest resources as Permanent Forest Estate;
3. To engage the private sector and the local population in ensuring food security, poverty reduction and socio-economic development;
4. To coordinate the many stakeholders involved to enable the harmonization of the different perceptions, interests and objectives of the various forest interest groups; and
5. To support forestation of arable land and to protect those trees for the development of forest resources.

To achieve the objectives of the National Forest Sector Policy, the Ministry of Agriculture, Forestry and Fisheries has developed the long-term *National Forestry Program 2010–2029 (NFP)*, which aims to attain sustainable forest management and reduce poverty in the country. The specific objectives and goals relate to environmental protection, biodiversity conservation, economic development and good governance. The NFP has identified four tasks – forest resource conservation, good governance, socio-economic development and poverty reduction – that need to be achieved by 2029.

The fisheries sector in Cambodia has developed a 20-year *Strategic Planning Framework for Fisheries 2010–2029 (SPF)* to guide the Fisheries Administrative in effective support to the National Strategic Development Plan, in compliance with the Law on Fisheries.

National law related to natural resource conservation

Cambodia has adopted a number of laws to support natural resource management, within which the above policies are directly and indirectly used to manage the country's Protected Area System.

Nine relevant laws related to biodiversity conservation and Protected Areas management were selected for review and description in this section. However, only three laws (the

Protected Area Law, the Law on Forestry and the Law on Fisheries) relate directly to Protected Areas System management and establishment of conservation communities.

The *Law on Environmental Protection and Natural Resource Management 1996* intends to protect and promote environmental quality and public health through the prevention, reduction and control of pollution; to assess the environmental impacts of all proposed projects prior to issuance of a decision by the Royal Government of Cambodia; to ensure the rational and sustainable conservation, development, management and use of the country's natural resources; to encourage and enable the public to participate in environmental protection and natural resource management; and to suppress any acts that cause harm to the environment.

The objective of the *Land Law 2001* is to determine the regime of ownership for immovable property in the Kingdom of Cambodia for the purpose of guaranteeing the rights of ownership and other rights related to immovable property, according to the provisions of the 1993 Constitution of the Kingdom of Cambodia. This law provides the legal basis for government institutions to manage state land such as Protected Areas, public land and community land.

The *Law on Water Resources Management 2007* emphasizes the management and development of water and water resources based on an Integrated Water Resources Management approach, which requires the coordination of multi-sectoral water use planning, including conservation of biodiversity and ecosystems. Article 23 of this law authorizes the Ministry of Water Resources and Meteorology to declare any watershed as a protected "water use" zone if it is prone to degradation by human activities or natural factors.

The *Law on Biosafety 2008* was developed five years after Cambodia became a party to the Cartagena Protocol on Biosafety. The purpose of the law is to ensure Cambodia meets its obligation and commitment to implement the Biosafety Protocol of the Convention on Biological Diversity to which Cambodia became a party in 1995. This law aims to prevent adverse impacts on the conservation of biodiversity and natural resources caused by the trans-boundary movement, development, handling, transfer, use, storage and release of living modified organisms resulting from modern biotechnology; and to ensure effective conservation of biodiversity and sustainable use of biological resources, taking also into account risks to human health.

In the same year, the Royal Government of Cambodia also adopted the *Law on Seed Management and Plant Breeder's Right 2008*, which serves as a legal instrument to manage and control the breeding, release for use, production, processing, registration, distribution, import and export of seeds. This law has the objectives of protecting new plant varieties, securing the management and sustainable development of varieties and encouraging the development thereof for social, economic and environmental benefits.

One year later, the Royal Government endorsed the *Law on Tourism 2009*, to allow the Ministry of Tourism to govern the tourism sector in a sustainable manner for poverty reduction. This law aims to protect and conserve the natural resources, culture and customs that serve as the foundation of the tourism sector, through its optimization (Article 2).

In addition to the above laws, three specific laws are directed at defending the legal framework for biodiversity conservation within Protected Area System in Cambodia.

The *Law on Forestry 2002* defines the framework for the management, harvesting, use, development and conservation of the forests in the Kingdom of Cambodia. The objective of this law is to ensure the sustainable management of these forests to ensure their social, economic and environmental benefit, including the conservation of biological diversity and cultural heritage.

The *Law on Fisheries 2006* aims to ensure fisheries and fishery resource management to enhance aquaculture development, enable the management of production and processing and promote the livelihood of people in local communities for the socio-economic and environmental benefits, including the sustainability of the conservation of biodiversity and natural cultural heritage.

The *Protected Area Law 2008* defines the framework of management, conservation and development of Protected Areas to ensure the management and conservation of biodiversity and the sustainable use of natural resources in protected areas.

National strategies

The National Strategic Development Plan and its Update 2009–2013 contains policy priorities that support the establishment of protected areas and protected forests with the objectives to conserve biodiversity and improve the livelihoods of people living in rural areas and contribute to economic growth. It covers all aspects of sustainable development,

including chapters on enhancement of the agricultural sector for improving agricultural productivity and diversification. While National Strategic Development Plan 2014-2018 has been formulated for implementing the Rectangular Strategy Phase III (RS, Phase III, 2010): Growth, Employment, Equity, & Efficiency, to ensures development sustainability and poverty reduction and sustainable management of natural resources. Cambodia Climate Change Strategic Plan 2014-2023 (CCCSP, 2013) is a continuation of national policy response, in providing a framework for climate change responses and guiding the transition to low-carbon and climate resilient development. It supports national preparedness in responding to climate risks and disaster management, and in capitalizing on emerging opportunities such as green growth, mobilizing climate funds from bilateral and multilateral sources, and enhancing effective participation in international dialogues and negotiations on climate change, and biodiversity. National Biodiversity Strategy and Action Plan (NBSAP, 2015) sets its vision to use, protect and manage biodiversity for sustainable development in Cambodia. To ensure this, biodiversity issues and values are mainstreamed in national development and sectoral policies, plans and programmes; biodiversity, our natural capital, is protected by reducing the various direct and indirect pressures causing its loss or degradation, and is used wisely so as to enhance the benefits from it to the people of Cambodia, particularly in rural areas; and the enabling environment for effective and efficient implementation of this mission is strengthened.

3.2.2.2. Policy analysis of the Protected Area Law

The Protected Area Law, established by Royal Decree dated February 15, 2008, defines the management, conservation and establishment of new and existing Protected Areas, as identified by Royal Decree on November 1, 1993. This law is composed of 11 chapters and has the objective of ensuring the management and conservation of biodiversity and the sustainable use of natural resources in Protected Areas. Article 2 of this law sets the scope of application in Protected Areas as defined by the provisions of the Law on Environmental Protection and Natural Resources Management, which was promulgated by Royal Decree NS/RKM/1296/36 on December 24, 1996, the Royal Decree on the Establishment and Designation of Protected Areas of November 1, 1993, the Royal Decree on the Establishment and Management of Boeung Tonle Sap Biosphere Reserve NS/RKT/0401/070 of April 10, 2001, and other relevant standard documents.

Chapter II attaches responsibility to the Ministry of Environment with regard to the management of Protected Areas, with full participation from local communities, indigenous ethnic minorities and the public in decision-making on the sustainable management and conservation of biodiversity.

This law provides a legal framework and an opportunity to conserve and manage biodiversity resources in line with Cambodia obligation to implement the United Nations Convention on Biological Diversity and its protocol. Articles 5, 6 and 38 set the rights and duties of the Ministry of Environment with regard to monitoring national resource of all kinds in the Protected Areas, including the right to control exports and imports of wild flora and fauna, seeds and samples and the cross-breeding of wild species or fish of all species from/into Protected Areas based on scientific research. These articles are most relevant to the control measures set in the Nagoya Protocol on access and benefits-sharing in the Convention on Biological Diversity, and the Ministry of the Environment's duty to develop strategic plans, action plans and technical guidelines to manage the country's Protected Areas.

Articles 9 and 10 of the law state that the Royal Government of Cambodia may establish provincial/municipal Protected Areas and modify any Protected area that is already designated as a world or regional heritage site to comply with national legislation, to ensure their management and conservation is consistent with procedures and relevant regulations.

Articles 15, 16 and 19 determine the need for the development of a National Protected Area Strategic Management Plan by introducing the process and instructions in this regard.

Article 22 recognizes and secures access to traditional uses, local customs, beliefs and religions of local communities and of indigenous ethnic minority groups residing within and adjacent to the Protected Areas, and allows access to traditional uses of natural resources and customary practices on a family scale within sustainable use zones and conservation zones, subject to guidelines. This article responds to the implementation of Article 8(j) of the Convention on Biological Diversity.

Articles 32, 33 and 34 define the establishment of a Protected Area Trust Fund, the sources for this fund and the use of such a fund to support activities.

Chapter 10 defines procedures and mechanisms related to penalties for natural resource offenses. However, the procedures for penalties in this law do not capture all forest offenses;

it is necessary to use the provisions of the Law on Forestry to complain in court in some cases.

3.2.2.3. Gaps in the Protected Area Law provisions

Although the Protected Area Law has many strong provisions, some gaps remain with regard to its potential to achieve the country's goal in relation to natural resource management and biodiversity conservation for sustainable development. Table 5 below describes these gaps.

Table 5: Gap Analysis of the Protected Area Law Provisions

Provision	*Gap description*
Article 2	This law has a scope of application related to the Royal Decree of November 1, 1993 only. However, the Protected Area System includes forest protection, fish sanctuaries and community conservation areas, which should also be covered by this law.
Article 11	The law identifies four zones for Protected Area management but it does not include cultural and heritage zones under the Apsara Authority.
Article 12	The law only sets criteria for zoning identification, it does not introduce procedures and guidelines.
Article 16	The law does not contain guidelines or mechanisms for implementing the National Protected Area Strategic Management Plan.
Article 19	No financial mechanisms to implement the action plan are outlined.
Article 25	The law does not cover any part of Community Protected Areas outside Protected Area boundaries.
Article 41	The law fails to include rare and endangered species, or those that are threatened through prohibited practices considered destructive and harmful.

Besides gaps in provisions in the Protected Area Law, there are gaps related to policy coverage. For example, no environmental policy or biodiversity policy/law exists that defines the functions of responsible institutions in biodiversity conservation and the benefit values of biodiversity and the ecosystem for socio-economic development.

3.2.2.4. Overlapping jurisdictions

The Royal Government of Cambodia has endorsed the following relevant sectoral laws, the Protected Area Law, the Law on Forestry, the Law on Fisheries, the Land Law and the Law on Water Resources Management, to directly and indirectly manage and conserve natural resources for sustainable development. These laws have created overlapping responsibilities among government sectors dealing with the various areas of natural resource management (Figure 16).

The Protected Area Law aims to manage and conserve biodiversity within the 23 Protected Areas under the jurisdiction of the Ministry of Environment, whereas the Ministry of Agriculture, Forestry and Fisheries has responsibility for biodiversity conservation outside the Protected Areas.

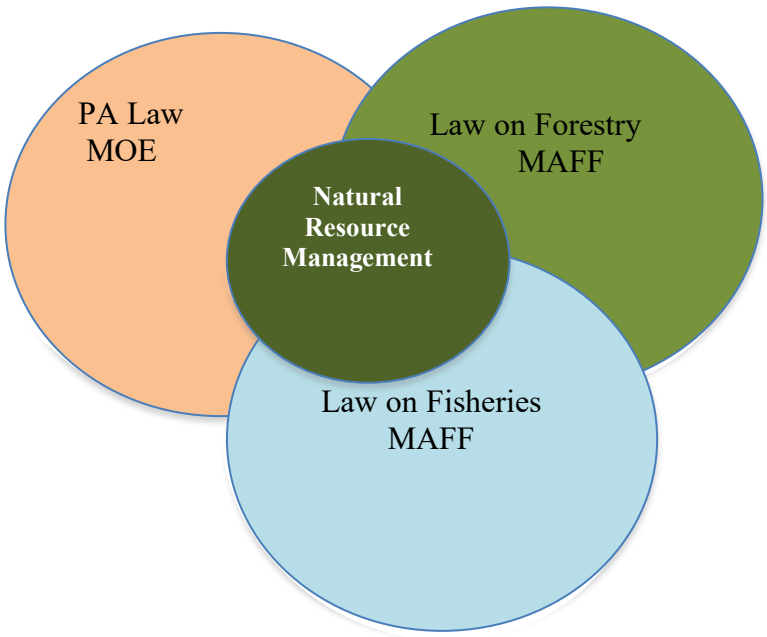


Fig. 16. Overlapping Areas of Protected Area Law, Forestry Law and Fisheries Law

The conservation of biodiversity within forestry protection comes under the jurisdiction of the Forestry Administration; that within fish sanctuaries comes under the jurisdiction of the Fisheries Administration.

Moreover, the Law on Forestry emphasizes that the area of forestry protection as well as the protection of all kinds of wildlife species, comes under the management, research and

conservation of the Forestry Administration, with the exception of fish and animals that breed in water.

Chapters 4, 5 and 6 of the 2006 Law on Fisheries present approaches to the protection and conservation of fisheries in inland and marine waters in general, and in inundated forests and mangrove forests more specifically.

Table 6. Comparison of Protected Area Law with Laws on Forestry and Fisheries

Policy	*Institute*	*Overlapping Responsibility*
Protected Area Law	Ministry of Environment	Management, conservation and development of protected areas to ensure the management and conservation of biodiversity and natural resources for sustainable use
Law on Forestry	Ministry of Agriculture, Forestry and Fisheries	Management, harvesting, use, development and conservation of forests to ensure the sustainable management of forests for social, economic and environmental benefits, including conservation of biological diversity and cultural heritage
Law on Fisheries	Ministry of Agriculture, Forestry and Fisheries	Ensuring fisheries and fishery resource management, enhance aquaculture development, the management of production and processing, and promoting the livelihoods of people in local communities for socio-economic and environmental benefits, including sustainability of the conservation of biodiversity and natural cultural heritage

Overlapping jurisdictions among key ministries such as Environment; Agriculture, Forestry and Fisheries; Water Resource Management; and Land Management, Urban Planning and Construction have often led to ambiguity as to which ministry has the key role in managing which resource.

3.2.2.4.1. Overlapping jurisdictions in natural resource management

The provisions of the Laws on the Establishment of the Ministry of Environment define the institution's jurisdiction as managing the environment sector. The provisions of the Law on Environmental Protection and Natural Resource Management outline duties for the Ministry of Environment to include responsibility for environmental protection and the management of natural resource areas, by providing it with a jurisdiction to manage, conserve

and develop biodiversity and the appropriate and sustainable use of natural resources and sustainable living.

The jurisdiction and duties of the Ministry of Environment in this regard seem to overlap with those of the Ministry of Agriculture, Forestry and Fisheries. This latter has the jurisdiction to monitor the evolution of natural resources in the agriculture sector and to supervise natural resource exploitation in order to satisfy the needs of the country and to respect ecology (according to the Sub-Decree on the Organization and Functioning of the Ministry of Agriculture). It must also manage the conservation of parts of the country that are related to agricultural land use, plant seeds and animal species and ensure a natural balance, make inventories and take part in the determination of measures to protect the environment. Furthermore, it is charged with organizing and establishing plans to manage reserved forest land for wildlife habitats, natural protected areas and forest restoration areas and with managing the exploitation of hydrological resources, fresh water areas and sea areas.

From this comparison, we can see that the Ministry of Agriculture, Forestry and Fisheries has a jurisdiction to manage natural resources in the agriculture sector, such as resources related to land, forests, mines, wildlife, hydrology and plants. The Ministry of Environment also has a mandate to manage natural resources; in this case, the phrasing of the jurisdiction is different, to cover the framework of Protected Areas. There are ambiguities and overlaps as stated below:

Forestry resource management

According to the Law on Forestry, the Ministry of Agriculture, Forestry and Fisheries has jurisdiction over forest management, conservation and development. Forest management shall be carried out with sustainability in order to respond to the interests of society, the economy and the environment by also including biodiversity development and attention to the country's cultural heritage. The Ministry of Agriculture, Forestry and Fisheries has the authority to cooperate on and strengthen all adherence to the law regarding forestry offenses occurring within the Protected Area System under the jurisdiction of the Ministry of Environment.

This shows that, although forests are located within the country's Protected Areas, the Ministry of Agriculture, Forestry and Fisheries still has some authority in this regard, and that the Ministry of Environment must coordinate with the Ministry of Agriculture, Forestry and

Fisheries to be able to carry out duties related to law enforcement on forestry offenses occurring in the country's Protected Areas. It also shows that both ministries are required to work together and to coordinate with each other within the same goal of management, conservation and protection of forest resources.

Meanwhile, according to the Protected Area Law, the Ministry of Environment has the jurisdiction to prevent and to crack down on natural resource offenses such as the reprocessing of natural resource products and by-products, through the establishment and processing of sawmill bases for wood processing, timber processing plants, handicrafts, the processing of natural resource products and by-products and all kinds of kilns in the Protected Areas. No natural person or legal entity has the authority to grant permits regarding any direct or indirect form of invasion of forest lands, land control, deforestation, wildlife hunting or activities to collect forest products and by-products or natural resources in the natural protected area, in compliance with the provisions of the Law.

This means that neither the Ministry of Agriculture, Forestry and Fisheries nor the Ministry of Environment has full jurisdiction over every product and by-product related to natural resources or every species of wildlife in the Protected Areas. This leads to controversy with regard to how natural resources located within one country can be managed, conserved and developed sustainably when they come under two different ministries' mandates.

Previously, the Royal Government of Cambodia has enabled integrated inter-ministerial work to crack down on offenses occurring within natural protected areas and permanent reserved forest land such as through Ministry of Agriculture, Forestry and Fisheries Instruction No. 001, dated January 9, 2007, on Measures to Prevent Forest Land Control and the Issuance of Certificate of Land Buy and Sale in the Natural Protected Area, and Prakas No. 01 dated on January 25, 1999, on Measures on Management and Elimination of Anarchic Form in Forestry Sector, etc to distingue role and responsibility between conservation and consuming of natural resource entities. It is to clarifying the ineffectiveness in carrying out roles, duties in its jurisdiction that Law triggered the management and development of these natural resources.

Therefore, there should be a separation of jurisdictions to ensure effectiveness with regard to the sustainable management, conservation and exploitation of forests. It is seen that, (only) forest resources are divided into forests in natural protected areas under the jurisdiction

of the Ministry of Environment and forests in permanent reserved forest areas and private forests under the jurisdiction of the Ministry of Agriculture, Forestry and Fisheries.

Moreover, the Ministry of Agriculture, Forestry and Fisheries has the authority to collect forest products and by-products, and to exploit all kinds of forests, whereas the Ministry of Environment does not have clear provisions that state whether it has the authority to exploit natural resources in natural protected areas. This case of unstated provisions in the law means that the Ministry of Environment does not have the authority to grant permits for the use, collection and transportation of all types of forest products and by-products in natural protected areas; this authority is given only to the Ministry of Agriculture, Forestry and Fisheries.

The Apsara Authority and Preah Vihear Authority also have a mandate relevant to all forestry resources within their jurisdiction as determined by Royal Decree.

Wildlife and plant resource management

The Ministry of Agriculture, Forestry and Fisheries has the jurisdiction to grant permits for the import and export of wildlife in a medium-existence group type. All species of wildlife are state property and represent a part of the country's forestry resources. All wildlife comes under the management of the Forestry Administration, excluding fish and types of animal born in the water.

Related to plants, the Ministry of Agriculture, Forestry and Fisheries also has the authority to organize and to manage Protected Areas with the aim of conserving genetic plant resources and wildlife to ensure constant natural resource development within the Kingdom of Cambodia. The Ministry of Agriculture, Forestry and Fisheries also has jurisdiction over the management of plant seeds and cross-breeding plant seeds.

However, the Ministry of Environment has jurisdiction over the examination of import and export of types of animals, plants and plant seeds and the cross-breeding of all species of wildlife and fish in the natural protected areas.

Meanwhile, according to the Protected Area Law, the Ministry of Environment also has the jurisdiction to shield the Protected Areas and to prevent all activities causing damage or negative impacts to these as a result of digging and invasion of forest land, through exploitation, pollution of the biodiversity resource circle, forest fires, nomadic agricultural

cultivation, the transmission of diseases and pests and plant species and epidemic disease animals.

It is clear that the protection, conservation and management of animal and plant resources come the under the jurisdiction of the two different ministries regarding separation by area of management only; they are forest protected areas and natural protected areas. However, plants and wildlife represent natural resources that should come under the jurisdiction of only one ministry, to ensure the facilitation of constant conservation and management. This is particularly the case because animals naturally move and breed freely, crossing from forest protected areas to natural protected areas or vice versa. Therefore, it is clear that jurisdiction over animal and plant resources, which comes under two different ministries, should not overlap; the fact that it does overlap causes complexity in wildlife and plant resource management, resulting in more ineffective management and conservation of wildlife and plants.

Moreover, the provisions of the Law on Amendment of the Law on Medicine Management present a definition of the word “medicine” as one or more substance(s) derived from chemical substances, product fertilizers or products of microorganisms or plants that are mixed for use in human and animal illness prevention or treatment, medical or pharmaceutical research, symptom diagnosis or organic function support or modification (Article 2). The provisions of this law are unclear in terms of the exploitation of natural resources, especially of some species of plants for medicine production, which has impacts on other institutions, such as the Ministry of Environment and the Ministry of Agriculture, Forestry, and Fisheries.

For example, if the Ministry of Health finds that a rare species of plant containing pharmaceutical value comes under the jurisdiction of the Ministry of Environment, can the Ministry of Health take this resource independently without the permission of the Ministry of Environment? If the Ministry of Environment does not agree to this, what measures are to be taken? This issue needs to be dealt with under national legislation on access and benefit sharing.

Moreover, it is also of issue that the Apsara Authority and the Preah Vihear Authority are also relevant to all wildlife and plant resources that come under their jurisdiction as determined by Royal Decree.

Land resource management

Land is a resource the comes under the management jurisdiction of four ministries – the Ministry of Agriculture, Forestry and Fisheries; the Ministry of Land Management, Urban Development and Construction; the Ministry of Mines and Energy; and the Council of Ministers, which also reserves the right to relieve or release its control over concession land with a land size of over 10,000 hectares. In addition, the provincial or municipal governor is authorized to and responsible for granting economic land concessions with a total investment value under 10 million riels or a total concession land area of 1,000 hectares. On a separate note, social land concessions come under the jurisdiction of two other institutions: the National Social Land Concession Committee and the Provincial and Municipal Land Use Committee.

The Ministry of Environment has jurisdiction over the management of wetland areas and coastal land areas as well as natural protected areas. It also reserves the right to grant parts of sustainable use areas to local communities and ethnic indigenous minorities that live in or adjacent to the natural protected area, in pursuit of the establishment of a Community Natural Protected Area. The Ministry must discuss with, cooperate and instruct related ministries on its work to protect and conserve ecosystems in areas that include slope areas and coastal areas that are present in natural protected areas and also outside of natural protected areas.

The Ministry of Environment is also authorized to submit proposals to the Royal Government of Cambodia to clear and pave paths in the forest in natural protected areas to build all sorts of infrastructure.

The Ministry of Agriculture, Forestry and Fisheries has jurisdiction in agricultural lands, industrial lands, economic land concession lands, national forest land reserved for replantation, community forests and forest concession lands.

In relation to this, the Ministry of Mines and Energy has jurisdiction over the management of mineral enterprises, the use of mineral wells and all other activities associated with mineral resources in Cambodia. (Mineral resources include any substance, whether in solid, liquid or gaseous form, originating naturally, or by geological process or as a result of mining in or on the land, or in or on the sea or seabed, including gemstones, coals, metal and non-metal mines, mineral water, rock, gravel, sand, clay, petroleum and gas.) The Ministry of Mines and Energy is authorized to issue permits on natural resources for concessionaires who

execute their mineral activities on concession lands for mining. The Petroleum Authority, which functions under the Ministry of Mines and Energy, has jurisdiction over identifying and classifying petroleum areas throughout the country.

The Ministry of Land Management as well has jurisdiction over the organization of land, urbanization and construction, which also includes important sites, such as economic development sites, industrial sites, urban areas, natural conservation areas, tourism sites, protected heritage sites and infrastructure sites, and over determining orders for land possession, reserved lands and construction levels, differentiated into agricultural lands, forestry areas, water resource areas and protected areas. The Ministry of Land Management is authorized to register the lands of indigenous ethnic minorities, which are community properties, and to facilitate the granting of economic land concessions to poor families for housing and to carry out family farming, to be decided by the Provincial and Municipal Land Use Committee and the National Committee for Land Concessions chaired by the Minister of Ministry Land Management, Urban Planning and Construction.

In addition to this, the Apsara Authority and the National Authority for Preah Vihear also have a mandate to manage the land in their own territorial jurisdiction as well.

According to the above jurisdictions, four ministries and two authorities have jurisdiction over the land in the country, a situation that has led to a lack of clarity and the overlapping of jurisdictions.

For one thing, among three ministries – the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment and the Ministry of Mines and Energy – the latter reserves the right to manage the mineral sector both under and on the ground, even if those areas are in the natural protected areas or belong to the permanent reserved forest areas of the Ministry of Agriculture, Forestry and Fisheries.

The issue here relates to how to ensure effective and sustainable results in the country's efforts to manage, conserve and develop its land resources. How can offenses related to land and mineral resources in natural protected areas and permanent reserved forest areas be prevented since there mineral exploration is being carried out in these areas without authorization?

Moreover, determining different land for ethnic groups, Community Protected Areas, community forest lands, social concession lands, economic concession lands, forest

restoration lands and forest concession lands is a job that requires classification and standardization under a number of specific criteria. It is very difficult to enable this to happen when there exist multiple ministries and institutions implementing activities in overlapping jurisdictions in the same areas.

As a result, difficulties exist with regard to coordination between related ministries and institutions in terms of managing the land of the Kingdom of Cambodia. This has made it difficult to prevent the illegal deforestations that have been spreading through the country's natural protected areas and other areas, leading to multiple land conflicts throughout Cambodia.

As a result of the above overlaps, we do not know what specific institutions are responsible for dealing with each conflict. Another problem is that different ministries use their different jurisdictions over the same land resources for different purposes, which leads to difficulties in setting clear boundaries and lack of clarity and disorder with regard to land concession management.

Mineral resource management

The Law on Mineral Enterprise Management defines a mineral resource as any substance, whether in solid, liquid or gaseous form, that naturally originates, or results from a geological process or mining, in or on the land, or in or on the sea or seabed, including gemstones, coals, metal and non-metal mines, mineral water, rock, gravel, sand, clay, petroleum and gas.

According to the Protected Area Law, the Ministry of Environment has jurisdiction over management of natural resources and natural protected areas, and the term "natural resources" also includes any mineral resources that may be found in these natural protected areas.

Meanwhile, according to the Law on Forestry, the Ministry of Agriculture, Forestry and Fisheries reserves the right to assess the situation prior to the extraction of rocks, soil, sand, mines or other natural resources in permanent reserved forests.

On a separate note, the Law on Water Resource Management gives the Ministry of Water Resources and Meteorology the right to issue water permits for sand, soil, rock, gravel, petroleum and gas extraction from riverbeds, coastal areas, river banks, lakes, ponds, canal and streams.

In relation to this, the Ministry of Mines and Energy has the jurisdiction to manage the mineral sector, which includes petroleum, gas and mineral enterprises, mineral developments and all uses of mineral resources, sand, gravel and other building materials, as well as the management of mineral wells. The Ministry of Mines and Energy is also authorized to grant mineral resource licenses to concessionaires to implement their mineral operations. Mineral operations include the acts of prospecting and exploring, as well as commercial mineral activities.

According to the definition of "mineral resources", these are found on land, in land, in the sea, on the sea bottom, in rivers, in streams, in tributaries, in lakes, in ponds and in other sources. Such resources may also come under the management jurisdiction of the Apsara Authority, the Preah Vihear Authority and the Tonle Sap Lake Authority, if they are found in these areas.

The Ministry of Environment reserves the right to give counsel and direction to other related ministries whose work relates to the management and utilization of natural resources, which include mines, energy, petroleum, minerals of gaseous form, rock, sand, gemstones, etc. The related ministries should discuss with the Ministry of Environment any work related to the development, conservation and utilization of natural resources, and the Ministry of Environment must notify the related ministries immediately in any case where it becomes aware that these natural resources are not being managed, developed and used reasonably or sustainably. This means that the Ministry of Environment also reserves the right to participate in managing and conserving mineral resources. Apart from this, the Ministry of Environment also has mandate to carry out Environmental Impact Assessments on such development projects.

On reviewing the above jurisdictional aspects, overlapping jurisdictions exist when one management jurisdiction related to mineral resources falls across two different ministries, and the only different is that Ministry of Water is authorized to grant water resource license, and Ministry of Mines and Energy is authorized to gran mine resource license.

Moreover, mineral resource management also falls under the jurisdiction of four ministries and of different authorities in various sites. When the mines to be explored and commercialized are under the land surface and in natural protected areas, a question relates to

whether the Ministry of Environment should have to issue a license or permit first? There seems to be no provision on this matter.

Water and fisheries resource management

Water and fisheries are also natural resources. According to the Law on Environmental Protection and Natural Resource Management, the Ministry of Environment must instruct related ministries on work carried out in the management and use of natural resources, including fish, water and fishery resources. These fisheries and water resources are also found in natural protected areas that come under the Ministry of Environment – in particular coastal area. Related ministries must discuss with the Ministry of Environment any work related to the development, conservation, management and utilization of these natural resources. The Ministry of Environment must also disseminate information immediately to the related ministries when it sees that these natural resources are not being developed, managed and used reasonably and sustainably. This means that the Ministry of Environment also has partial jurisdiction over water resources and fishery resources. In addition, the Ministry of Environment has the competence to carry out Environmental Impact Assessments on development projects.

The Ministry of Agriculture, Forestry and Fisheries has jurisdiction over the management of the forestry sector, flooded forests and mangrove forests in any areas related to the lifecycle of fishery resources. The Ministry of Agriculture, Forestry and Fisheries also has the competence to take part in strengthening law enforcement with regard to any fishery offenses existing in the natural protected areas in coordination with the Ministry of Environment. The Ministry of Agriculture, Forestry and Fisheries also reserves the right to authorize any legal person or legal entity to carry out fishery business activities and collect fishery resources (fishery sites include permanent flooded areas, tributary areas of the Mekong River and areas that receive water as a result of the high tides and low tides of seas, which serve all crucial fishery activities).

The Ministry of Water Resources and Meteorology also has jurisdiction over natural resource management, and also must discuss with related ministries on water resource matters except for when necessary, when the Royal Government of Cambodia may intervene by forming a joint committee tasked with dealing with and coordinating the collaboration work between ministries. With regard to the responsibility to manage reservoirs (basins), sub-

reservoirs (sub-basins), slope water, ground water, the Ministry of Water Resources and Meteorology should work with other related ministries.

The Ministry of Water Resources and Meteorology is authorized to grant water resource licenses for:

- Navigating, drawing or use of water resources for the purpose of agricultural cultivation, industrial activities that are off-limits and the building of water use settlements;
- Filling of rivers, tributaries, streams, canals, lakes, water storage and natural reservoirs;
- Uses of ground water (basin) for commercial purposes that are off-limits as stated in Article 11 of the Law on Water Resource Management (all persons reserve the right to use water resources as needed).

The Ministry of Water Resources and Meteorology has the competence to establish Water User Communities. It also has the competence to declare contingency or protected "water use" zones in the following cases:

- When surface or underground water sources are seriously affected in terms of their quantity, quality or ecological balance;
- When the watershed is degraded by human activities or natural causes;
- When water is hazardous to people's health.

According to the Sub-Decree on River Basin Management of the Royal Government of Cambodia, the Ministry of Water Resources and Meteorology is the leading institution with regard to inspecting, facilitating, managing, protecting, conserving and developing the river basin according to the spirit of the Law on Water Resource Management. A National Committee for River Basin Management is to be established and to be responsible for creating policies to inspect, assess and create master strategic plans related to the management and conservation of river basins, and to monitor water-related aspects in river basins and climate change factors.

Apart from this, the Ministry of Rural Development has jurisdiction to create clean water resource planning and improve sanitation, including through well digging and maintenance and through water filtering and storage with the purpose of sustaining citizens' welfare, as well as digging ponds and master tributaries for communities' water use.

According to the Sub-Decree on Organization and Functioning of the Ministry of Public Works and Transportation, the Water Department of the Ministry of Public Works and Transportation shall inspect building activities on (in) rivers, under rivers and in the air space around rivers, and is able to create measures to restore good river depths to serve public transportation. It shall also monitor water resource requests to draw water from or add water into rivers, which may affect water depths.

According to the above jurisdictions on water resources and fisheries, we see that:

- There are three ministries whose jurisdiction is related to the management, conservation, development and usages of water and fishery resources: the Ministry of Environment, the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Water Resources and Meteorology. This brings about a situation of overlapping jurisdictions. Since water and fisheries resources are present in the protected areas that come under the Ministry of Environment, this Ministry should have jurisdiction over such resource management and conservation. However, the Ministry of Agriculture, Forestry and Fisheries also has jurisdiction over the fishery sector; it is even authorized to participate in legal enforcement related to fishery offenses that occur in Protected Areas in collaboration with Ministry of Environment. In addition, the Ministry of Agriculture, Forestry and Fisheries reserves the right to grant licenses for the use of fishing areas for fishery collecting enterprises. This means that the Ministry of Environment can only advise the Ministry of Agriculture, Forestry and Fisheries on natural resource management and utilization, which also includes fishery resources. The issue here relates to potential disagreements between the two ministries on natural resource management.
- In relation to water resources, the Ministry of Water Resources and Meteorology has exclusive jurisdiction over the management of water resources, including the management of river basins, water resource licensing and determining areas for water use. This brings about another overlap in jurisdictions. The Law on Water Resource Management and the Law on Environmental Management and Protection require the two ministries to come into discussion with other related ministries. However, again, an issue arises when the two ministries do not agree on water resource management. What should the solution be? Meanwhile, there are also concerns regarding situations when the Ministry of Water Resources and Meteorology gives a license for a

commercial industrial activity that affects work to conserve water resources (for bio-organisms and biodiversity resources). If the Ministry of Environment disagrees with the decision to issue such a license, can the Ministry of Water Resources and Meteorology still issue the license anyway? In addition to this, in another case of overlapping jurisdictions, the Ministry of Public Works and Transportation reserves the right to make water resource requests to draw water from or add water to the rivers, which may affect water depth. For water uses that involve drawing water from the rivers, how many ministries need to issue a license?

- Another overlapping jurisdiction exists in relation to the Ministry of Rural Development, in terms of providing clean water. The Ministry of Rural Development may dig wells, use filtering storage for water resources, dig ponds and master tributaries and build dikes as ways to provide water for communities. Meanwhile, the Ministry of Water Resources and Meteorology takes the responsibilities for managing river basins, streams, ponds, tributaries, canals, water storage and water on the ground and under the ground to ensure a sustainable amount of water and a balance for the country's ecosystems. As such, does the Ministry of Rural Development need to first discuss with or obtain agreement from the Ministry of Water Resources and Meteorology and the Ministry of Environment in relation to its activities listed above? What about when it is unnecessary to do so since the water is used to serve the people's needs? How should the Ministry of Environment manage, conserve and utilize water resources to ensure the sustainability of water, water volume and water quality, and maintain the balance of the country's ecosystems?

In relation to the area of building infrastructure, in particular bridges across rivers, tunnels under rivers and infrastructure related to the airspace surrounding rivers, such activities need a license from the Ministry of Public Works and Transportation. This means there is another overlap, this one with the jurisdiction of the Ministry of Water Resources and Meteorology, since construction of small or big bridges across rivers or tributaries, or of ports on the shores or banks of a river, first needs scientific approval from the Ministry of Water Resources and Meteorology. Thus, all infrastructure to be installed or built across rivers has to have a license from the Ministry of Water Resources and Meteorology and also from the Ministry of Public Works and Transpiration. In another area, the Ministry of Public Works and Transportation reserves the right to extract water from rivers to ensure a good depth for

public transportation. Does such an activity need a license from the Ministry of Water Resources and Meteorology?

Conservation of biodiversity and ecosystems

The Ministry of Environment has the main jurisdiction over the management and conservation of biodiversity and ecosystems, whereas the Ministry of Agriculture, Forestry and Fisheries has jurisdiction over the protection of biodiversity and ecosystems in the permanent reserved forest and fishing areas located in its territorial jurisdiction. Meanwhile, the Ministry of Water Resources and Meteorology has jurisdiction over the management of water and is charged with ensuring the quantity and quality of water and ecological balance in the water.

As such, we can see that the three ministries above all seem to have jurisdiction over the management and conservation of biodiversity and ecosystem; however, there are no clear provisions related to this issue, or any provisions dealing with mechanisms for coordination among relevant ministries. Biodiversity and ecosystems cannot be managed and conserved in a sustainable manner through the division of territorial jurisdiction of management among the three ministries, given that biodiversity and ecosystems have the potential to move from one place to another in a natural way.

3.2.2.4.2. Overlapping jurisdictions in environmental protection

The Ministry of Environment has the main jurisdiction over the protection of environmental quality through the prevention, mitigation and control of pollution of air, water and land and the nuisance caused by noise and vibration, as well as waste, toxic substances and other hazardous substances. With this role, the Ministry is authorized by law to manage and control environmental pollution from various sources and also has the jurisdiction to manage liquid, solid and sludge waste and hazardous waste in factories, enterprises and companies. Moreover, the Ministry of Environment also has jurisdiction over the issuance of permits for the discharging of liquid waste from various polluting sources and permission related to investment in the construction of incinerators, dumping places and treatment of hazardous waste. Moreover, the Ministry has exclusive jurisdiction over Environmental Impact Assessments for both private and public investment projects. This mechanism has been established in order to ensure environmental quality and to enable the Ministry of

Environment to impose sanctions (monetary fines) with regard to offenses related to environmental pollution.

The Ministry of Agriculture, Forestry and Fisheries also has jurisdiction over the prohibition of dumping, disposing of, draining or spreading, in fishing areas, of solid or liquid waste or toxic substances that have been determined by laws and international conventions, and has the mandate to prohibit activities that pollute or cause harm to aquatic animals and plants. Moreover, the Ministry has the right to impose monetary sanctions with regard to offenses of draining waste into fishing areas.

According to the above, we can see that there is an overlap of jurisdictions between two ministries in relation to water pollution and monetary sanction for offenses related to releasing waste into fishing areas or water sources. However, Article 8 of the Sub-Decree on Water Pollution Control determines that the Ministry of Environment has jurisdiction over the control of all dumping or draining of liquid waste from the polluting sources and over the regular monitoring of the situation of water pollution along public water areas throughout the Kingdom of Cambodia. The Ministry of Environment also has jurisdiction over the inspection of all polluting sources.

The Ministry of Water Resources and Meteorology has jurisdiction over the granting of water licenses to permit the discharging, leaving behind or keeping of toxic substances that may adversely impact water quality, and that could cause harm to humans, animals or plants. The release of toxic waste in water sources without a permit is a criminal offense. Therefore, the jurisdiction of the Ministry of Water Resources and Meteorology overlaps with that of the Ministry of Environment and the Ministry of Agriculture, Forestry and Fisheries in relation to the protection of water quality and water pollution.

According to the Sub-Decree on Solid Waste Control, the Ministry of Environment has jurisdiction over the management and control of the disposing, collecting, transporting, storing, processing and dumping of hazardous rubbish or waste, and over the granting of permits for investment in or construction of places for dumping, incinerating, storing or recycling rubbish. Waste owners shall prepare and submit quarterly reports to the Ministry of Environment in relation to hazardous waste. In addition, according to Article 16 of the Sub-Decree, the collection, transportation, storage and dumping of hazardous waste in houses, markets, maternity clinics, hospitals, hotels, restaurants and public buildings comes under the

jurisdiction of municipal and provincial authorities, be in compliance with a Prakas of the Ministry of Environment on Guideline on Hazardous Waste Management. Article 22 of the Sub-Decree provides jurisdiction to the Ministry over the control of wrapping, keeping, transporting, storing, recycling, incinerating and treating to clean toxic substances and disposing of hazardous waste; the Ministry of Health has jurisdiction over the management of medical waste, such as keeping it separately from general waste, wrapping it up, collecting it and burning it in an incinerator or by means of sterile (saline) solutions.

According to the jurisdictions above, the control and disposal of medical waste seems to come under the jurisdiction of the Ministry of Health; however, control of the dumping of this hazardous waste is the jurisdiction of the Ministry of Environment. As such, we can see that the two ministries need to cooperate with each other; however, the law does not clearly determine this, and it is problematic that jurisdiction over the management of the same kind of waste has been given to two different ministries.

3.2.2.5. Gaps in the law in terms of jurisdictional determination

Following on from the above analysis of jurisdictions of relevant ministries, together with the research on relevant laws and regulations, we are able to identify gaps in the determination of jurisdictions of relevant ministries and institutions related to natural resource management and environmental protection as follows:

- There has been no preparation of botanical parks for the purpose of botanical study and research, and, in relation to this, there are no legal provisions related to the management and organization and establishment of botanical parks.
- In relation to the determination of maps to govern biodiversity areas on land, there are no laws or legal provisions that determine the boundary lines that divide biodiversity between the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Environment.
- In relation to the construction of hydropower dams, there are no legal provisions to directly govern this.
- There are no guidelines or legal instruments to clearly determine the mapping process and the determination of surface areas of land under ecosystem services in order to make it possible to make decisions on the determination of areas that are subject to protection or biodiversity conservation.

In general, many national policies and pieces of legislation have been established by the Royal Government of Cambodia for the management and conservation of biodiversity within or outside the Protected Areas System. However, based on this study, it seems that almost all sectoral policy and legislation has been developed on an *ad hoc* basis according to individual sectors and institutional circumstances. Almost all sectoral laws exclude financial mechanisms and implementation measure, as well as resourcing. This gap limits law enforcement and participation from all relevant stakeholders.

Learning from this, it appears that there is a need to establish and strengthen coordination mechanisms, mobilize adequate resources and enhance capacity to review and amend laws to be coherent and consistent and to contain clear mandates for individual institutions. To achieve biodiversity conservation, the national policy and laws on biodiversity should be established urgently. Fortunately, in February 2016, Prime Minister Hun Sen announced a reform of jurisdictions to give a mandate to the Ministry of Environment for environmental protection within the Protected Area System to include twenty-three Protected Areas. The Ministry of Agriculture, Forestry and Fisheries has responsibility for production forests and economics land concession areas, and the protection and management of fisheries. Therefore, soon sectoral policies have been amended within this new reform.

3.2.2.6. Protected Area expansion and Biodiversity Corridor establishment

Cambodia's contribution to the world Protected Area System is noteworthy. In the past three years, the country has added a bit more than 23 per cent of its territory to the system. including corridors that ensure the necessary connectivity; wildlife sanctuaries protecting important fauna and flora, including endangered species that are found mainly in Cambodia or can breed only in Cambodia; a marine national park; a genetic conservation area to protect some of the country's rare genetic materials; natural heritage parks and landscapes; and areas that can be used for many purposes.

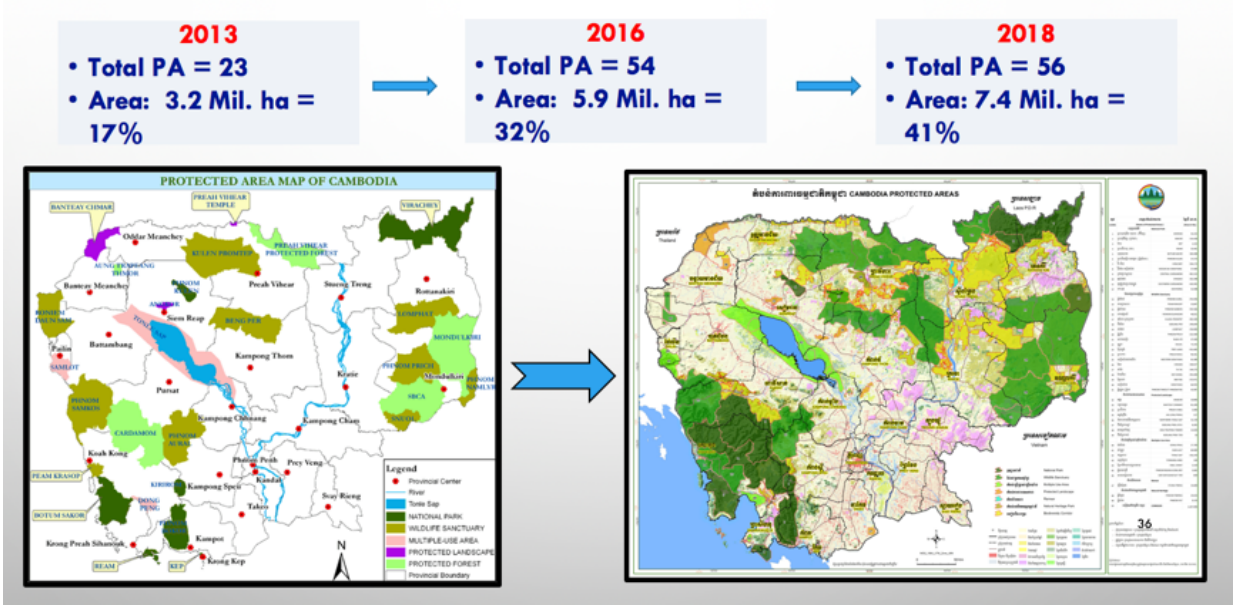


Fig. 17. Protected Area System Expansion

This addition represents less than 0.05 per cent at the global level but its role is significant. Cambodia's Protected Area System provides sanctuary to almost 2 per cent of globally threatened species on IUCN Red List, including thirty-four mammals, thirty-nine birds and twenty reptiles. For example, the Prek Toal Core Area of the Tonle Sap Biosphere Reserve is an internationally recognized priority site, the habitat for globally important bird colonies. Populations of many of the targeted globally threatened bird species (e.g., the greater adjutant (*Leptoptilos dubius*), the lesser adjutant (*Leptoptilos javanicus*) and the white-shouldered ibis (*Pseudibi davisoni*)) are increasing in Protected Areas.

3.2.2.7. Human resource and institutional capacity assessment

A 1993 Decree of the Royal Government of Cambodia designated twenty-three Protected Areas comprising approximately 18 per cent of the total land area of the country. Following IUCN categorization (IUCN, 2004), these Protected Areas can be classified into National Parks (seven), Wildlife Sanctuaries (ten), Multiple Use Areas (three) and Protected Landscapes (three). Through Royal Decree (2001) and Declaration No. 4010 (1999), one Biosphere Reserve has been established and three Ramsar sites have been identified in addition to the twenty-three Protected Areas. These Protected Areas are managed by the

General Department of Administration for Nature Conservation and Protection of the Ministry of Environment under the Law on Protected Areas 2008.

In addition, the Royal Government of Cambodia has designated six Protected Forests, which are managed by the Ministry of Agriculture Forestry and Fisheries. The management of Protected Forests is regulated under the Law on Forestry and relevant royal decrees, sub-decrees and declarations of the Ministry of Agriculture Forestry and Fisheries.

Each type of Protected Area has a specific inclusion definition and management objective. The management of Protected Ares complies with the Royal Decree on the Creation and Designation of Protected Areas 1993, the Law on Environmental Protection and Natural Resource Management 1996 and the Protected Area Law 2008, which define a framework of management, biodiversity conservation and sustainable use of natural resources within Protected Areas.

Other Protected Area-related legislation and regulations include the Environmental Impact Assessment Sub-Decree 1999, the Biosafety Law 2008, the Law on Forestry 2002 and the Law on Fisheries 2002, alongside other relevant laws, royal decrees, sub-decrees and declarations.

Protected Areas are the main approach to biodiversity conservation in Cambodia.

According to data collection and interviews in 2012 by the Department of International Convention and Biodiversity, the twenty-three Protected Areas have residents within or around them. Tourism activities, unsustainable use of natural resources, illegal logging, wildlife trade and insufficient resources are the main challenges to Protected Area management. Meanwhile, the resources for Protected Area management are generally considered insufficient, and updated information and practical evaluation are lacking. This study recommends that responsible institutions increase the budget and sustain their financing for effective management of the Protected Area System in Cambodia.

This section aims to identify the fiscal gap and financing needs for Cambodia's Protected Area management. The overall objective is to analyze the resource gaps in Protected Area management. The research looks at the twenty-three Cambodian PAs under the administration and management of the Ministry of Environment. The data was analyzed based on setting internal and external indicators and relevant criteria as appropriate. The findings related to resource gaps, and the recommendations, on filling these gaps by increasing national budgets

and recruiting more rangers or full-time staff, are expected to be used by responsible institutions for the effective management of Protected Areas in Cambodia.

Research was conducted using both primary and secondary data/information collected from 23 Protected Areas established by Royal Decree in 1993. The data was collected directly from each Protected Area's manager, key experts, relevant institutions, partners and stakeholders, alongside any other relevant sources.

Analysis of data collection, cluster classification and benchmark identification were based on the following methodologies.

Primary data collection and surveys

A research questionnaire was designed in Khmer language for data collection from the twenty-three Protected Areas. It was divided into four parts:

1. Part 1 focused on background information of the Protected Area, including name, date of establishment, land area, location, IUCN classification and purpose.
2. Part 2 related to the physical characteristics of the Protected Area, including access to the Protected Area, inhabitants, travelling within the Protected Area and facilities available within the Protected Area.
3. Part 3 aimed to gather information on visitor characteristics, such as the number of visitors to the Protected Area, the visitors' entry fee, visitor accommodation fees and activity fees.
4. Part 4 captured information on staffing revenues and costs, numbers of staff, staff capacity, operation expenditure, fee collection and annual revenues for an individual Protected Area.

Secondary data collection

Some data could not be collected from the field. In this case, the team communicated directly with relevant institutions, local authorities and international agencies through available contact persons and sent official letters to request cooperation in providing data. Data/information from research projects, annual reports, censuses, materials from workshops and seminars was also collected.

Data analysis

To analyze the fiscal gap for each Protected Area, pressure and response indicators were identified. The pressure indicators were population within a 5 kilometer radius; visitors; and road and hiking trails. These study selected number of full-time staff and operational expenditures in 2009 as the response variables to assess the response to pressure factors as represented by population; visitor numbers; and roads and hiking trails.

Analysis of the population focused on the total population in the five most populated villages within a 5 kilometer radius of the boundary; a lower population represented less pressure on natural resources. Total operational expenditure from the Royal Government of Cambodia budget and other external sources supported activities in some Protected Areas.

The study carried out an analysis of pressure and response indicators and a comparison of these against benchmarks on the response indicators constructed as set out below. This was then used to identify resources gaps in relation to the response indicators.

Benchmarking on response indicators

According to the size variance of each Protected Area, and to maximize the accuracy of the resulting gap analysis, the twenty-three Protected Areas were classified into three clusters, as follows:

- Cluster 1: Protected Areas with a total land area from 0 hectares to ≤5,000 hectares; two Protected Areas;
- Cluster 2: Protected Areas with a total land area from >5,000 hectares to ≤50,000 hectares; six Protected Areas;
- Cluster 3: Protected Areas with a total land area from >50,000 hectares to ≤402,500 hectares; fifteen Protected Areas.

A benchmark of response indicators was identified for each cluster to analyze resource gaps, carried out for full-time staff (FTS) per 1,000 hectares and operational expenditure (OpEx) per hectare. The average and highest indicators of FTS/1,000 hectares and OpEX/hectare within each cluster are used as benchmarking tools to estimate gaps.

Resource gaps in the response in Protected Areas

According to a method introduced by the Economy and Environmental Program for Southeast Asia (EEPSEA, 2012), the following rules were applied in the calculation of resource gaps:

1. If Number of FTS & OpEX is lower than the average in the Cluster, bring the value of FTS & OpEx to the Cluster *Average (Avr)*.
2. If Number of FTS & OpEX is higher than the average in the Cluster, bring the value of FTS & OpEX to the *Highest* (*Hst*) value in the Cluster.

The resource gap analysis was carried out by comparing existing resource allocation for Protected Area management with the Average and Highest of individual Clusters. The comparisons present scenarios for looking at how Protected Areas are currently managed and should stimulate discussion as to whether any action needs to be taken for further improvement.

Table 7. Clusters and Benchmarks for Full-Time Staff and Operational Expenditure

PA Total Area Clustering			**FTS**			**OpEx**		
Cluster interval (ha)	No. of PA in Cluster	Avr total area (ha)	Avr no. FTS	Avr no. FTS per 1,000 ha	Hst no. FTS per 1,000 ha	Avr OpEx (US$)	Avr OpEx per ha (US$)	Hst OpEx per ha (US$)
Total = 23		**Highest = 402,500 ha**			**Lowest = 27,95 ha**			
0–≤5,000	2	3,898	10.50	2.97	3.94	7,570	2.10	2.67
>5,000–≤50,000	6	28,004	30.17	1.03	1.77	17,576	0.60	0.94
>50,000–≤402,500	15	209,919	45.93	0.25	0.52	74,725	0.30	1.24

As we saw above, Cambodia's Protected Areas were divided into three clusters based on size for the purposes of this analysis. Cluster 3 represents the highest number of Protected Areas in the study, or the amount of fifteen out of twenty-three Protected Areas. According to

the data in Table 7, the average total land area in Cluster 1 is 3,898 hectares, that in Cluster 2 is 28,004 hectares and that in Cluster 3 is 209,919 hectares; Kulen Promtep Wildlife Sanctuary has the highest total land area of 402,500 hectares.

In 2009, 204,117 Cambodians visited 9 Protected Areas: 3 National Parks, 3 Wildlife Sanctuaries, 1 Protected Landscape and 2 Multiple Use Areas. The same year, 339,199 foreigners visited 10 Protected Areas. Therefore, the total number of tourists recorded in 2009 was 543,316 people. However, Bokor National Park and Phnom Kulen National Park, as well as Angkor Multiple Use Area, are not included in this analysis: the information on the number of visitors in these Protected Areas could not be obtained as these are managed by other agencies and private companies.

According to interview information received from Protected Area directors, deputy directors, rangers and commune chiefs, the revenue of each Protected Area is generated through entry fees (US$ 0.25–0.75 for local visitors and US$ 5 for foreigners), accommodation, facilities such as boat rentals, car parks and guide fees, etc. Tourist facilities and accommodation rates vary from Protected Area to Protected Area depending on customer demand. For a Protected Area whose road condition is not so good and that is far from the town, entry fees are lower – for example US$ 0.12 per person. Some Protected Areas entail additional charges for visitors to see rare species.

Pressure indicators

Population of the five largest villages within a 5 kilometer radius in 2009: The total population in the five largest villages within a radius of 5 kilometer from the border of each Protected Area is 347,625 people.

Roads and hiking trails: Roads and trails in each Protected Area have been constructed for filed monitoring recreation and ecotourism. Phnom Prich Wildlife Sanctuary has the largest road (380 kilometers), while Botum Sakor National Park has more trails (1,750 kilometers) compared with other Protected Areas. On the other hand, for Roniem Daun Sam Wildlife Sanctuary, no road has been constructed. Preah Vihear Protected Landscape has only a 4 kilometers trail.

Response indicators

Number of full-time staff in 2009: The Ministry of Environment has set up thirty-two offices and seventy-eight sub-offices around and within twenty-three Protected Areas. For daily operations, the Royal Government of Cambodia has employed 891 full-time staff to work in 23 PAs.

Operational expenditures in 2009: The operational expenditure for each Protected Area, including staff salary, uniforms and medicine, is covered under the budget of the Royal Government of Cambodia. Other operational costs, such as project-based activities, are supported by other donors. Total operation expenditure in 2009 for twenty-three Protected Areas was US$ 1,241,476.

Response versus pressure

This research compared pressure with response in pairs as follows: Population vs. Full-Time Staff; Population vs. Operational Expenditure; Visitors vs. Full-Time Staff; Visitors vs. Operational Expenditure; Roads vs. Full-Time Staff; and Hiking Trails vs. Full-Time Staff. Roads and Hiking Trails identified as pressure factors are elaborated in the following paragraph.

Population vs. Full-Time Staff: According to data collected from all Protected Areas in 2009, the distribution of the population and full-time staff per 1,000 hectares tended to have a positive association in general: the greater the population, the more full-time staff were employed. In this regard, high pressure by population within a 5 kilometer radius in Protected Areas had the response of a higher number of full-time staff, except in Angkor Protected Landscape, which had fewer full-time staff (0.93/1,000 ha) in proportion to the population of 4,212.50 per 1,000 hectares compared with the situation in other Protected Areas.

Population vs. Operational Expenditure: The same source of data – that is, directors and rangers in twenty-three Protected Areas in 2009 – was consulted on the distribution of the population and operational expenditure for twenty-three Protected Areas and this also resulted in a positive trend; the results indicated that the greater the population, the more staff were employed for management. However, the distribution of both factors in Preah Vihear Protected Landscape, Phnom Samkos Wildlife Sanctuary and Kirirom National Park saw more response to less pressure. This was especially the case in Preah Vihear, with operational

expenditure of US$ 1,533 per 1,000 hectares in 2009 with no population within the Protected Area. Meanwhile, Angkor Protected Landscape had fewer resources in terms of operational expenditure (US$ 470.09/1,000 hectares) to respond to a high population of 4,212.50 per 1,000 hectares.

Visitors vs. Full-Time Staff: Only nine Protected Areas had recorded the number of visitors. The distribution of pressures and response factors in terms of visitors and full-time staff, respectively was thus analyzed only for the nine Protected Areas that had data available. The trend of was towards a positive relationship, although three Protected Areas (Preah Vihear Protected Landscape, Kirirom National Park and Peam Krosop Wildlife Sanctuary) were experiencing high pressure because the number of full-time staff did not fully respond to the number of visitors, leading to limited human resources for effective management in these Protected Areas.

Visitors vs. Operational Expenditure: The distribution of the number of visitors per 1,000 hectares and total operational expenditure per 1,000 hectares in the twenty-three Protected Areas also displayed a positive trend. Distribution of visitors ranged from 0 to 3,589 per 1,000 hectares, while operational expenditure saw a distribution range from US$ 82.27 per 1,000 hectares in Roniem Daun Sam Wildlife Sanctuary to US$ 2,674.06 per 1,000 hectares in Kep National Park. In general, many distributions of both factors showed on less pressure.

Roads vs. Full-Time Staff: Length of roads per 1,000 hectares is considered a pressure factor in Protected Area management because this makes it easier for poachers to conduct illegal activities within the Protected Area. Length of roads can also be considered a response factor in relation to potential road use by Protected Area managers or rangers in controlling other activities. Nevertheless, this study deems existing roads within Protected Areas to be a pressure factor, even though road distribution tended to see a positive response. According to data in this study, there are outliers: Angkor Protected Landscape trended towards high pressure, with road distribution at 13.80 kilometers per 1,000 hectares, and Kep National Park saw high response, with four full-time staff per 1,000 hectares.

Hiking Trails vs. Full-Time Staff: Length of hiking trails was also considered a pressure factor. The results showed that almost all Protected Areas had enough staff to deal with illegal activities if poachers used only hiking trails.

Benchmarking

This study sets benchmarks of *full-time staff/1,000 hectares* and *operational expenditure/hectare* at *average* and *highest* points for each Cluster, to estimate and calculate resource gaps, using the above rules and methodology. However, resource gaps with regard to Protected Area management do not refer to the quality of full-time staff and sufficient financial resources for *effective* Protected Area management.

Resource gaps

To estimate resource gaps, the number of full-time staff/1,000 hectares and operational expenditure/hectare were identified as shown in Table 8. The serial number on the horizontal axis in Figures 18, 19, 20 and 21 represent each Protected Area.

The seven National Parks are:

1. Kirirom
2. Bokor
3. Kep
4. Ream
5. Botum Sakor
6. Phnom Kulen
7. Virachey

The ten Wildlife Sanctuaries are:

8. Phnom Aural
9. Peam Krasop
10. Phnom Samkos
11. Roniem Daun Sam
12. Kulen Promtep
13. Beng Per

14. Lomphat

15. Phnom Prich

16. Phnom Nam Lyr

17. Snoul

The three Protected Landscapes are

18. Angkor

19. Banteay Chmar

20. Preah Vihear

The three Multiple Use Areas are:

21. Dong Peng

22. Samlaut

23. Tonle Sap

Full-time staff gap

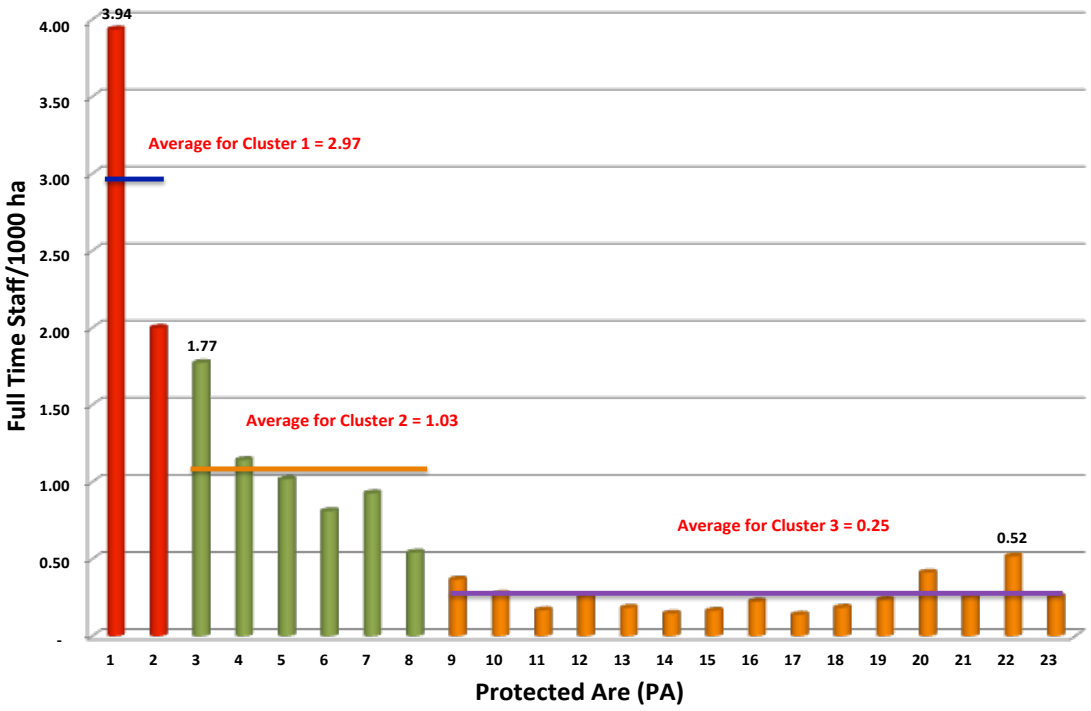


Fig. 18. Full-Time Staff/1,000 hectares

According to the *average* and *highest* benchmarks related to full-time staff (Table 7) and the data shown in Figure 18, Cluster 1 has only one Protected Area below *average*; Cluster 2 has four Protected Areas below and one Protected Area above *average*; and Cluster 3 has eight Protected Areas below and six Protected Areas above *average.*

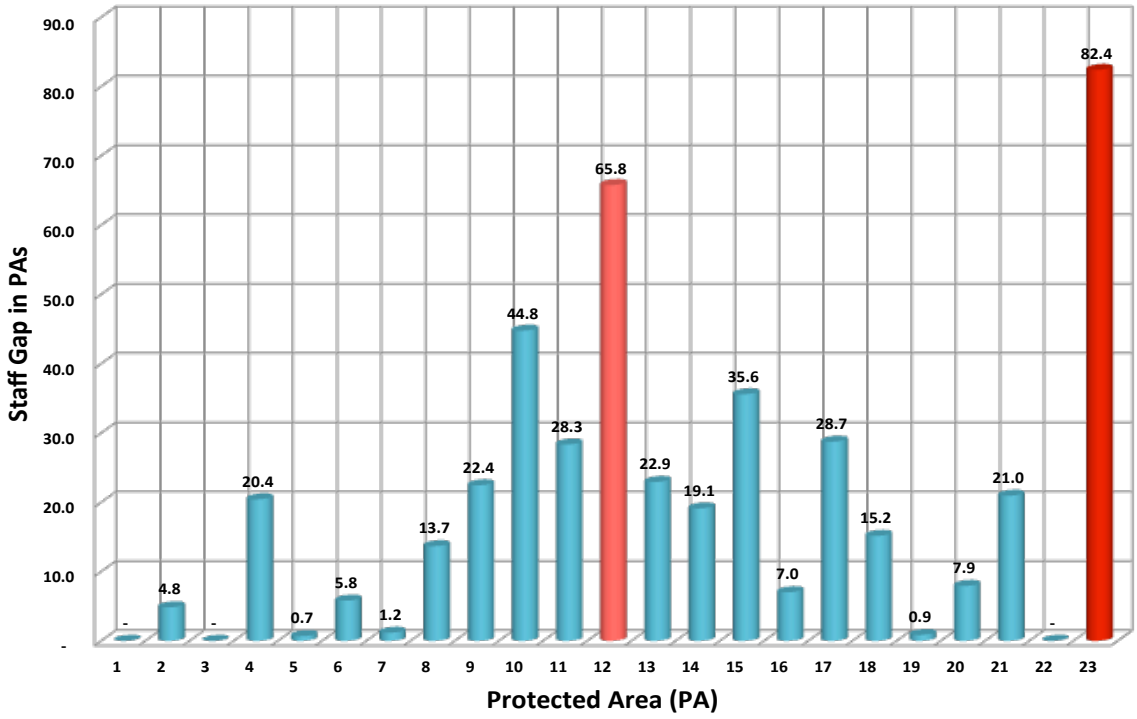


Fig. 19. Full-Time Staff Gap in each Protected Area

As such, Cluster 1 has 0.97 staff/1,000 hectares or a gap of approximately 5 (4.8) full-time staff; Cluster 2 has 1.47 staff/1,000 hectares or a full-time staff gap of 42; and Cluster 3 has 1.85 staff/1,000 hectares or a full-time staff gap of 402.

Figure 19 shows the calculation of the full-time staff gap in each Protected Area. Among the twenty-three Protected Area, only Tonle Sap Multiple Use Area and Phnom Aural Wildlife Sanctuary have a high full-time staff gap: the gap for Tonle Sap is eighty-two staff members and that for Phnom Aural is sixty-six. For other Protected Areas, the gap is between zero and forty-five staff.

The results of this full-time staff gap assessment indicate that an additional 449 staff members needed to be employed to add to the existing 891 staff members to meet the

benchmark of 1,340 staff members. This means that an additional third of the benchmark needs to be recruited.

Operational expenditure GAP

Assessment of the financial gap is based on the annual budget (2009) for Protected Area management of the Ministry of Environment.

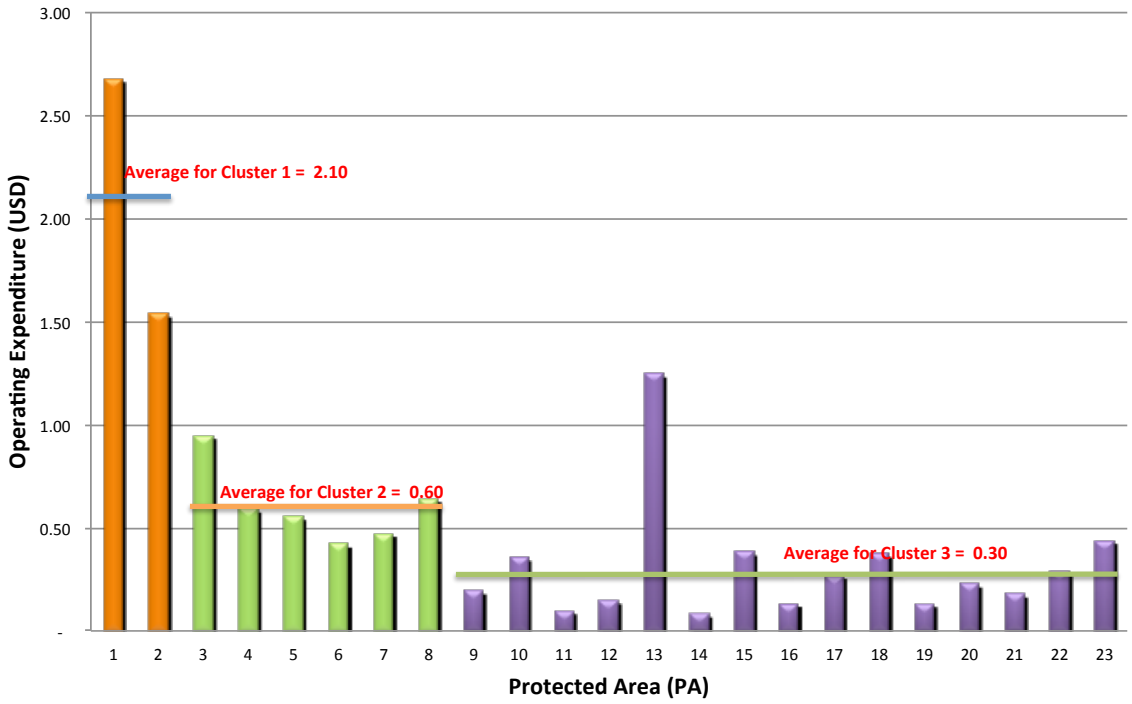


Fig. 20. Operational Expenditure per Hectare

The funding to support Protected Area management received from the Royal Government of Cambodia is for 40 persons (equivalent to US$ 499,515) and from other external sources is for 60 persons (equivalent to US$ 741,964). This amount of external resources pertains to only nine Protected Areas. Here too, not all donor funding is included, as some parts are undisclosed as a result of a policy of confidentiality. As such, this paper focuses only on donor funding that works with the Royal Government of Cambodia or that is used through joint projects with the Ministry of Environment.

Operational expenditure for each Protected Area includes salaries for full-time staff and expenditure on uniforms, medicine and conservation projects. The *average* and *highest* operational expenditure for each cluster is presented in Table 7. Figure 21 shows that Cluster

1 has an *average* expenditure of US$ 2.10/hectare and a *highest* expenditure US$ 2.67/hectare, so the total gap is US$ 2,853. In Cluster 2, operational expenditure in six Protected Areas does not vary greatly and is below the *average*: only Dong Peng Multiple Use Area is spending above the *average.* Therefore the total gap for this Cluster is US$ 16,886.

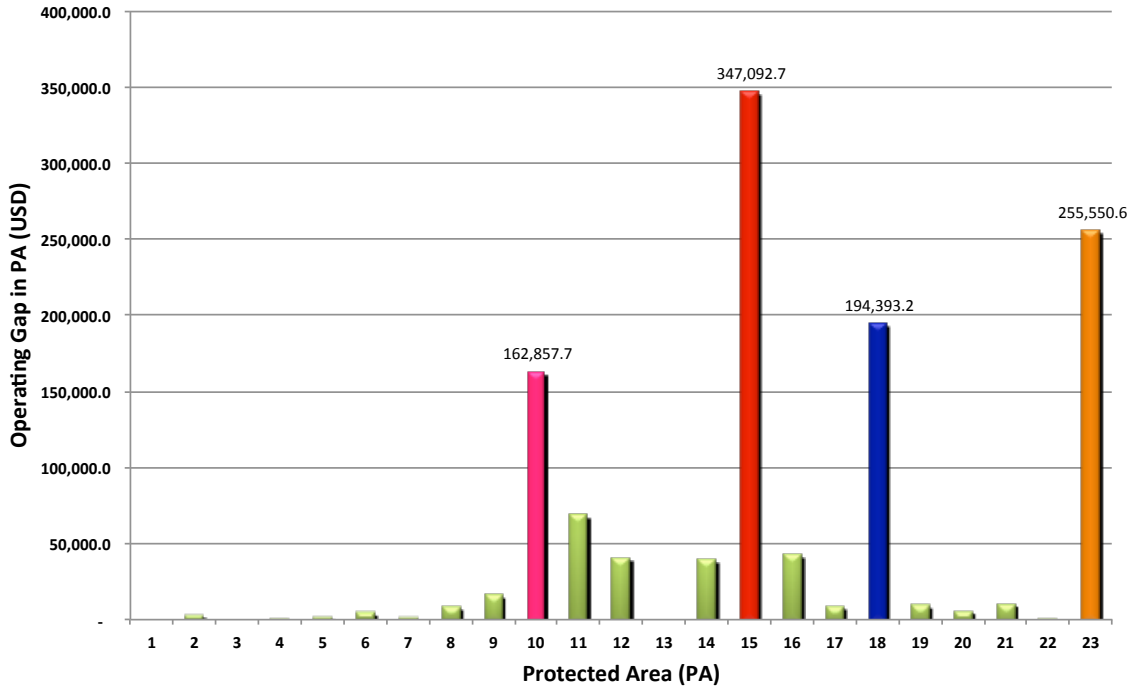


Fig. 21. Operational Expenditure Gap

The total gap with regard to operational expenditure in 2009 for twenty-three Protected Areas is US 1,221,405, or approximately 50 per cent of the benchmark estimation at US$ 2,462,881. For better management of the Protected Area System in Cambodia, operational funds should be increased to double what is in the 2009 budget.

Table 8 shows the results of our assessment of the resource gap with regard to full-time staff and operational expenditure for twenty-three Protected Areas.

This resource gap analysis is reliant on data availability in setting indicators. The gap analysis is based on *average* and *highest* full-time staff per 1,000 hectares and operational expenditure per hectare in 2009. The *average* and *highest* for both indicators varies from Cluster to Cluster according to the size of the Protected Area. Logically, the bigger the size of the Protected Area, the higher the number of full-time staff and the bigger the operational

budget. However, the results of this study show that the smaller the size of the Protected Area, the higher the *average* number of full-time staff and the higher the *average* amount of operational expenditure. In this case, expenditure is more than double that compared with in Protected Areas of the highest size.

Table 8. Resource Gap

Resources Gap Assessment	**FTS (number)**	**OpEx (US$)**
Existing resources (2009)	891.00	1,241,476
Estimated resource benchmark	1,339.55	2,462,881
Estimated resource gap	*448.55*	*1,221,405*

Generally, the Protected Areas with high resource gaps are those in Cluster 3, as this Cluster shows a very wide gap between *highest* and above *average*. For Cluster 1 and Cluster 2, each Protected Area does not differ greatly in terms of proportions.

The full-time staff gap in this research does not take into account the qualifications of the staff. As such, this study focuses on quantity only. To assess the effectiveness of Protected Area management, staff quality should be considered as an important indicator; it should thus be seen as an area for further research.

Protected Areas that depend on the government budget are able to support only staff salaries, uniforms and medicine. This budget is adequate neither for effective management nor to improve facilities for resource mobilization. However, more than half of total operational expenditure in 2009 was received from external sources. If this study could have assessed in detail the budgets of conservation projects for Protected Area management that are supported and implemented by external partners, the operation expenditure figure for the twenty-three Protected Areas would increase.

In conclusion, to assess the resource gap to understand the effectiveness of Protected Area management in relation to full-time staff, it is necessary to examine both quantity and quality, including skills and professional requirements, as well as other criteria such as management planning, equipment, operation facilities, etc. If there is no guarantee of quality, motivation and incentives, even if the number of staff members is adequate, then we cannot

be sure that Protected Area management will be successful or effective. Meanwhile, even though a third of the number of staff at the benchmark are required to fill the gap, if existing staff members can improve their capacity and have well-equipped facilities there will still be an improvement in Protected Area management.

As shown in Figures 20 and 21, this analysis of the fiscal gap and the gap in financing of Cambodia's Protected Areas was conducted to identify resource gaps in the management of twenty-three Protected Areas in Cambodia. However, in the research area of the North Tonle Sap Region, only sixteen Protected Areas are located, and only seven Protected Areas were selected for this study.

For these, the study again used a benchmark for full-time staff members per 1,000 hectares and operational expenditure per hectare.

The results show that the total gap with regard to full-time staff members in 2009 in these areas was 449, equal to 33.5 per cent of the benchmark estimation. The total operational expenditure gap in 2009 was US$ 1,221,405, equal to 49.6 per cent of the benchmark estimation.

In conclusion, for better management of Protected Areas, the budget for operations should be doubled; therefore, increasing it to US$ 2.5 million per year is necessary, from external sources.

3.2.2.8. Resource mobilization

Cambodia has increased the budget of the various ministries dealing directly with biodiversity over time. This will enable the ministries to improve their implementation of the NBSAP, engage more people in this work and enhance effectiveness and efficiency in this endeavor. However, there is also a need to put in place a strategy to mobilize resources for biodiversity conservation and sustainable use of natural resources.

3.2.2.8.1. Strategy development for sustainable management of biodiversity and ecosystems in the North Tonle Sap Region

The recommended strategies in this section respond to environmental issues, geographical locations and socio-economic opportunities in the North Tonle Sap Region. For effective management of biodiversity and ecosystems within and outside of the Protected Areas in the region, the following approaches are recommended: Ecotourism Development,

Ex-Situ Conservation and Payment for Ecosystem Services. As the Royal Government of Cambodia has increased the conservation area in the country to 7.5 million hectares, the last of these, Payment for Ecosystem Services, has become one of the more sustainable solutions to the issue of management of the Protected Area System. As such, we look at this in particular here.

3.2.2.8.2. Payment for Ecosystem Services

Ecosystem services refer to the profit and the contributions that ecosystems provide directly or indirectly to the people or to enhance human well-being (MEA, 2005). The Payment for Ecosystem Services mechanism involves people contributing to the financial sustainability of the operations, maintenance and management of natural resources of the services being provided by the area.

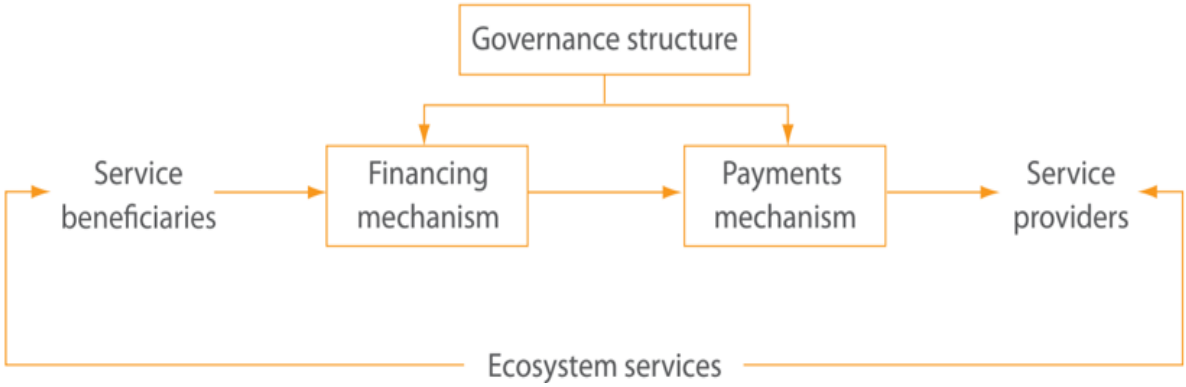


Fig. 22. The Payment for Ecosystem Services Flow Chart (*Pagiola and Platais, 2005*)

Cambodia's experience with Payment For Ecosystem Services shows that this innovative financing tool can be an effective incentive for the protection/conservation and sustainable use/management of biodiversity and related ecosystem services. Payment for Ecosystem Services is referred to in new strategic and policy documents. For example, it is featured in the National Action Program to Combat Land Degradation 2018–2027, the Cambodia Climate Change Strategic Plan 2014–2023 and the National Strategic Development Plan 2014–2018. The Environment and Natural Resources Code of Cambodia also devotes a great number of articles to Payment for Ecosystem Services schemes.

However, there is as yet no specific law or regulatory framework on Payment for Ecosystem Services. The issue of land property rights is of particular concern among local communities and indigenous peoples. Discussions are under way to agree on modalities and possible contents of a regulatory mechanism for Payment for Ecosystem Services.

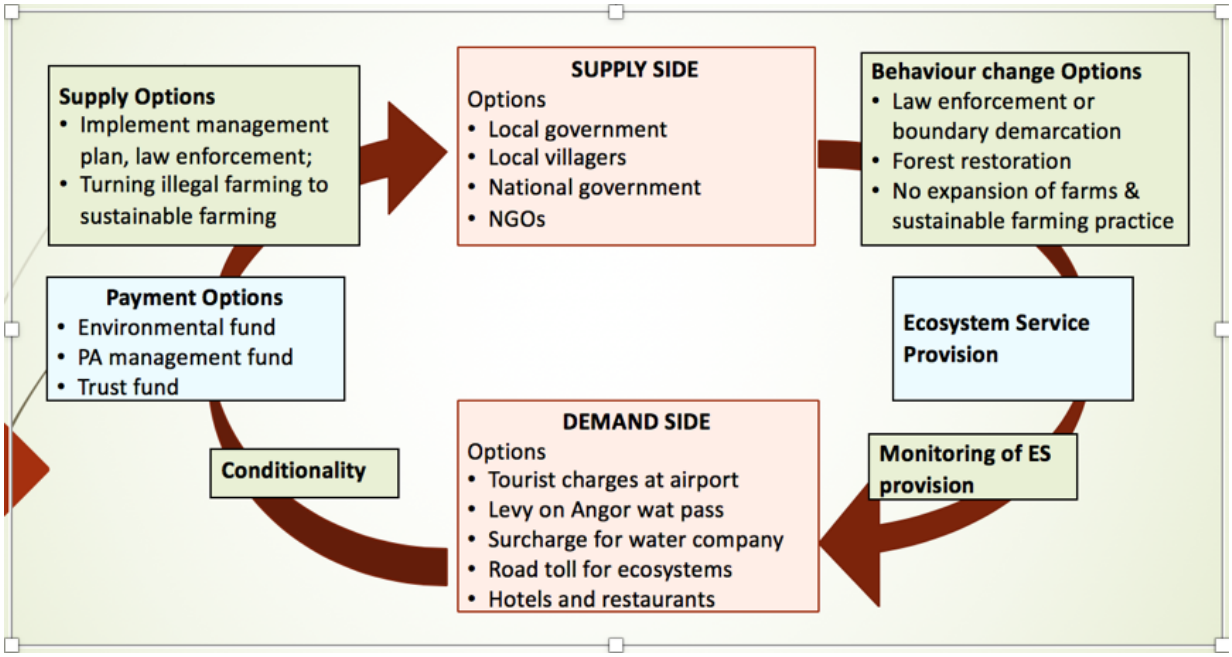


Fig. 23. The PES Process in Phnom Kulen National Park

In this paper, we consider:

1. Direct payments for biodiversity conservation of threatened species of fauna and flora, particularly the Nest Protection Program;
2. Community conservation agreements, particularly in the context of watersheds and ecotourism;
3. The Ibis Rice Program, or agri-environmental payment; and
4. The REDD+ projects and programs in which the environmental services involve carbon sequestration and the aim is to secure buyers from the voluntary carbon market.

Direct payments for the conservation of threatened species of fauna and flora, particularly the Nest Protection Program and the Ibis Rice Program, are functioning well. Examples of successful protection of nests and wildlife are reported. A key success factor is that these schemes are small in scale and have a relatively simple payment system without cumbersome transaction costs.

Underground and aboveground water in Siem Reap city, which is mainly sourced in Phnom Kulen National Park, has seen substantial extraction, at approximately 6.8 million meters cubed, and has been sold at an estimated value of US$ 1.9 million.

This study has found that the water supply in Siem Reap City, which is largely based on underground water, can supply approximately 30 per cent of the market; the remaining 70 per cent is based on private extraction of underground water by different types of business establishments (e.g. hotels, restaurants and other business establishment). The rate of annual underground water exploitation increased slowly from 1995 to 2005 but then went up abruptly from 2016 onward (Figure 24). The water exploited was less than 1 million meters cubed per year before 2006; trading reached 1.2 million cubic meters in 2006, 3.5 million cubic meters in 2010, 5 million cubic meters in 2015 and 6.8 million cubic meters by the end of 2018, traded at around US$ 1.9 million (US$ 0.28/cubic meter). Over time, water trading has increased more linearly (R2 = 0.97) than exponentially (R2 = 0.87), meaning that the increase in water consumption from one year to another has been relatively similar (e.g. 1 unit every year).

Compulsory water consumption charge

In this mechanism, we propose the introduction of a charge based on three categories of potential water consumers, relatively similar to what is used in the Kuntha Bopha Hospital Fund. These include Option 1: a charge of US$ 1/person for international tourists arriving at Siem Reap Airport; Option 2: a charge of US$ 0.50/night on the number of rooms occupied in three-, four- and five-star hotels; and Option 3: a charge of US$ 1/night on other types of accommodation such as two-star hotels, apartments, guesthouses and restaurants, regardless of number of rooms or size. Altogether, this compulsory charge can garner a revenue between US$ 2.9 million and US$ 3.6 million/year from Siem Reap City.

Voluntary contribution for water

One proposition would be for each person to contribute 1 per cent up to a maximum of 5 per cent of their annual net income to a Payment for Water Services program. This voluntary contribution will represent more revenue for the Protected Area Trust Fund created toeensure the sustainability of the ecosystem.

This study has found that the water system in Siem Reap City, which is based largely on underground water, can supply approximately 30 per cent of the market; the remaining 70 per cent comes from private extraction of underground water by different types of business establishment (e.g. hotels, restaurants and other business establishments). The rate of annual underground water exploitation increased slowly from 1995 to 2005 but then went up abruptly from 2016 onward (Figure 24). The water exploited was less than 1 million meters cubed per year before 2006; trading reached 1.2 million cubic meters in 2006, 3.5 million cubic meters in 2010, 5 million cubic meters in 2015 and 6.8 million cubic meters by the end of 2018, traded at around US$ 1.9 million (US$ 0.28/cubic meter). Over time, water trading has increased more linearly (R2 = 0.97) than exponentially (R2 = 0.87), meaning that the increase in water consumption from one year to another has been relatively similar (e.g. 1 unit every year).

In Phnom Kulen National Park, consumption from 1 to 2 cubic meters per family per day of stream and pumped water has been reported. This represents 0.37 million to 0.73 million cubic meters per year for ~1,000 families that live in Phnom Kulen National Park. Based on our survey, it is also reported that there are two local-scale trading bodies exploiting the underground water, which can supply from 10 to 17 cubic meters per day or 3,650 to 6205 cubic meters per year. Each local-scale business is operated by a family, which sells the pumped water to the nearby households.

The number of tourists and business establishments has a strong and significant positive association with water consumption in the two provinces, Sihanouk Vile and Siem Reap under study, suggesting that a very high rate of water consumption is the result of higher numbers of tourists and business establishments.

To mitigate the impact of water shortages in the city of each province of Sihanouk or Siem Raep and to better manage the ecosystem in Kball Chay Multiple Use Aare and Phnom Kulen National Park, thea first step of applying a Payments for Water Services scheme in the

two sites is proposed. Based on analysis of the current situation, an annual revenue from Payment for Water Services can be generated that is of US$ 2.9 to US$ 3.9 million for Phnom Kulen National Park in Siem Reap and from US$ 0.9 to US$ 1.1 million for KCMUA in Preah Sihanouk Ville.

Improved and sustainable management of the ecosystem can be achieved through adapting the focus of the ecosystem approach, for example through the integrated management of land, water and other living resources. Other than this, Payment for Ecosystem Services has recently gained a great deal of interest.

During the past decade, the number of tourists visiting Siem Reap City has increased exponentially (Figure 25). Moreover, we observe that the number of domestic tourists has increased faster than the number international tourists since 2010. International tourists prefer visiting Siem Reap City by plane rather than using other means (e.g. bus, boats, etc.). Within 11 months in 2018, as of November of that year, approximately 2.46 million international tourists had visited Siem Reap City, of which 1.76 million (159,754 tourists per month) travelled by plane to Siem Reap Airport.

In the near future, the number of international tourists visiting Siem Reap City by all means of all transportations is predicted to continue to increase, reaching 2.55 million, 2.62 million, 2.68 million and 2.71 million in 2019, 2012, 2025 and 2030, respectively.

A correlation analysis shows that water consumption in Siem Reap City is highly and positively correlated with the growing number of tourists. The correlation coefficients are very high ($R > 0.9$) and significant (Figure 24), indicating that, when the number of tourists increases, demand for water increases at the same time. The results of linear regressions also indicate that water consumption is highly associated with the number of tourists, explaining 95 per cent (adjusted $R2 = 0.949$) of the variation of water consumption in Siem Reap City.

Meetings with key stakeholders and a triangulation study have given us the chance to report important results related to the number of rooms in starred hotels, guesthouses, restaurants and apartments, and numbers of tourists and private companies. Important information obtained from villagers relates to the economic value of cashew nut plantations, ranging from US$ 0.75 to US$ 2.00 per kilogram, with an annual yield ranging from 0.3 to 1.5 tonnes/hectare.

Another important piece of information, obtained from the Provincial Department of Tourism, is that high-class guests/tourists staying in starred hotels consume water at an average rate of 300 litres/day. This data is crucial to the development of funding mechanisms for Payment for Ecosystem Services programming in Siem Reap City. Table 9 illustrates the details on the mechanism options.

Income generation is a key factor in sustainable development and the conservation of the ecosystems. The income generated from the ecosystem services in Siem Reap's Phnom Kulen National Park has to be in the form of a Protected Area Trust Fund, which represents a long-term secure source of funding for environmental and natural resource-based activities. Related to possible funding mechanisms identified (Table 9), there are two prioritized options for the payment mechanisms that can be feasibly implemented. Although others are of interest and need further discussion, the two following options are seen as more important and necessary to implement at this initial stage.

The number of tourists and business establishments has a strong and significant positive association with the water consumption in the two provinces Sihanouk and Siem Reap, suggesting that a very high rate of water consumption follows the increased number of tourists and business establishment.

To mitigate the impact of water shortages in the city of each province and to better manage the ecosystem in Kball Chay Multiple Use Aare and Phnom Kulen National Park, the first step of applying a Payments for Water Services scheme in the two sites is proposed. Based on analysis of the current situation, an annual revenue from Payment for Water Services can be generated that is of US$ 2.9 to US$ 3.9 million for Phnom Kulen National Park in Siem Reap and from US$ 0.9 to US$ 1.1 million for KCMUA in Preah Sihanouk Ville.

The water system in Siem Reap city, which is based largely on underground water, can supply approximately 30 per cent of the market; the remaining 70 per cent is based on private extraction of underground water by different types of business establishment.

A highly increasing trend of tourists and business establishments in Siem Reap City has been observed over the past decade, and numbers are predicted to continue to increase gradually until 2025. Based on these predictions, the number of international tourists visiting Siem Reap will accumulatively reach 2.55 million in 2019, 2.62 million in 2021 and 2.68

million in 2025, and will become relatively stable with a plateau value of 2.71 million in 2030.

During the past decade, the number of tourists visiting Siem Reap City has increased exponentially (Figure 25). Moreover, we observe that the number of domestic tourists has increased faster than the number international tourists since 2010. International tourists prefer visiting Siem Reap City by plane rather than using other means (e.g. bus, boats, etc.). Within 11 months in 2018, as of November of that year, approximately 2.46 million international tourists had visited Siem Reap City, of which 1.76 million (159,754 tourists per month) travelled by plane to Siem Reap Airport.

In the near future, the number of international tourists visiting Siem Reap City by all means of all transportations is predicted to continue to increase, reaching 2.55 million, 2.62 million, 2.68 million and 2.71 million in 2019, 2012, 2025 and 2030, respectively.

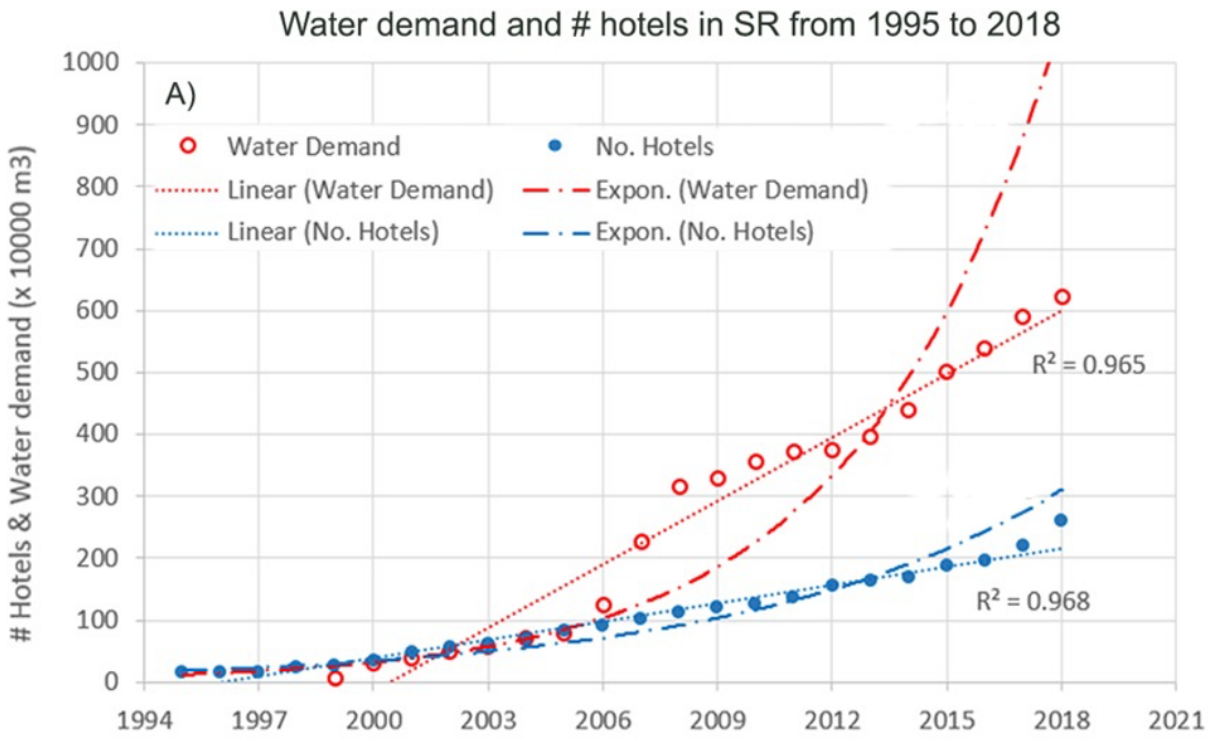


Fig. 24. Trends in Water Demand in Siem Reap (1995–2018)

A correlation analysis shows that water consumption in Siem Reap City is highly and positively correlated with the growing number of tourists. The correlation coefficients are very high ($R > 0.9$) and significant (Figure 24), indicating that, when the number of tourists

increases, demand for water increases at the same time. The results of linear regressions also indicate that water consumption is highly associated with the number of tourists, explaining 95 per cent (adjusted R2 = 0.949) of the variation of water consumption in Siem Reap City (Figure 24).

The North Tonle Sap Region's co-existence of cultural heritage and nature represents a unique ecosystem and place of attraction for both national and international tourism. Within 11 months as of November 2018, approximately 2.46 million international tourists had visited the temples in Siem Reap. Such visits represent a very good opportunity for tourists to visit the natural environment after they visit the temples.

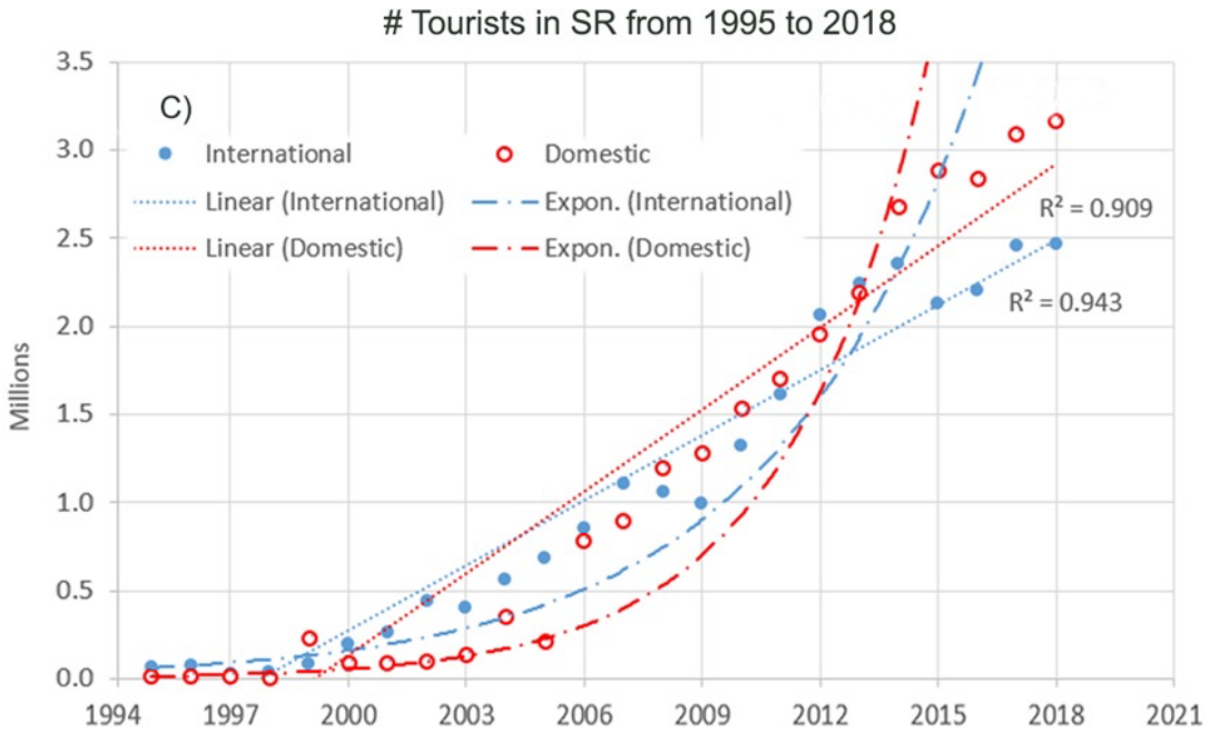


Fig. 25. Trend in Tourist Numbers in Siem Reap (1995–2018)

The Royal Government of Cambodia has declared the establishment of Orchid Research and Conservation Center near Phnom Kulen National Park to serve as an ex-situ conservation center, with four objectives: the conduct of scientific research, conservation of native species, educational purposes and recreation.

This represents a good opportunity for the North Tonle Sap Region in terms of strengthening the operations of this center for to build capacity and make the management of natural resources within the region more effective.

Limitations with regard to financial resources for the effective management of natural resources remain a critical challenge. Payment for Ecosystem Services is one of most important resource mobilization mechanisms, and represents an approach that has been widely implemented with the aims of environmental protection, biodiversity conservation, protected area management and sustainable development.

Given its cultural heritage and its unique ecosystem, the North Tonle Sap Region has high potential to implement a Payment for Ecosystem Services mechanism.

Table 9. Payment for Ecosystem Services Funding Mechanisms

Payment for Ecosystem Services options	Charge ($)/unit	Minimum value ($)*/year	Maximum value ($)*/year
1. International tourists arriving at airport (average 159,754 tourists/month)	$1/person	1,917,054	1,917,054
2. Hotels (3-, 4-, 5-star)*	$0.5/room/ night	740,950	1,481,900
3. Other types of accommodations (2-star hotels and apartments [34 total], guesthouses [351 total] and restaurants [183 total])	$1/day	207,320	207,320
4. Water trading companies (e.g. Kulen Water, etc.)	1–5% of benefit/year?	--	--
5. Private underground exploitation (e.g. hotels, restaurants, etc.)	1–5% of benefit/year?	--	--
	Total values	**2,865,324**	**3,606,274**

* *The minimum and maximum value is applied only to three-, four- and five-star hotels as their units/rooms are not always fully occupied. The minimum relates to an estimated half of the number of rooms occupied and the maximum relates to full occupation.*

An initial feasibility study on potential Payment for Ecosystem Services in Phnom Kulen National Park shows that underground and aboveground water in Siem Reap City, which is mainly sourced in Phnom Kulen National Park, saw substantial extraction of approximately

6.8 million cubic meters to be sold at an estimated value of US$ 1.9 million in 2018. The rate of annual underground water exploitation increased slowly from 1995 to 2005 but accelerated abruptly after 2005, with the same trend from 2016 onward (Figure 24).

Given the high rate of water exploitation in Siem Reap City, Payment for Water Services should be implemented immediately.

A highly increasing trend in numbers of tourists and business establishments in Siem Reap City is predicted to continue to increase gradually, to reach 2.68 million international tourists in 2025 (Figure 25). This dramatic increase in the number of tourists represents a potentially rich source of Payment for Water Services.

Our correlation analysis has shown that water consumption in Siem Reap City is correlated with the growing number of tourists. When the number of tourists increases, water demand increases at the same time (Figure 24).

Applying Payment for Water Services

There is a view that "The more it is free, the more it is wasted." Applying a Payment for Water Services initiative provides a double benefit: it generates revenue and also saves water. Payment for Water Services is highly recommended for the initial stages of ecosystem management because it represents an effective approach for the better management of natural protected areas/natural parks or areas of interest.

Given the high rate of water exploitation in Siem Reap City, Payment for Water Services must be implemented immediately. As Ingram et al. (2014) suggest, Payment for Ecosystem Services is an approach that has been widely implemented for the purposes of environmental protection, biodiversity conservation, protected area management and sustainable development.

This clearly indicates that, on the one hand, Siem Reap City is the most important destination for tourists and business investment in Cambodia. On the other hand, a high number of tourists and investors are putting heavy pressure on water, which we can see from the strong positive correlation with water consumption.

Given this pressure on water, several suggestions are made, of which the following should be taken into account as a priority.

Phnom Kulen National Park plays a vital role in providing water to the entire Siem Reap watershed. It attracts rain for a longer period than the low-lands of Cambodia during the rainy season.

The generation is a key factor for sustainable development and the conservation of ecosystems. The income generated from ecosystem services in Siem Reap, from Phnom Kulen National Park, must be in the form of a Protected Area Trust Fund, which represents a long-term secure source of funding for environmental and natural resource-based activities. With regard to the identification of possible funding mechanisms (Table 9), we prioritize two options for payment mechanisms that can be feasibly implemented. Although others are of interest and would benefit from further discussion, the two following are foreseen important and need to be implemented at the initial stage:

Based on our analysis of the current situation, an annual revenue from Payment for Water Services to a value of US$ 2.9 to US$ 3.9 million can be generated from Phnom Kulen National Park in Siem Reap (Table 9).

According to the striking results found on the exploitation of water ecosystem services, we strongly recommend the application of Payments for Water Services in Siem Reap City to enable the sustainable management and conservation of Phnom Kulen National Park.

To provide the financial recompense to people or management authorities (e.g. via restoration, bottom-up strategy conservation and management) whose lands or activities in the ecosystems providing the provisioning service of water, we proof the potential of the PWS in Siem Reap city as provided in Table 4 above.

At the meantime of applying the PES, conservation actions such as zonation and management plan of the protected area, forest conservation and restoration, and maintenance and restoration of existing reservoirs should be prioritized as well.

3.2.2.9. Coordination mechanism and participation

Aware that biodiversity management represents a cross-cutting issue; the Royal Government of Cambodia established the National Council for Sustainable Development (NCSD) with the vision of “Promoting Sustainable Development aimed at ensuring economic, environmental, social and cultural balance within the country” (Royal Decree No. NS/RKT/0515/403).

The NCSD is composed of the Prime Minister of the Kingdom of Cambodia as the Honorary Chair, the Minister of Environment as the Chair, a Secretary of State of the Council of Ministers as First Deputy and a Secretary of State for the Environment as the Second Deputy, with the attendance of various secretaries of state of the line ministries, secretary generals of the national committees and the twenty-five cities/provincial governors of the Royal Government of Cambodia.

> *Vision of the NCSD: "Promoting Sustainable Development aimed at ensuring economic, environmental, social and cultural balance within the Kingdom of Cambodia."*

The NCSD has a mandate of coordination and cooperation with line ministries and institutions to develop and implement policy legislation, strategies and programs and projects related to biodiversity, climate change, the green economy and science and technology for sustainable development.

The NCSD was established by Royal Decree No. NS/RKT/0515/403 on the establishment of the National Council for Sustainable Development of May 9, 2015. It has roles and duties as follows:

- Formulating, directing and evaluating policies, strategic plans, action plans, legal instruments, programs and projects related to sustainable development;
- Promoting the mainstreaming of sustainable development into relevant policies, legal instruments, strategic plans, action plans, programs and projects in collaboration with relevant line ministries and agencies;
- Mobilizing resources for the implementation of policies, legal instruments, strategic plans, action plans, programs and projects related to sustainable development;
- Establishing and fostering partnerships with development partners, the private sector, academia and other relevant stakeholders aimed at supporting sustainable development;
- Encouraging and promoting research study, education, training, exchange of technologies and dissemination relevant to sustainable development;
- Proposing national positions and strategies for participating in international agreements, meetings and negotiations relevant to sustainable development;

- Reviewing and giving approval on national communications under the multilateral environmental agreements to which Cambodia is a party;
- Managing government information and communications relevant to sustainable development;
- Leading, managing and facilitating the works related to the green economy, climate change, biodiversity conservation and biosafety; and
- Implementing any other duties assigned to it by the Royal Government of Cambodia.

To carry out daily operations, the NCSD has a General Secretariat situated in the the Ministry of Environment. This General Secretariat, known as GSSD, was created by Sub-Decree 59 RNK.BK dated May 18, 2015, on the Establishment and Functioning of the General Secretariat of National Council for Sustainable Development.

The functions and duties of GSSD are, among other things, to coordinate and perform day-to-day work in accordance with instructions and decisions of the NCSD to ensure the achievement of the vision of the NCSD. The detailed roles and duties of GSSD are provided in Article 2 of Sub-Decree 59 RNK.BK. GSSD performs its duties under the leadership of the NCSD's Executive Committee, which is composed of the Minister of Environment as Chair, the Secretary of State for Agriculture, Forestry and Fisheries as First Deputy, the Secretary of State for Environment as Second Deputy and members from other ministries of the Royal Government of Cambodia.

The Biodiversity Department is one of the technical departments of the GSSD, with the mandate to coordinate and perform day-to-day work in accordance with the instructions and decisions of the NCSD to ensure the achievement of the vision of the NCSD on biodiversity conservation and ecosystem management.

To ensure the full participation of relevant stakeholders, especially from indigenous and local communities, in biodiversity and ecosystem conservation programming, the Royal Government of Cambodia has established 168 Community Protected Areas up to July 2019. In the North Tonle Sap Region, 77 Community Protected Areas have been established and are functioning (Annex 1).

3.2.3. Results and Findings

This study has analyzed the effective management of biodiversity and ecosystems in the North Tonle Sap Region focusing on four core aspects: legislation development and enforcement; human and financial resources; measures taken for strategic development; and effective coordination mechanisms.

According to the results of a research paper on the impact of *Mimosa pigra* on local livelihoods in biosphere reserves, it can be concluded that Stung Sen Core Area is not only rich in biodiversity but also has great value in terms of its contribution to national and local economic growth. Each family in Phat Sonday commune can earn around $8,760 annually from fisheries along, and can generate an additional income from agriculture and farming around the areas.

Unfortunately, Stung Sen Core Area has been affected by an invasive alien species – namely, *M. pigra* – which was introduced to Cambodia from 1980 and spread rapidly to the area surrounding the Tonle Sap Great Lake as well as along the Mekong River. The impact of this invasion on the ecosystem and fish stocks in Stung Sen Core Area has led to a loss of profit to the amount of at least US$ 5.5 million annually, excluding the impact on agricultural produce and farming yields.

In order to respond to this invasion of *M. pigra*, four methods have been introduced to remove the species. These include physical control, chemical control, biological control and revegetation control. Given the geographical area of Stung Sen Core Area and the limited research data available on bio-agent, chemical and biological controls are not recommended. Therefore, only physical and vegetable controls are applicable – but physical methods are costly and do not ensure permanent removal.

The results of this study show that two relevant policies (related to land and forest) have been developed and implemented, while nine laws relevant to biodiversity and natural resource management were developed between 1996 and 2006. However, implementation is still limited and challenges remain as a result of overlapping jurisdictions and lack of clarity in some provisions.

The Ministry of Agriculture, Forestry and Fisheries has the jurisdiction to manage natural resources in the agriculture sector, such as land, forests, mines, wildlife, hydrology and plants,

whereas the Ministry of Environment also has jurisdiction over natural resources albeit within the framework of natural protected areas.

Additional resources, both human and financial, for effective Protected Area management need to be mobilized in accordance with the result of the fiscal gap analysis. At least 153 additional full-time staff members must be employed and there is a need to mobilize an additional budget to the amount of US$ 662,000 for seven Protected Areas in the North Tonle Sap Region, established by Royal Decree in 1993.

The result of the assessment of the value of Stung Sen Core Area in terms of fisheries stocks show that these are worth US$ 5.5 million/year, which represents clear evidences of the profits that can be received from ecosystem services.

Based on the study of Payment for Ecosystem Services in Phnom Kulen National Park, according to analysis of the current situation, annual revenue from Payment for Water Services can be generated to the value of US$ 2.9 to US$ 3.9 million from Phnom Kulen National Park in Siem Reap (Table 9).

Finally, this study recommends a few approaches, such as Ecotourism Development, Ex-Situ Conservation, Payment for Ecosystem Services, REDD+ programming, biodiversity value change and adding value to forest produce, to deal with conservation challenges, enable the more effective management of the Protected Area System and to enhance socio-economic and local livelihoods as well as conserving the spiritual cultural heritage in the North Tonle Sap Region.

Chapter 4: Conclusion and Recommendations

4.1. Conclusion

The North Tonle Sap Region contains a rich biodiversity an is characterized by its unique ecosystem. The region covers an extensive range of landscapes, from the mountains to the plateau, and is home to many species and many heritage temples. It also covers wetland areas that contain the Tonle Sap Great Lake, which provides the largest freshwater fish yields in the world.

However, this region has suffered from over-exploitation of natural resources in many forms, mainly through illegal logging, land encroachment, soil and water pollution, over-fishing, population growth and settlement expansion, as well as being subject to the adverse effects of climate change and invasive alien species. These consequences lead to habitat loss, land degradation, ecosystem fragmentation and declines in and extinction of species and genetic diversity.

The Royal Government of Cambodia is taking serious action and measures to deal with these challenges, including through institutional capacity-building, the development and enforcement of legislation, the setting up and operation of coordination mechanisms, multi-stakeholder participation and livelihood improvement to reduce the unsustainable use of natural resources.

A number of approaches, such as Ecotourism Development, Ex-Situ Conservation and Payment for Ecosystem Services, have been recommended to deal with the challenges related to sustainable development in the region, which depends on biological resources and ecosystem services.

This study has analyzed the effective management of biodiversity and ecosystem in the North Tonle Sap Region focusing on four core aspects: legislation development and enforcement; human and financial resources; measures taken for strategic development; and effective coordination mechanism.

In conclusion, the results of the study show that two relevant policies (related to land and forestry) have been developed and implemented; meanwhile, nine laws relevant to biodiversity and natural resource management were developed between 1996 and 2006, although implementation is still limited and challenges remain as a result of overlapping jurisdictions and lack of clarity in some provisions.

Additional resources, both human and financial, need to be mobilized to enable effective Protected Area management, according to the results of our fiscal gap analysis. At least 153 additional full-time staff members must be employed and an additional budget to the amount of US$ 662,000 needs to be mobilized for seven Protected Areas in the North Tonle Sap Region, established by Royal Decree in 1993.

4.2. Recommendations

According to the result of this study and evidence from research papers, the following approaches are recommended:

1. A realistic and applicable incentive approach, such as ecosystem services, to include REDD+ programming, ecotourism and value change produce, etc., should be considered and applied.
2. Payment for Ecosystem Services, especially water ecosystem services in the studied area (Phnom Kulen National Park), could represent an effective solution to sustainable Protected Area financing as well as ecosystem and biodiversity conservation in Stung Sen Core Area.
3. The results of the assessment of the value of Stung Sen Core Area – that it contains a potential fisheries stock worth US$ 5.5 million/year – should be used as evidence for decision-making on the profits received from ecosystem services in contributing to local household and national economies.
4. A participatory approach and partnership are very important to ensure the full participation of all stakeholders in managing and conserving biological resources for sustainable development.
5. In response to the serious impacts of the spread of *M. pigra* to affect local livelihoods, the ecosystem and natural habitats, there are two possible policy recommendations: for a short-term strategy of continuing to use local methods to suppress new seedlings and sprouting of *M. pigra* on agricultural land, using local vegetable cover such as water hyacinth and water spinach; and for a long-term strategy to develop and implement a rehabilitation program to replant native species on abandoned agricultural land and degraded ecosystem area.

Moreover, other applicable tools, strategies and programs, including ex-situ conservation, biodiversity value change and adding value to forest produce, should be considered to deal with conservation challenges and ensure better effective management of the Protected Area System, as well as to enhance the socio-economic situation, improve local livelihoods and protect the spiritual cultural heritage in the North Tonle Sap Region.

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Royal Kram No. NS/RKM//0208/006 2008. The Promulgating of thLaw on Biosafety

Royal Decree 1993. The Creation and Designation of the Protected Areas: National Park, Wildlife Sanctuary, Multiple Use Area, and Protected Landscape

Royal Decree 2001. The Establishment and Management of Tonle Sap Biosphere Reserve

Sub-Decree 1999. Ministry of Environment: The Environmental Impact Assessment (EIA)

Sub-Decree No. 118 2005. State Land Management

Land Policy 2001, Ministry of Land Management, Urban Planning and Construction

National Forest Sector Policy 2002, Ministry of Agriculture Forestry and Fisheries

Annex 1: Total Population by Province and Sex, 2019[2] (NIS, 2019)

Provinces	Households	Males	Females	Total	Household size
Banteay Meanchey	177,526	426,104	433,441	859,545	4.8
Battambang	218,584	458,902	528,498	987,400	4.5
Kampong Cham	215,923	428,481	467,282	895,763	4.1
Kampong Chhnang	122,925	251,895	274,037	525,932	4.3
Kampong Speu	187,835	424,039	448,180	872,219	4.6
Kampong Thom	154,458	327,013	350,247	677,260	4.4
Kampot	138,374	280,537	312,308	592,845	4.3
Kandal	273,111	580,129	615,418	1,195,547	4.4
Koh Kong	26,716	62,304	61,314	123,618	4.6
Kratie	86,137	185,429	187,396	372,825	4.3
Mondul Kiri	19,609	45,533	43,116	88,649	4.5
Phnom Penh	399,203	1,039,192	1,090,179	2,129,371	5.3
Preah Vihear	56,331	126,624	124,728	251,352	4.5
Prey Veng	227,008	501,346	556,082	1,057,428	4.7
Pursat	102,253	200,392	211,367	411,759	4.0
Ratanak Kiri	47,417	102,325	101,702	204,027	4.3
Siem Reap	218,659	491,568	514,944	1,006,512	4.6

[2] *These figures exclude migrants working abroad. According to the Report of the Annual General Meeting 2018 at the Ministry of Labor and Vocational Training, the total numbwe of migrants working abroad amounted to 1,235,993, in which Thailand: 1,146,685, Republic of Korea: 49,099, Japan: 9,195, Malaysia: 30,113, Singapore: 831, Hong Kong: 54 and Saudi Arabia: 16.*

Provinces	Households	Males	Females	Total	Household size
Preah Sihanouk	51,983	153,255	149,632	302,887	5.8
Stung Treng	34,627	83,093	76,472	159,565	4.6
Svay Rieng	131,937	249,446	275,108	524,554	4.0
Takeo	199,362	432,649	466,836	899,485	4.5
Otdar Meanchey	56,331	134,350	126,902	261,252	4.6
Kep	9,347	20,615	21,183	41,798	4.5
Pailin	16,833	36,151	35,449	71,600	4.3
Tbong Khmum	169,281	377,205	398,091	775,296	4.6
Total	**3,341,770**	**7,418,577**	**7,869,912**	**15,288,489**	**4.6**

Annex 2: Community Protected Areas in the North Tonle Sap Region

No.	Name of community	Established	Villages	Communes	Families	Total land (ha)
1. Boeung Peae Wildlife Sanctuary						
1	Chi Ouk Boeung Prey	2002	1	1	135	2,065
2	Cheum Prey	2010	1	0	179	2,825
3	Cheum Thlork	2010	7	1	1,113	5,204
4	Phnom Preah Lean	2010	1	0	76	1,869
5	Boeung Tonle Marech	2010	1	0	412	2,351
6	Chroab Pouy Ruong Roeung	2009	2	1	158	1,988
7	Cheum Pen	2013	1	1	127	1,891
8	Cheum Mrech	2004	2	1	319	2,908
9	Domnak Chonghan	2010	1	0	242	2,117
10	Steung Kro Sang	2013	1	1	239	1,751
11	Skor Kruoch	2010	5	1	642	3,449
12	O Sopheap	2013	1	1	153	896
13	O Sros	2013	1	0	55	804
14	Boeung To Til	2004	1	1	360	2,587
15	Tra Pang Prey Thom	2010	3	1	534	3,291
16	O Pon	2013	1	0	56	1,252
17	O Chonh Chean	2010	1	1	250	2,295
18	O Prasat	2012	1	0	130	2,192
19	O Panha	2010	4	0	240	5,681
20	Phnom Brong	2012	1	0	150	2,540

No.	Name of community	Established	Villages	Communes	Families	Total land (ha)
21	Kbet Chong O Khna	2011	2	0	94	2,187
22	Tra Pang Kruol Kor	2012	1	0	320	934
23	Koki Bra Hong	2010	2	1	165	1,524
24	Domnak Trach	2010	4	1	368	2,832
25	Prey Thom	2003	4	1	953	2,440
26	Phnom Balang	2010	6	1	570	3,801
2. Kulen Prum Tep Wildlife Sanctuary						
27	Tmat Poeuy Thoeun Krasang	2004	1	1	188	1,760
28	Sambo Aphivat	2012	1	1	110	1,071
29	Aphivat Prey Veng	2012	1	0	84	1,048
30	Cheum Ta Moeun	2012	1	1	193	1,767
31	Roluom Teuk Khmao Teuk Sar	2012	1	0	123	1,305
32	Tom Nuop O Ta Kaech	2012	1	0	184	1,907
33	Prey Phdav	2012	1	0	147	1,582
34	Prey Thmor Kol	2013	1	1	46	783
35	A Phlonh Phnom Dey	2016	1	1	235	1,190
36	Kan Tuot	2016	1	0	275	2,323
37	Prey Srong A Phlonh	2016	1	0	105	1,591
38	Prey Chhoeu Ploeung	2016	1	0	171	2,162
39	Prey Kda	2016	1	0	105	1,190
40	Romdoul Prey Sros Samros Trampor	2011	2	1	255	2,778
41	Prey Sros Samros Tram Pong	2011	5	1	716	2,753
42	Kramom Bol	2012	1	1	155	1,492

No.	Name of community	Established	Villages	Communes	Families	Total land (ha)
43	Po Reang	2019	1	1	77	567
44	Chub Sum	2012	1	1	470	1,348
3. Chheb Wildlife Sanctuary						
45	Prey Pi Lveng	2017	1	1	55	744
46	Tra Peang Phuong	2017	1	0	106	1,153
47	Baray Kham Koeut	2017	1	0	112	1,108
48	Prey Anduong Dong Phlit	2018	1	1	149	2,428
4. Banteay Chhmar Protected Landscape						
49	Phum Tro Peang Thlok	2003	1	1	89	300
50	Phum Dong Rek	2003	1	0	105	600
5. Jayavarman-Norodom Phnom Kulen National Park						
51	Prey Phnom Kduch	2000	1	1	82	78
52	Prey Phnom Mnoas	2000	1	0	125	230
53	Prey Thom Po Pel	2000	1	0	96	187
54	Prey Thom	2000	1	0	215	270
55	Chub Ta Sok	2000	1	0	65	306
6. Tonle Sap Biosphere Reserve						
56	Koh Tonlea Kras	2008	3	1	577	4,732
57	Tolneangsav Plov Long	2007	1	1	260	1395
58	Ba Lot	2007	1	1	62	65
7. Prey Lang Wildlife Sanctuary						
59	Ph'av	2019	1	1	181	1,119
60	Toal	2019	1	0	161	640
61	Anluong Phe	2019	1	0	147	682

No.	Name of community	Established	Villages	Communes	Families	Total land (ha)
62	Kiri Sok San	2019	1	1	490	1,338
63	Anluong Chhrey	2019	1	0	196	1,269
64	Prasat Phnom Kral	2019	1	1	150	2,266
65	Prasat Chhoeu Kong	2019	1	0	563	728
66	Sre Veal	2019	1	0	154	2,675
67	Phnom La Ang	2019	3	1	487	2,194
68	Phnom Chriep Trey Ksan	2019	3	0	567	1,349
69	Phum Poeuk	2019	1	0	867	2,348
70	Bang Korn Sen Chey	2019	1	1	262	3,129
8. Biodiversity Corridor Protected Area System "Near Prey Lang"						
71	Kbal Donkrey	2019	1	1	84	1,803
72	Kang Meas	2019	1	1	175	795
73	Kampong Kboeung	2019	1	1	157	981
74	Koh En Chey	2019	1	0	154	1,380
75	Angkor En	2019	1	0	86	1,307
76	Kampong Domrey	2019	1	0	92	1,302
77	Prey Kamreng	2019	2	1	237	700

Annex 3: Total Population of Eight Provinces in the North Tonle Sap Region Census 2019

Provinces	Households	Males	Females	Total	Household size
Banteay Meanchey	177,526	426,104	433,441	859,545	4.8
Kampong Chhnang	122,925	251,895	274,037	525,932	4.3
Kampong Thom	154,458	327,013	350,247	677,260	4.4
Kratie	86,137	185,429	187,396	372,825	4.3
Preah Vihear	56,331	126,624	124,728	251,352	4.5
Siem Reap	218,659	491,568	514,944	1,006,512	4.6
Stung Treng	34,627	83,093	76,472	159,565	4.6
Otdar Meanchey	56,331	134,350	126,902	261,252	4.6
Total	**906,994**	**2,026,076**	**2,088,167**	**4,114,243**	**4.5**

Annex 4: Population Density by Province, 2008 and 2019[3]

Provinces	Total population		Area (km^2)	Population/km^2	
	2008	2019*		2008	2019
Banteay Meanchey	677,872	859,545	6,679	101	129
Battambang	1,025,174	987,400	11,702	88	84
Kampong Cham	918,956	895,763	4,549	202	197
Kampong Chhnang	472,341	525,932	5,521	86	95
Kampong Speu	716,944	872,219	7,017	102	124
Kampong Thom	631,409	677,260	13,814	46	49
Kampot	585,850	592,845	4,873	120	122
Kandal	1,091,170	1,195,547	3,179	343	376
Koh Kong	117,481	123,618	10,090	12	12
Kratie	319,217	372,825	11,094	29	34
Mondul Kiri	61,107	88,649	14,288	4	6
Phnom Penh	1,501,725	2,129,371	679	2,212	3136
Preah Vihear	171,139	251,352	13,788	12	18
Prey Veng	947,372	1,057,428	4,883	194	217
Pursat	397,161	411,759	12,692	31	32
Ratanak Kiri	150,466	204,027	10,782	14	19
Siem Reap	896,443	1,006,512	10,299	87	98

[3] *These figures exclude migrants working abroad. According to the Report of the Annual General Meeting 2018 at the Ministry of Labor and Vocational Training, the total numbwe of migrants working abroad amounted to 1,235,993, in which Thailand: 1,146,685, Republic of Korea: 49,099, Japan: 9,195, Malaysia: 30,113, Singapore: 831, Hong Kong: 54 and Saudi Arabia: 16.*

Provinces	Total population		Area (km^2)	Population/km^2	
	2008	2019*		2008	2019
Preah Sihanouk	221,396	302,887	1,938	114	156
Stung Treng	111,671	159,565	11,092	10	14
Svay Rieng	482,788	524,554	2,966	163	177
Takeo	844,906	899,485	3,563	237	252
Otdar Meanchey	185,819	261,252	6,158	30	42
Kep	35,753	41,798	336	106	124
Pailin	70,486	71,600	803	88	89
Tbong Khmum	761,036	775,296	5,250	145	148
Total	**13,395,682**	**15,288,489**	**178,035**	**75**	**86**

Annex 5: Population Density in the North Tonle Sap Region, 2008 and 2019

Provinces	Total population		Area (km^2)	Population/km^2	
	2008	2019		2008	2019
Banteay Meanchey	677,872	859,545	6,679	101	129
Kampong Chhnang	472,341	525,932	5,521	86	95
Kampong Thom	631,409	677,260	13,814	46	49
Kratie	319,217	372,825	11,094	29	34
Preah Vihear	171,139	251,352	13,788	12	18
Siem Reap	896,443	1,006,512	10,299	87	98
Stung Treng	111,671	159,565	11,092	10	14
Otdar Meanchey	185,819	261,252	6,158	30	42
Total	**3,465,911**	**4,114,243**	**78,445**	**50**	**60**

Annex 6: Protected Areas System in Cambodia (MoE, 2018)

No.	Name	PA type	Area (ha)	Established
1	Bokor	NP	154,458.00	1993
2	Botum Sakor	NP	183,408.00	1993
3	Kep NP	NP	1,152.00	1993
4	Kirirom Preah Soramarith	NP	35,232.00	1993
5	NamLyr	WS	47,500.00	1993
6	Virachey	NP	334,173.00	1993
7	Banteay Chhmar	PL	81,200.00	1993
8	Kulen Promtep	WS	402,500.00	1993
9	Stung Treng	RS	14,600.00	
10	Phnom Kulen Preah Cheyvarama	NP	37,373.00	1993
11	Lomphat	WS	250,000.00	
12	Angkor	PL	10,800.00	1993
13	Beng Per	WS	249,694.00	1993
14	Samlaut	MU	60,000.00	
15	Phnom Samkos	WS	332,566.00	
16	Phnom Aural	WS	255,036.00	
17	Snuol	WS	75,335.00	Declared for cancellation February 16, 2018
18	Roniem Daun Sam	WS	40,021.00	
19	Tonle Sap	MU	316,250.00	
20	Peam Krasop	WS	25,897.00	1993

No.	Name	PA type	Area (ha)	Established
21	Dong Peng	MU	27,700.00	1993
22	Phnom Prich	WS	222,500.00	1993
23	Boeng Chhmar Core Area	RS	-	
24	Prek Toal Core Area	RS	-	
25	Stung Sen Core Area	RS	-	
26	Preah Vihear	PL	5,000.00	1993
27	Ream Pheah Sihanouk	NP	32,401.00	1993
28	Chhaeb	WS	190,027.00	May 9, 2016
29	Central Cardamom	NP	401,313.00	
30	Tatai	WS	144,275.00	May 9, 2016
31	Boeung Prek Lpov	PL	8,305.00	
32	O'Yadao	NP	101,348.00	May 9, 2016
33	Koe Seima	WS	292,690.00	
34	An Long Pring	PL	217.00	May 9, 2016
35	SrePok	WS	372,971.00	May 9, 2016
36	Siem Pang	WS	66,932.00	May 9, 2016
37	Ponnhea krek	MU	199.00	May 9, 2016
38	North TonleSap	PL	31,159.00	May 9, 2016
39	Southern Cardamom	NP	410,392.00	May 9, 2016
40	Veounsai-Siem pang	NP	57,469.00	
41	Preah Roka	WS	90,361.00	
42	Prey Lang Wildlife Sanctuary	WS	431,683.00	May 6, 2016
43	Western Siempang	WS	65,389.00	May 9, 2016

No.	Name	PA type	Area (ha)	Established
44	Ang Trapeng Thmor	PL	12,650.00	May 23, 2016
45	Kbal Chay	MU	5,520.00	May 9, 2016
46	Boeung Prektob	PL	16.00	September 13, 2016
47	Koh Rong	NP	2,517.00	September 13, 2016
48	Phnom Tberng	NH	24,654.00	September 13, 2016
49	Phnom Thnout-Phnom Pok	WS	42,097.00	
50	Phnom Yat	NH	32.00	
51	Sorsor Sdam Sat Tor	MU	839.00	
52	Phnom Neang Kong Rey-Phnom Touk Meas	MU	5,063.00	
53	Beng Yak Laom	MU	225.00	June 13, 2018
54	Koh Rong	MP	52,498.00	February 8, 2018
55	Sambo Preikuk	PL	438.00	March 13, 2018
56	Songka Roka Vong	WS	30,254.00	January 5, 2018
57	Sam Bo	WS	50,093.00	October 5, 2018
58	Prek Prosop	WS	12,770.00	October 5, 2018
59	Cardamon	GC	506.00	May 5, 2018
60	Biodiversity Corridor	BC	1,427,939.76	January 26, 2017
Total			**7,412,281.76**	

Notes:

NP : National Park
WS : Wildlife Sanctuary
PL : Protected Landscape
MU : Multiple Use Area
MP : Marine National Park
NH : Natural Heritage Park
GC : Genetic Conservation Area
BC : Biodiversity Corridor
RS : Ramsar Site

Annex 7: Protected Areas System in the North Tonle Sap Region, (MoE, 2018)

No	NAME	PA Type	Area (Ha)	ESTBLSIHMENT
1	Phnom Kulen Preah Cheyvarama	NP	37,373.00	1993
2	Angkor	PL	10,800.00	1993
3	Preah Vihea	PL	5,000.00	1993
4	North TonleSap	PL	31,159.00	09 May 2016
5	Ang Trapeng Thmor	PL	12,650.00	23 May 2016
6	Banteay Chhmar	PL	81,200.00	1993
7	Tonle Sap	MU	316,250.00	
8	Phnom Neang Kong Rey- Phnom Touk Meas	MU	5,063.00	
9	Beng Per	WS	249,694.00	1993
10	Chhaeb	WS	190,027.00	09 May 2016
11	Preah Roka	WS	90,361.00	
12	Prey Lang Wildlife Sanctuary	WS	431,683.00	06 May 2016
13	Phnom Thnout-Phnom Pok	WS	42,097.00	
14	Kulen Promtep	WS	402,500.00	1993
15	Phnom Tberng	NH	24,654.00	13 Sep 2016
16	Stung Treng	RS	14,600.00	
17	Biodiversity Corridor	BC	1,427,939.76[4]	26 Jan 2017
Total			**1,945,111.00**[5]	

Noted:

NP : National Park
WS : Wildlife Sanctuary
PL : Protected Landscape
MU : Multiple Use Area
NH : Natural Heritage Park
RS : Ramsar
BC : Biodiversity Corridor

[4] This area is for all biodiversity corridor throughout the country.
[5] This total number is excluding biodiversity corridor