
**Content of
Environmental Life Skills
for
Teacher Training Centers**

2013

Unofficial translation

Content of Environmental Life Skills for Teacher Training Centers

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Preface

Nowadays, the world pays close attention to climate change and the depletion of natural resources which are basic needs of humans on the earth. Meanwhile, scientists and experts have increased their efforts to find out how to prevent those problems and possible impacts on the earth. In the bid to prevent these problems from happening, our working group and SEAL programme (VVOB) of Belgium in association with the Ministry of Education, Youth and Sport have collected and compiled this document as reference for environment teacher trainers and student teachers' teaching.

On behalf of the Ministry of Education, Youth and Sport, I profoundly thank the working group and SEAL project (VVOB) of Belgium for compiling this document.

If there are any accidental mistakes or errors in this document, we are happy to accept suggestions and feedback.

Phnom Penh, 17 June 2013
Minister of Education, Youth and Sport

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Preface

The Environmental Life Skills document is compiled under collaboration with the Ministry of Education, Youth and Sport, trainers in teacher training school in Siem Reap and VVOB's SEAL project technician assistance of Belgium.

This book provides briefing notes for trainers, teachers in teacher training centers and primary schools to use as their reference in teaching environment life skills.

All the lessons in this book mainly focus on increasing awareness; it contains findings on environmental issues, life skills development, solutions, decisions and considerations in a bid to make teaching activities and the learning process of teachers to have better outcomes.

The book is composed for broadening teachers' knowledge of environmental issues in which the world is interested in nowadays and pay close attention in order to avoid, reduce and take measure to prevent the issues or event caused by environment.

This Environment Manual has been checked for accuracy by the Centre for Environment Education India and Live & Learn Cambodia. VVOB wishes to thank both organisations for their support. Osmose has been supportive with providing pictures for the manuals and posters for the Teacher Training Centers and practice schools.

The author group hopes that the book will contribute to improve the environment in Cambodia and provide more benefits for learners as well as the general population who wishes to sustainably live in a clean and healthy environment.

We are happy to accept your constructive criticism.

Note

This book is the translation of ឯកសារការអប់រំបំណិនជីវិតស្តីពីបរិស្ថាន (the training manual Content of Environmental Life Skills for Teacher Training Centers) which was issued in 2013 by the Ministry of Education, Youth and Sport (MoEYS).

This translation was made by VVOB (the Flemish Association for Development Cooperation and Technical Assistance) and is not an official translation.

We hope it may be useful to External Development Partners of MoEYS and Teacher Training Centers who wish to consult the original Khmer manual in English.

INTRODUCTION ON THE ENVIRONMENTAL LIFE SKILLS CONTENT MANUAL

Definition of Environment Education

“Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its problems and which has the knowledge, attitudes, commitments and skills to work individually and collectively towards action to solve current problems and to prevent of new ones.”
UNESCO

This content manual provides a tool to give future teachers background information that can be used to teach environmental life skills. Together with the teaching manual for environmental life skills it provides a range of ideas and methods that are suitable for environmental lessons. These lessons stimulate awareness building, deeper understanding of environmental issues, development skills for problem solving, decision making, persuading, critical thinking, and they also provide opportunities for action which can lead to behaviour change.

Objectives of Environmental Life Skills lessons

After completion of the environmental lessons according to the curriculum student teachers will become teachers who:

- Have a broad understanding about environmental issues in Cambodia and the action that should be undertaken to change these problems.
- Changed their attitude and behaviour in relation to environment
- Have methodological skills to transfer understanding, attitude and behaviour change related to environmental issues to students of primary education.

Definition of Life Skills

‘The intellectual, personal, interpersonal and vocational skills that enable informed decision-making, effective communication, and coping and self-management skills that contribute to a healthy and productive life to ensure successfully solving daily problems’.

Policy for Curriculum Development 2005-2009, Ministry of Education, Youth and Sport

Some guiding principles for environment education

To meet above mentioned objectives, we propose a number of guiding principles that should be taken into account in environmental education:

- Consider the environment in its totality: natural and built, technological and social. Talking about environment is not confined to talking only about nature or forests or tigers, nor about issues like pollution or deforestation only, but also concerns such as quality of life e.g., in an urban area, congestion, traffic, garbage, noise, etc. is as much part of the environment.
- Environment education should be a continuous lifelong process, beginning at the pre-school level and continuing through all formal and non-formal stages of education. School is one institutional framework through which Environment Education can be introduced.
- Environmental Education is not a “subject”; it is a process of multidiscipline-based learning. Therefore, it should be integrated in different subjects and related to different topics in the curriculum.

- Examine major environmental issues from local, national, regional and international points of view, but start with focusing on the learners' own community and relate environmental sensitivity (attitude change) and problem solving to every level of the learners' own community.

Definition of Life Skills Education

“Life Skills based education is used to empower young people in challenging situations. It involves an interactive process of teaching and learning, which enables learners to acquire knowledge and develop attitudes and skills to support the adoption of healthy behaviours.”

UNICEF

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Chapter 1 Introduction to Environment

1.1 What is environment

Environment can be described as the sum of all living and non-living components that constitute surroundings of an organism, or group of organisms. The living and the non-living things on earth are all interconnected and can affect each other.

There are 3 types of environment:

- A. Nature world called “Natural Environment”
- B. Society and culture that are created and adjusted by human called “Socio-Cultural Environment”
- C. Humanitarian called “Human Environment”

A. The Natural Environment

The natural environment is everything on the earth that is not created by human. Nature creates living things that are depending on non-living things such as water, soil, fire and air. In Cambodia the natural environment for example includes the Tonle Sap Lake, the Mekong River, highland areas including the forest and mountains and the Khmer seaside. Wildlife is also an important component of natural environment.

B. Socio-Cultural Environment

Anything derived from the natural environment and invented by humans to meet the basic needs in their daily life is part of the socio-cultural environment: e.g. food, energy, water, shelter, clothes. Besides this there are many other things created by humans such as schools for education, roads for transportation, markets for selling and buying goods and hospitals for the health sector.

The socio-cultural environment also includes activities people organize to fulfil spiritual needs such as monasteries, mosques, churches and places of worship and ways of living in a family, religious beliefs, customs and traditions, arts, literatures, sports, society organizing systems.

C. Human Environment

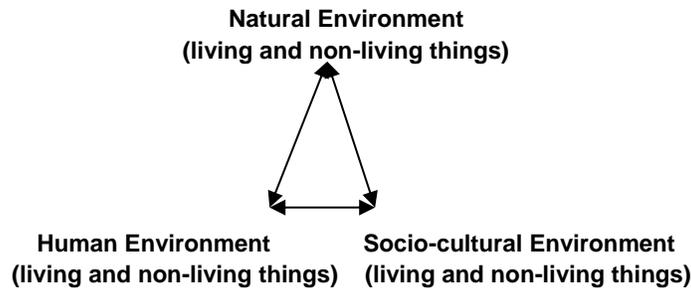
In this world there are people living in different areas with different native languages and their different ways of living. People live with a combination of natural and socio-cultural environment. In Cambodia most people are Khmer. Some of them live in lowland areas where they can produce rice and other crops. About 85 per cent of Cambodians are farmers. The others are public servants, teachers, army, police, traders, handcrafters, monks and nuns.

,Particularly 1/10 of the population living in the Kingdom of Cambodia are not Khmer. Among them, Cham like to live along rivers whereas Phnong, Skuoy, Samre, Sa'och, etc like to live in highland and mountainous areas. These are ethnic minorities and also known as Khmer Loeu, a term meaning "Highland Khmer".

Cambodian people and other nationalities together is the human environment of the Kingdom of Cambodia.

D. The Relationships between the 3 types of environment

The three parts of environment have a close interaction. Each part consists of both living things and non-living things. These components are often depending on each other to ensure sustainability of life on earth. These relationships can be shown in the figure below:



Although we learn that all things are part of the environment it is difficult to completely understand the relationship between the components. If people change the environment by using natural resources too fast, we know it will affect future generations to come, but we cannot always predict in what way.

For example we know that the productivity of fish in the Tonle Sap Lake is connected to the flooded forest. However if all the flooded forests are destroyed, we cannot foresee how it will affect all the other living and non-living things in that area such as birds, fish, plants and what the effect on the existence of communities in the flooded forest area will be.

1.2 Environmental Problems of Cambodia

Problems and conflicts arise over natural resources when different people want to use the same resources for different purposes or when resources are harvested at unsustainable levels. For example, fisher folk communities and the Fisheries Administration want to utilize the flooded forest for fish production, whereas, outside communities or people from the upland area, want to cut the forest to increase agricultural land and production.

Some of the main environmental problems in Cambodia such as climate change, air pollution, water pollution, soil pollution, noise and waste pollution that are caused by human activities:

- Illegal logging
- Fragmentation of wildlife habitats and wildlife trafficking
- Land encroachment on protected areas
- Insufficient management of irrigation water and watersheds
- Infiltration of pesticides and agrochemicals in ground and inland waters
- Excessive fishing of inland waters particularly in the Tonle Sap Lake
- Destruction of flooded forests for fuel sources
- Destruction of coastal mangroves

- Increased energy demand
- Soil erosion on slopes
- Weakening of riverbank stability
- Land tenure insecurity

1.3 Environmental Education and Education for Sustainable Development

A. Definition

Environmental education (EE) is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978).

Environmental education refers to organized efforts to teach how natural environments function and particularly how human beings can manage their behaviour and ecosystems in order to live sustainable. The term is often used to imply education within the school system, from primary to post-secondary. However, it is sometimes used more broadly to include all efforts to educate the public and other audiences, including printed materials, websites, media campaigns, etc. Related disciplines include outdoor education and experiential education.



Picture 1 Natural resources Copyright © Live & Learn

B. Why did environmental education begin?

Environmental education began as a movement and is a way to contribute to solving global environmental problems caused by development of borderless economic growth. The borderless economic growth refers to the exploitation of world's resources such as forests, mines, fuels, fossils, soils, water, wildlife... for the development of modern economics. The development of industry in this way may encourage the maximized use of natural resources and may lead to waste and pollution management problem which threatens the atmosphere, the earth, soils, waterways and wildlife habitat. Moreover, the development has negative impacts on the social, cultural and traditional livelihoods of indigenous people that have been coexisting with the environment. Further development of industries and economic growth cannot ensure the sustainability of the future for humans.

C. Way to Sustainable Development

The most important way to "Sustainable Development" is environmental education. The roots of Education for Sustainable Development are inspired in environmental education. Environmental education has fundamental policies to encourage people to live and organize their societies compatible with the natural laws of the earth and according to their own ideals. Environmental education provides good knowledge, attitudes and skills for students, the public, and decision makers (administrators) to have an in-depth understanding of complexities and environmental vulnerability as well as to take actions to improve their environment.

D. Education for Sustainable Development

"Education for Sustainable Development (ESD) is a learning process (or approach to teaching) based on the ideals and principles that underlie sustainability and is concerned with all levels and types of learning to provide quality education and foster sustainable human development – learning to know, learning to be, learning to live together, learning to do and learning to transform oneself and society." (UNESCO definition)

ESD is a dynamic concept that utilizes all aspects of public awareness, education and training to create or enhance an understanding of the linkages among the issues of sustainable development. It is a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the earth's natural resources. It applies trans-disciplinary educational methods and approaches to develop an ethic for lifelong learning; fosters respect for human needs that are compatible with sustainable use of natural resources and the needs of the planet; and nurtures a sense of global solidarity.

Pursuing sustainable development through education requires educators and learners to reflect critically on their own communities; identify non-viable elements in their lives; and explore tensions among conflicting values and goals. ESD brings a new motivation to learning as pupils become empowered to develop and evaluate alternative visions of a sustainable future and to work to collectively fulfil these visions.

E. Education for sustainable development in Cambodia

In Cambodia ESD and EE are incorporated into basic education, the teacher training curriculum, higher education, and informal education influenced by international and non-governmental organizations (environmental awareness). Education is a way to prevent the environmental problems and to promote positive behaviour towards the environment very effectively. Environmental awareness is conducted officially each year on the World Environment Day on the 5th of June, on National Fish Day on the 1st of July and on Tree Planting Day (Arbor Day) on the 9th of July.

Some characteristics of education for sustainable development are:

- **Envisioning** – being able to imagine a better future. The premise is that if we know where we want to go, we will be better able to work out how to get there.
- **Critical thinking** and reflection – learning to question our current belief systems and to recognize the assumptions underlying our knowledge, perspective and opinions. Critical thinking skills help people learn to examine economic, environmental, social and cultural structures in the context of sustainable development.
- **Systemic thinking** – acknowledging complexities and looking for links and synergies when trying to find solutions to problems.
- **Building partnerships** – promoting dialogue and negotiation, learning to work together.
- **Participation in decision-making** – empowering people.

Chapter 2 Biodiversity and Ecosystem

2.1 Biodiversity in Cambodia

A. Definition

Biodiversity means the variety of different species living in many different areas all over the world. Each species has an important role in the ecosystem. Scientists estimate that there are 10 million species living on the earth. So far, only 1.8 million species have been discovered.

B. Biodiversity in Cambodia

Cambodia is rich in biodiversity; there are approximately 200 species of mammals, 720 species of birds, and 240 species of reptiles and 15000 plant species. In the Tonle Sap Lake there are as many as 850 species of fish. The marine waters around Kampot and Kompong Som also contain coral reefs, sea grass beds, 435 species of fish and marine mammals such as dugong and dolphins. The coastal wetlands of Cambodia also have a lot of biodiversity and are reported to contain at least 74 tree species. Some species exist by depending on one, two or multiple other species. If one component is affected, it will affect the others

C. Importance of biodiversity

Biological diversity is the resource upon which families, communities, nations and future generations depend. It is the link between all organisms on earth, binding each into an interdependent ecosystem, in which all species have their role. **It is the web of life.** The richer the biodiversity the more stable is the ecosystem.

The Earth's natural assets are made up of plants, animals, land, water, the atmosphere and humans. Together we all form part of the planet's ecosystems, which means if there is a biodiversity crisis, our health and livelihoods are at risk too.

For example, biodiversity is often threatened and is very fragile. Areas that are disturbed by people are very likely to contain less biodiversity than areas with fewer disturbances.

D. Threats on biodiversity

Biodiversity on earth is disappearing at an alarming rate. Estimations suggest that at least one species becomes extinct every twenty minutes and that it seems certain that more than twenty five per cent of the earth's biodiversity will be lost during the next few decades.

(More information on wildlife and endangered species can be found in Chapter 3 paragraph 3.2 Wildlife.)

Currently worldwide people use 25% more natural resources than the planet can sustain. As a result species, habitats and local communities are under pressure or direct threats (for example from loss of access to fresh water).

Reduced biodiversity means millions of people face a future where food supplies are more vulnerable to pests and disease, and where fresh water is in irregular or short supply.

In general terms, population growth and our consumption are the reasons for this enormous loss. Specifically, habitat destruction and wildlife trade are the major causes of population decline in species.

Humans and human behaviour have changed the Earth's ecosystems more rapidly and extensively in the past 50 years than in any other period of human history. Biodiversity has declined by more than a quarter in the last 35 years. (WWF) People have picked, logged, plucked and hunted the animals, trees, flowers and fish for medicine, souvenirs, status symbols, building materials and food. This over-exploitation is currently totally unsustainable.

Biodiversity decline and loss of ecosystem services is a major global threat to the future of the planet and generations to come.



Picture 2 Biodiversity map of Cambodia Copyright © Live & Learn

2.2. Ecosystem

Ecosystem refers to different ecological communities having interaction with each other and with non-living things environment in a particular area. It is a complex set of relationships among the living resources, habitats, and residents of an area. For example, a community of living things in a lake or in a forest constitutes of one or more communities and when those communities have interaction with each other and with a number of non-living things then it is an ecosystem.

Diversity of an ecosystem means that there are lots of different kinds of living things in a natural community. For example, in a forest there are trees, mushrooms, vines, animals, insects, worms, and other microorganisms.

The diversity of the ecosystem the Tonle Sap Lake for example, which is the biggest lake in Cambodia and South-East Asia, includes fish, reptiles, birds, wildlife, insects, microorganisms as well as many types of flooded forests. These things constitute many different communities. These communities live and have interaction with each other and with water, soil, air, which are non-living things in that area. If non-living things, including water, soil, air, are polluted then the living things will not be able to grow naturally. In the event that those environments are seriously polluted then there must be threats to a number of living things.

The interrelationships of living things in ecosystem are shown in the form of food lines and foods networks which are called flow of energy. These are natural characteristics that help maintain the balance of living things in ecosystem. In other words, they help maintain environmental stability. Losing environmental stability may cause threats to people's everyday life especially to the people who depend on natural resources for their livelihoods.

Another example of an ecosystem in Cambodia is the wetland areas.

2.3 Wetland area

A. Definition

According to Ramsar Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed 6 meters.

B. Situation of wetland areas in Cambodia

With large areas flooded every year, wetlands dominate the Cambodian landscape. The three major inland wetlands are along the Mekong River, around the Tonle Sap and around Stung Sen. Coastal wetlands include Koh Pao and Stung Kep. Cambodia's wetlands are mainly used for agriculture, fisheries, water supply, forestry, tourism, transport, human settlement and conservation. Other uses include waste management, water regulation, storm barriers and energy production. Cambodia's wetlands are threatened by excessive exploitation and conversion of land for agriculture and human settlement. Specific threats include overfishing, degradation of flooded and upland forests, trading in birds, eggs, snakes and turtles, fragmentation of animal habitats, irrigation, navigation, tourism and dams.

Conservation efforts are likely to benefit 13 endangered animal species found in Cambodia's wetlands. These include five aquatic species– the Irrawaddy dolphin, the Chinese white dolphin, the Siamese crocodile, the Mekong giant catfish and the Isok barb. The other eight endangered species identified by the Ministry of Environment are all water birds – the white-winged duck, the Sarus crane, the giant ibis, the white-shouldered ibis, the greater adjutant stork, the lesser adjutant stork, the milky stork and the spot-billed pelican.

C. Major Types of Wetlands

Fens

Fens have a number of unique characteristics. These areas are rich in reeds and grasses. In general a part of these plants is submerged and another part is emerged. Fens receive water from other sources more than from direct rain. An example of a fen in Cambodia is known as Basac fen. It is located near Phnom Penh between Basac River and Mekong River, which is flooded every year.



Picture 3 Balancing wetland conservation with needs of people Copyright © Live & Learn

Marshes

Marshes are periodically saturated flooded with water and rich in one type of grass or herbaceous vegetation emerging from water.

For example, reeds fens are Mekong delta areas and located around Tonle Sap Lake. There are freshwater marshes forests which are flooded forest growing around Tonle Sap Lake as encirclements.

The major threats to fens and marshes in Cambodia are water draining and inventing these areas for multiple purposes such as rice fields and aquaculture. The formation of fine sand is caused by inappropriate use of land in slope area which is the most critical threat. Cutting flooded forest for firewood has very negative impacts on fishery resources and biodiversity.

Peatlands

Peat is a brown-coloured organic element rich in carbon and formed during incomplete separation of plant elements in acidic environment of a lake. It can be found in a various type of wetlands, including flooded marshes and coastal marshes such as mangroves. In the areas where the peats are available in deep parts of earth, the peats create different ecosystem wetlands such as acidic peatlands and base peatlands. Peats are dug for use as power sources and agricultural fertilizers. Peat zones serve a critical role in filtering surface water. However, peats exploitation causes serious environmental problems.

Swamps

Swamps are flat areas next to rivers or lakes and are seasonally flooded. Swamps extend widely along river's lowland. In many areas swamps are coastal zones, including confluence or delta such as Mekong delta.

Swamps can be found around Tonle Sap Lake, such as Mekong, Basac and Tonle Sap rivers swamps. For example, one of these swamps is a swamp around Udong Mountain where flooded fields can be seen as far as the eyes can see. In Cambodia, freshwater swamp forests [flooded forests] are destroyed very frequently.

Cutting down freshwater swamp forests will rapidly decrease a number of fish species.

Mangrove swamps

Mangrove swamps are formed when the trees in swamps cover coastal zones and are usually found in tropics and subtropics; trees grow along the coasts between high tide and low tide where trees are protected from water with strong flowing current and the waves on marshes and coasts. Apart from economic benefits (firewood, charcoal, fishery resources etc.), mangrove forests provide critical environmental services such as being habitats and feeds for aquatic animals, reducing water pollution, preventing coasts – storm barriers – from eroding. In Cambodia, mangrove forests are mostly found in Koh Kong province. Besides, they can be found in Kampot and Preah Sihanouk provinces. In addition, a part of mangrove forests are cut down for the purposes of shrimp farms, salt farms and charcoal productions.

D. The Benefits of Wetlands

Generally, a wetland is an ecosystem with high productivity which gives significant benefits. These benefits include:

Roles of wetlands: water reservoirs, storm protection, flood mitigation, shoreline stabilization, erosion control, groundwater replenishment, sediment traps and nutrients and other pollutants retention and weather condition stabilization in an area, especially rain water and temperature.

Products generated by wetlands include: wildlife resources, aquatic resources, forest resources, agricultural resources, feed sources, water supply, power supply (hydroelectric power, firewood, charcoal) and waterway transportation.

Functions of wetlands: diversity, physical features, special cultural heritage features. These features have two types of values, use values and their own values. The combination of products and functions gives the benefits and values of wetlands which make them important for society.

E. The Ramsar Convention

The convention on wetlands of international importance, especially water birds habitats, is called the Ramsar Convention on Wetlands. The Ramsar Convention is an intergovernmental treaty on the conservation and wise use of natural resources and it is a sole convention which focuses only on ecosystem.

One of the causes of forming this convention is the concern in early 1960s on the critical decrease in number of water birds.

More importantly, the Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Cambodia is in the process of applying for a registration of 3 zones as Ramsar wetlands.

Wetlands are vital ecosystems that provide livelihoods for people who live within and around them. The Millennium Development Goals (MDGs) called for different sectors to join forces to secure wetland environments in the context of sustainable development and improving human wellbeing. Wetlands also serve as natural wastewater purification systems.

Chapter 3 Natural Resources and Impact of Overuse

3.1 Forestry

A. Forest of Cambodia

A forest is a complex community of plants and animals in which trees are the most common members. Forests are vital for regulating the earth's climate and providing habitat for animals and plants. A forest habitat is a place where plants and animals can live and reproduce. The forests in the tropical regions are home to more than half the world's animals and plant species. Cambodia has many types of forest which cover approximately 57 per cent of the land area (Forestry Administration 2010).

Six examples of types of forest are:

- **Evergreen forests** are found in many areas of Cambodia, especially, at altitudes of seven hundred meters or higher in the humid coastal ranges and the humid north-eastern uplands. Evergreen forests stay green all year round. Cardamom Mountain, Ratanakiri and Mondulkiri
- There are also many **deciduous forests** in Cambodia. Deciduous means that the trees lose their leaves. In Cambodia, most deciduous trees lose their leaves in the dry season.(Kampong Thom, Preah Vihear
- **Mangrove forests** are commonly found in coastal areas, such as in Koh Kong and Kompong Som provinces. Coastal mangroves have roots which are submerged or exposed, according to the rise and fall of the tides. Their roots provide a vital breeding area for fish and crabs and their branches are important nesting sites for water birds.
- Around the Tonle Sap, there are **flooded forests**, which are a type of mangrove forest. Every year during the rainy season, this forest is flooded as the water in the Tonle Sap rises. The trees in this forest are specially adapted to rising water, so they can survive annual flooding. The flooded forest is also an important habitat for animals. The fish and crabs provide food for many people who live on the Tonle Sap.
- **Bamboo forests** are also common in Cambodia and are often found in places where the forest has been cut or cleared. Bamboo grows very quickly.
- The **pine forests** are rare in Cambodia and are only found in areas which are high such as Kirirom and some areas of Mondulkiri and Kompong Thom.

A typical forest is composed of the over story (or upper tree layer of the canopy) and the understory. The understory is further subdivided into the shrub layer, herb layer, and sometimes also a moss layer. In some complex forests, there is also a well-defined lower tree layer. Forests are central to all human life because they provide a diverse range of resources; they store carbon, aid in regulating our climate, purify water and mitigate natural hazards such as floods. Forests also contain roughly 90% of the world terrestrial biodiversity. A habitat is a place or an environment in which an animal can find all its basic needs including food, water, shelter, space (territory) and other animals so they can reproduce. The forest which has never been destroyed should be more protected than the forest which is in the reforestation process because it can provide a better habitat and more security. However the forest that is in reforestation process can become the green forest when it is well protected.

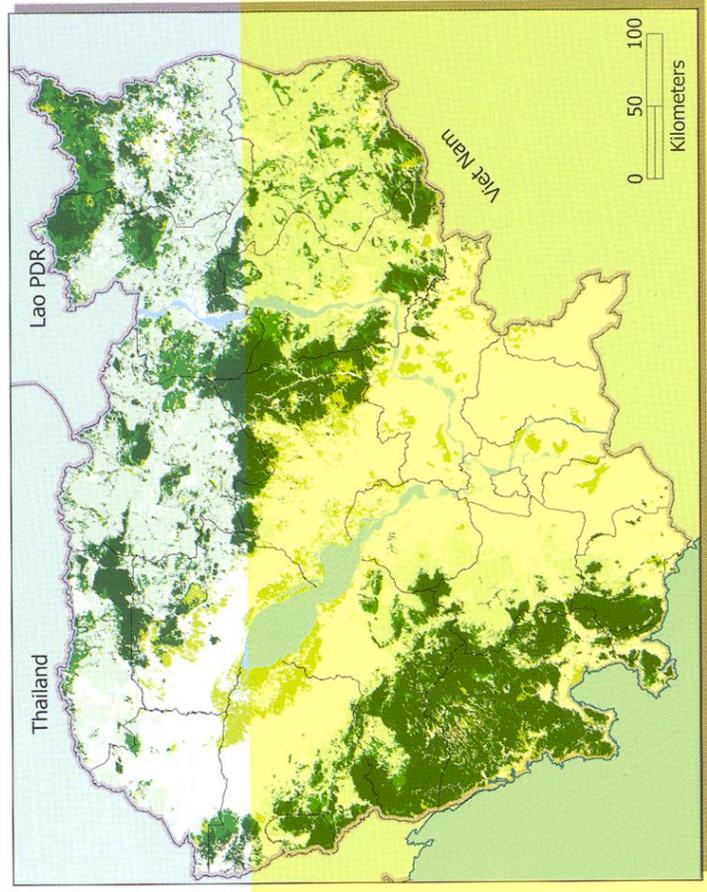
ផ្ទៃដីគ្របដណ្តប់ដោយព្រៃឈើ Forest Cover 2002

កំណត់ត្រា	Legend	ហិ.តិ	Ha
ព្រៃបៃតងជានិច្ច	Evergreen forest	3,720,506	
ព្រៃពាក់កណ្តាលស្រងាង	Semi-Evergreen	1,455,190	
ព្រៃជ្រៃស្លឹក	Deciduous forest	4,833,861	
ព្រៃផ្សេងទៀត	Other forest	1,094,727	
ចំនួនព្រៃសរុប	Total Forest	11,104,284	
ចំនួនដីកសិកម្មសរុប	Total Non Forest	7,056,388	

- ព្រំប្រទល់ខេត្ត
- ព្រំប្រទល់អន្តរជាតិ
- ផ្ទៃទឹក
- Water Body

Note: Original categorization of data includes Wood/Shrubland as non forest in 1997 and as other forest in 2002.

To account for the overestimation of deciduous forest and underestimation of non forest in 2002, a 15% adjustment must be applied to total forest area to obtain a final figure of 10,379,000ha of forest.



ក្រុមឯកសារសិក្សា នៃប្រទេសកម្ពុជា The School Atlas of Cambodia

Picture 4 Map forest cover 2002 Copyright © SCW 2006

B. Natural protected area and community forestry

Natural protected area is officially established for valuable conservation strategic goal of natural resources protection. Established natural protected areas are managed in response to many objectives.

Cambodia established Southeast Asia's first national park in 1925 when it declared 10,800 hectares of forest around the Angkor temples as a protected area. By 1969, Cambodia had six national parks and wildlife sanctuaries covering nearly 2.2 million hectares, about 12 per cent of the total land area. In 1993, King Norodom Sihanouk issued a royal decree designating 23 protected areas. These cover about 3.3 million hectares of forest land which include seven national parks, ten wildlife sanctuaries, three protected landscapes and three multiple-use areas. These four categories– reflecting different characteristics and management objectives – correspond to international classifications such as those used by the *International Union for Conservation of Nature* (IUCN). Protected areas play a big role in developing tourism, protecting watersheds and providing sanctuaries for wild plants and animals.

According to IUCN, natural protected areas are (solid) land or sea that are specially established to conserve the biodiversity, natural resources and related cultural resources and they are managed by law and other effective ways.

The Royal Government of Cambodia needed a solution to the country's forestry crisis, so it turned to community forestry. Community forestry is a community which is established according to the community forestry agreement in order to implement development activities and enhance sustainable use of natural forest resources by following articles of forestry law and other relevant formal documents.

It means the community forestry members execute their daily activities in terms of forest protection such as forest patrolling and to monitor the timber and non-timber forest production collection in cooperation with the local forestry administration officers.

It has been considered one of the most promising options of combining forest conservation with rural development and poverty reduction objectives. Community forestry is first implemented through the establishment of a legal and institutional framework including the revision of legal norms and regulations for forest management, the development of a forest management plan and the strengthening of decentralization processes to sub-national levels of government and community. Cambodia had first experimented with community forestry in the mid-1990s via small pilot sites. In 2002, a new law gave Cambodia's Forestry Administration the authority to grant areas of production forest to local community management. Soon after, in 2003, a community forestry sub-decree officially recognized community forestry as a national policy. Five years later, in early 2011, almost 450 sites were in progress, including more than 100 that have achieved legal agreements. Altogether, documented community forestry sites covered nearly 400,000 hectares by the beginning of 2011.

The 4 regions are created for the purposes of management and different characteristics according to the international classification used by the International Union for Conservation of Nature (IUCN).

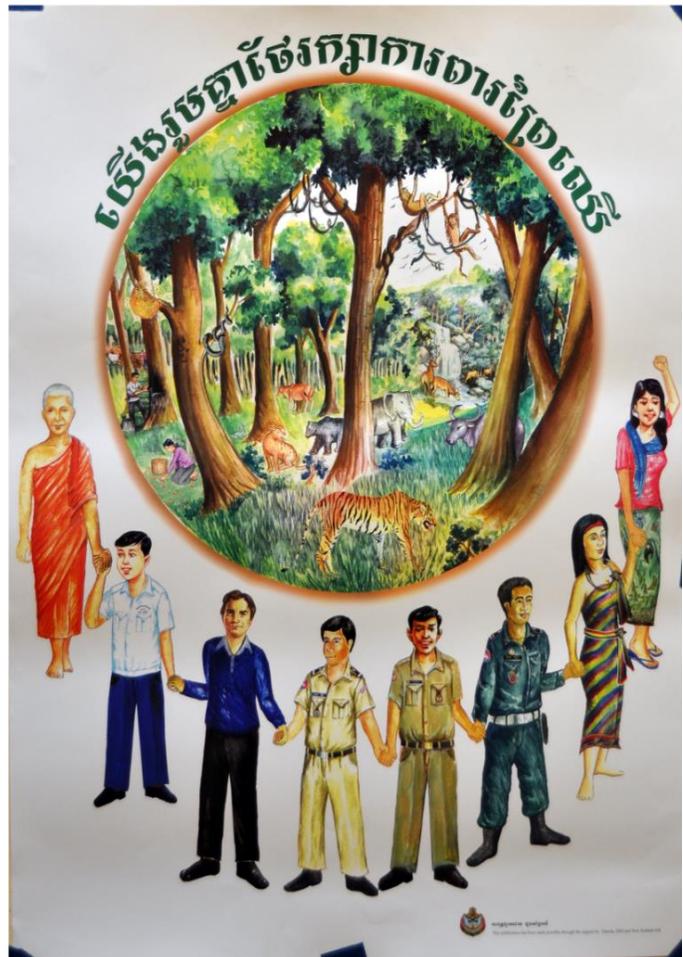
National park: To manage and protect natural and scenic area of national or international significance for its scientific, educational and recreational values. There are 7 national parks, including Kirirom National Park, Bokor National Park, Kep National Park, Ream National Park, Botum Sakor National Park, Phnom Kulen National Park, and Virachay National Park.

Wildlife Sanctuary:

To ensure necessary natural conditions for protecting animal and plant species of national significance, bio-community or geographical characteristics of the environment intervened by humans for their stability. The exploitations examined in some places are permitted. There are 10 wildlife sanctuaries, including Phnom Oral, Peam Krasop, Phnom Samkos, Roneam Daun Sam, Phnom Prich, Phnom Nam Lyr, Beng Per, Kulen Promtep, and Lomphat.

Protected Scenic Areas:

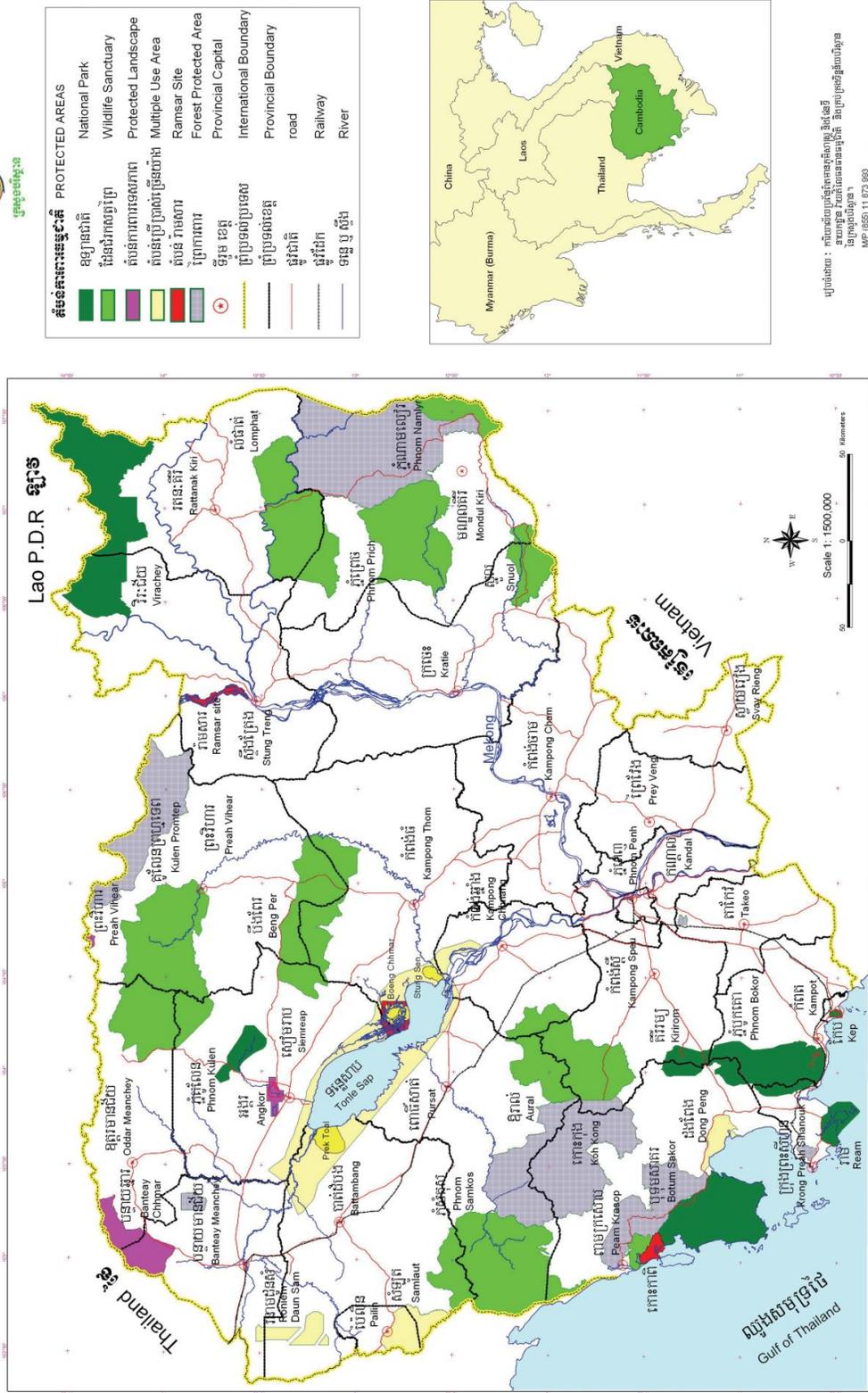
To maintain natural scene of national significances which are critical characteristics of a very compatible interaction between humans and lands and to provide public recreation and tourism by maintaining the ways of living and the normal condition of economic activities in this area. It is an area with multiple views between culture and nature and with high landscape value where traditional use of land is maintained. There are 3 protected scenic areas, including Angkor, Banteay Chmar and Preah Vihear.



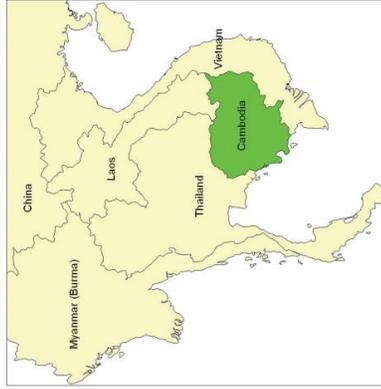
Picture 5 We are involved in protection the forest
Copyright © Live&Learn

Multiple Use Area: To ensure sustainable supply of water, dead log, wildlife, grass field, animal feeds and tourism with natural conservation for supporting those economical activities, special zone can be created particularly in that area in order to achieve a particular conservation objective. There are three multiple use areas, including Dong Peng, Sam Laut, and Tonle Sap.

ផែនទី តំបន់ការពារធម្មជាតិ នៃព្រះរាជាណាចក្រកម្ពុជា PROTECTED AREAS MAP OF CAMBODIA



សំនុំសញ្ញាស្ថិតិ		PROTECTED AREAS
	ឧទ្យានជាតិ	National Park
	ដែនរក្សាជីវិត	Wildlife Sanctuary
	តំបន់ការពារធម្មជាតិ	Protected Landscape
	តំបន់ប្រើប្រាស់ច្រើនប្រភេទ	Multiple Use Area
	តំបន់ រ៉ាមសារ	Ramsar Site
	តំបន់ការពារព្រៃឈើ	Forest Protected Area
	ក្រុង	Provincial Capital
	ព្រំប្រទល់ជាតិ	International Boundary
	ព្រំប្រទល់ខេត្ត	Provincial Boundary
	ផ្លូវជាតិ	road
	ផ្លូវដែក	Railway
	ទន្លេ ឬ បឹង	River



រូបថតផែនទី : ក្រុមការងារប្រយុទ្ធនឹងការបំប្លែងប្រព័ន្ធប្រព្រឹត្តិការណ៍ប្រជាជន
 ដោយប្រើប្រាស់ទិន្នន័យពីការប្រមូលទិន្នន័យ និងប្រើប្រាស់ទិន្នន័យ
 ដោយប្រើប្រាស់ទិន្នន័យពីការប្រមូលទិន្នន័យ និងប្រើប្រាស់ទិន្នន័យ
 MP (655) 11 573 983
 Email : suomean@hotmail.com

Picture 6 Protected areas map of Cambodia Copyright © Live & Learn and Ministry of Environment

C. Deforestation

Forests cover approximately one-third of the earth's total land area. During the last forty years, at least one third of the world's forests have been cut down. In Cambodia, prior to the 1970's, approximately seventy per cent of land was covered in forests. Deforestation is when people cut the forest so much that it cannot grow back. Usually, the land is used for something else, such as farming and new settlement.

There are many reasons for deforestation, including:

- Poor management of logging concessions: Large areas of forest have been sold to private companies who cut down the trees and sell the timber. These areas are called logging concessions. Most of these companies do not care what happens to the land after they have cut down the trees. For instance one company cleared the forest and replanted with acacia trees, which destroyed the soil.
- The increase in population and need for timber and firewood for energy. Many people in Cambodia use firewood from the forest to provide a source of energy cooking. Firewood and charcoal are also used to provide energy for industry.
- Clearing of land for agriculture: As the population of Cambodia grows the need for land to build houses and agricultural land also grows bigger. Generally, in rural area of Cambodia, a family has at least five children. When these five children get married and have children they may need to cut down the forest to build a house and grow food to support their family.
- Short-term thinking and lack of understanding of the long term benefits of the forest. For example, some people burn the forest so they can catch the small animals. People also cut young trees for firewood.

Deforestation is a contributor to global warming, and is often cited as one of the major causes of the enhanced greenhouse effect. Tropical deforestation is responsible for approximately 20% of world greenhouse gas emissions. Trees and other plants remove carbon (in the form of carbon dioxide) from the atmosphere during the process of photosynthesis and release oxygen back into the atmosphere during normal respiration. The water cycle is also affected by deforestation. Trees extract groundwater through their roots and release it into the atmosphere. When part of a forest is removed, the trees no longer evaporate away this water, resulting in a much drier climate. Deforestation reduces the content of water in the soil and groundwater as well as atmospheric moisture. Deforestation reduces soil cohesion, so that erosion, flooding and landslides ensue. Forests enhance the recharge of aquifers in some locales; however, forests are a major source of aquifer depletion on most locales, oxygen, cleaning the air, preventing floods and preventing soil erosion. Forestry operations themselves also increase erosion through the development of roads and the use of mechanized equipment. Deforestation results in declines in biodiversity. When deforestation occurs animals lose all of these basic needs and since it may be difficult for them to find new habitat, they may die. Deforestation occurs when the trees are cut down and the forest is destroyed. In Cambodia, animals are quickly losing their most important habitat, the forest.



Picture 7 Threats of logging Copyright © Live & Learn

D. Reforestation

Reforestation is the forest restoration through direct intervention of human by planting or transplanting or the human intervention on wild plant seeds by nature on the land area which lost the forest cover temporarily at least 10 years and it used to be a seriously degraded forest because of deforestation or natural disaster, but it was not regarded as a non-forest land yet. Reforestation will not be successful unless there is a good corporation between the community forestry or local authority and local administration officers to execute the following activities:

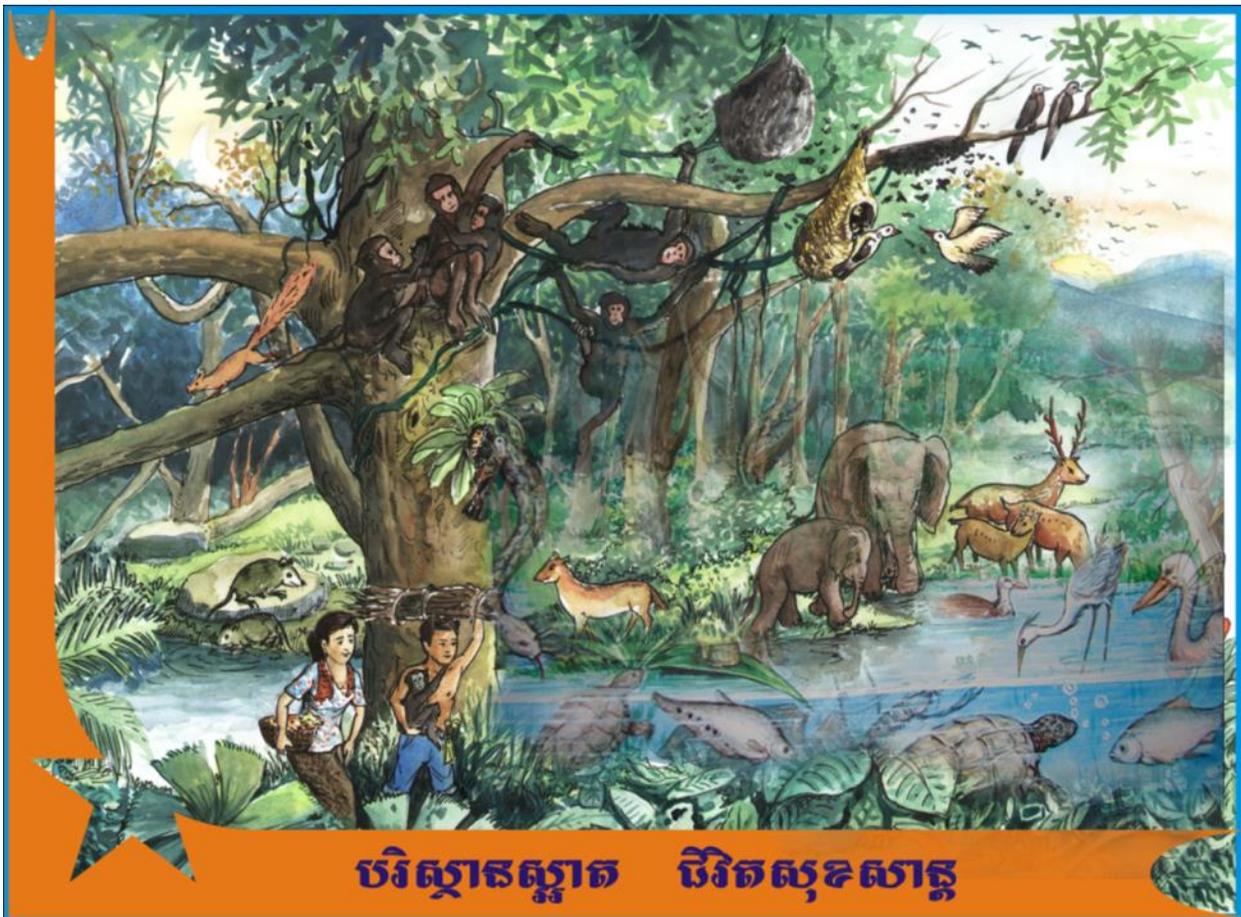
- Establish the nursery in order to ensure the availability of multi plant species in that area.
- Motivate the community people to involve in reforestation process.
- Promote awareness on the importance of reforestation to the local people.

During or after the reforestation is taken place, it demands a high attention on protection through patrolling movement of community forestry and legal ways according to the forestry law of Cambodia in order to offer good benefit for current and future generation.

3.2 Wildlife

Our world has many unique and rare animals, birds and reptiles. Wildlife represents all the non-cultivated and non-domesticated animals living in their natural habitats. All living non-domesticated animals, even if bred, hatched or born in captivity, are considered wild animals.

The variety of wildlife includes fish, birds, insects, reptiles (such as snakes, lizards, and crocodiles), amphibians (such as frogs and toads) and mammals (monkeys, elephants and tigers). What may be surprising is that wildlife includes the smallest animal organisms, even those that can be seen only through a microscope. Wildlife occurs in a tremendous variety of forms and colours. Wildlife lives in a variety of places - in the soil, on the ground, in water, in trees and in the air. Wildlife can be found all around us-in the deserts, the oceans, tropical jungles, and in cities. Wildlife can also be found in rice fields, around schools or temples, and in many other places. Although wildlife lives under natural condition but people seriously threaten the existence of wildlife.



Picture 8 Wildlife protection Copyright © Live & Learn

A. Wildlife situation in Cambodia

Cambodia has many wild animals, including mammals (tigers, elephants), birds and reptiles (turtles and crocodiles).

However the numbers of these wild animals are decreasing due to loss of habitat and hunting. When the number of animals in the wild decreases dramatically they are called threatened species and when there is a chance that they may become extinct, they are called endangered species. Some threatened species will disappear completely if no immediate actions in terms of conservation are undertaken.

B. Decreasing of wildlife

Major threats to wildlife are:

- **Habitat loss:** Fewer natural wildlife habitat areas remain each year. Moreover, the habitat that remains has often been degraded to bear little resemblance to the natural wild areas which existed in the past.
- **Climate change:** Because many types of plants and animals have specific habitat requirements, climate change could cause disastrous loss of wildlife species. A slight drop or rise in average rainfall will translate into large seasonal changes. Plants and wildlife are sensitive to moisture change so, they will be harmed by any change in the moisture level.
- **Pesticides and toxic chemicals:** Pesticides are deliberately spread to make the environment toxic to certain plants, insects, and rodents, so it should not be surprising that other plants and wildlife are deliberately harmed at the same time. In addition many chemical pollutants are toxic to wildlife, such as mercury, petroleum by-products, solvents, antifreeze, etc.
- **Hunting and poaching:** Unregulated hunting and poaching causes a major threat to wildlife.
- **Natural phenomena:** Floods, earthquakes, volcanoes, lightning, forest fires in general
- **Pollution:** Pollutants released into the environment are ingested by a wide variety of organisms.
- **Over-exploitation of resources:** Exploitation of wild populations for food has resulted in population crashes (e.g. over-fishing).
- **Accidental deaths:** Car hits, window collisions (birds), collisions with ships (fish).

C. Endangered Mammal species

In Cambodia approximately 200 mammals have been recorded. There are forty nine mammals currently threatened or endangered. There are still a number of large mammals (such as elephants) surviving in Cambodia. The most immediate threat to these mammal species is hunting. Most of the large-bodied mammals have both a commercial and a subsistence value to local communities. The near or total loss of populations in neighbouring countries (Thailand, Laos and Vietnam) has only increased the pressure on some species for illegal cross-border trade, especially the critically endangered such as Kouprey, Sumatran Rhinoceros, and Javan Rhinoceros otherwise other Endangered: Asian elephant, Banteng, Black-shanked Douc, Douc Monkey and Tiger. In addition to hunting, deforestation throughout the country continues to change the habitat of many of these endangered mammal species.

D. Endangered Bird species

A number of 720 species of birds have been recorded in Cambodia. At least thirty nine species of birds are threatened or endangered, the majority being large water birds. The major threats are: hunting, egg/chick/bird collection (for food, international trade, traditional medicine, prayer release, pets and private zoos), habitat loss; and human disturbance. The endangered bird species are:

- **The Giant Ibis:** this is so rare that it is believed to be a near-mythical species. It is surviving in very small population only in northern Cambodia (Preah Vihear) in a habitat of dry forest with pools. It is extinct in Thailand and Vietnam and almost extinct in southern Laos.
- **Bengal Florican:** Tonle Sap eastern grasslands support the most significant population in the world.
- **Sarus Crane:** this Crane survives in the wetlands of the northern dry forest (breeding) and to Tropeang Thmor reservoir (Banteay Meanchey) in the dry season.
- **Green Peafowl:** the world's largest remaining population survives in the lowland forest of southern Mondolkiri and across the Vietnamese border.
- **Spot-billed Pelican:** Southeast Asia's last breeding colony survives in Prek Toal, Tonle Sap.
- **Greater Adjutant:** this is the most endangered stork. One hundred to one hundred and fifty birds survive in Cambodia (twenty percent of world population). It is an important colony in Prek Toal, Tonle Sap.



Picture 9 Spot-billed Pelican



Picture 10 Greater Adjutant

E. Endangered Reptile species

There are four significant species of reptile in Cambodia that are endangered.

- **Siamese Crocodile:** Cambodia holds the only vital population in the world of this crocodile. It can grow up to four meters in length. It feeds on birds, frogs and small mammals. It lives in wetland areas but lay eggs on land. Only around 250 adult Siamese crocodiles remain in the wild, chiefly in the remotest highlands of Cambodia, particularly in the south-western Cardamom Mountains.
- **Asian Box Turtle:** this turtle lives in canals, streams and marshes. It survives on the land and in the water. It eats aquatic plants, molluscs and shrimps in the water and plants, fungi and worms on the land.
- **Tockay:** the Tockay is the largest Gecko in Asia and can reach thirty five centimetres in length. The Khmer name for this lizard is based on the distinctive call it makes, however it is only the males that call. They hunt on houses or trees and eat large insects such as beetles, locusts and large winged termites.
- **Reticulated Python:** this snake is the world's largest snake and can reach nine meters in length. It likes the water and is excellent swimmer. Pythons kill their prey by crushing it until it stops breathing and then they eat it whole. They typically hunt at night and eat small mammals and birds.



Picture 11 Python in Mondulkiri

F. Wildlife conservation

Wildlife conservation is the process of preservation, protection, or restoration of wildlife and their environment, especially in relation to endangered and vulnerable species.

There are 2 strategies that should be implemented to be able to preserve the wildlife: strategies within the country and internationally.

In order to preserve wildlife in Cambodia we should:

- Not cut flooded forests
- Not collect animal eggs for selling or eating
- Not hunt or poison animals especially those animals being endangered
- Not catch wildlife to raise at home and not causing wildfire
- Not dispose wastes into water sources and minimizing the use of chemical poisonous drugs
- Be involved in planting more trees especially flooded forests
- Be involved in dissemination to induce wildlife protection
- Informing competent fisheries, environment, NGOs and wildlife conservators in case a crime is found.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), also known as the Washington Convention) is an international agreement between governments, drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). The text of the convention was agreed upon in 1973, and CITES entered into force on July 1, 1975. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to more than 33,000 species of animals and plants.

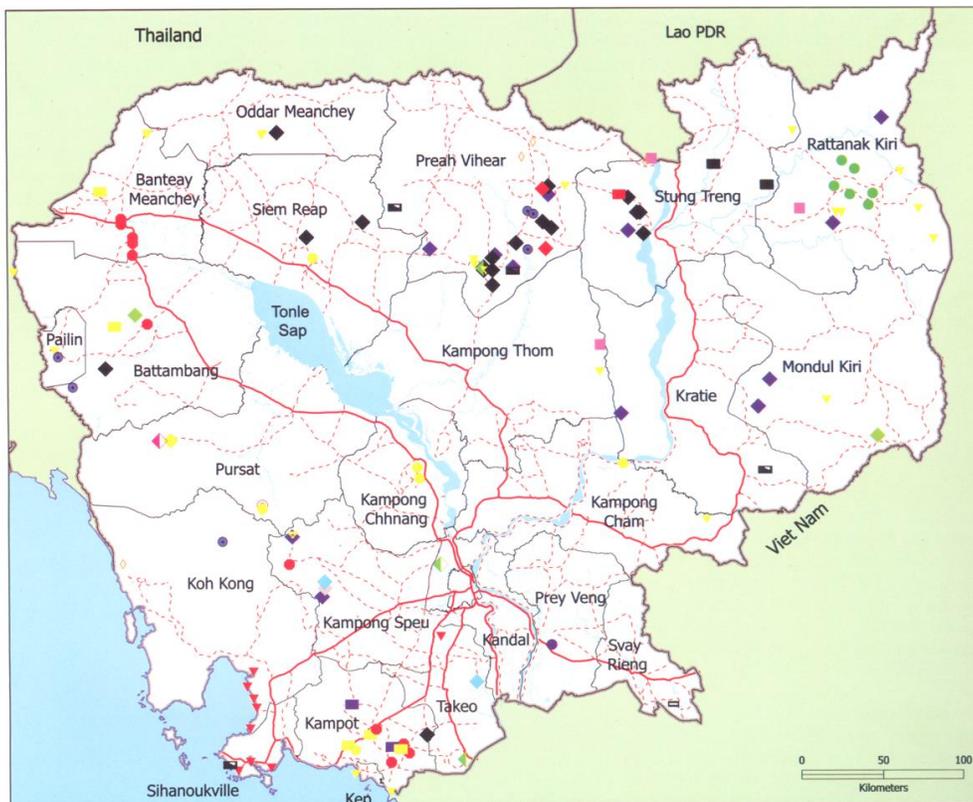
3.3 Mining resources

Mining is the extraction of valuable minerals or other geological materials from the earth, from an ore body, vein or (coal) seam. The term also includes the removal of soil. Materials recovered by mining include base metals, precious metals, iron, uranium, coal, diamonds, limestone, oil shale, rock salt and potash. Any material that cannot be grown through agricultural processes, or created artificially in a laboratory or factory, is usually mined. Mining in a wider sense comprises extraction of any non-renewable resource (e.g., petroleum, natural gas).

A. Mining Resources in Cambodia

In 2006, Cambodia's mineral resources remained, to a large extent, unexplored. Between 2003 and 2006, however, foreign investors from Australia, China, South Korea, Thailand, and the United States began to express their interest in Cambodia's potential for offshore oil and gas as well as such land-based metallic minerals as bauxite, copper, gold, and iron ore, and such industrial minerals as gemstones and limestone. The identified mineral resources in Cambodia were bauxite, carbonate rocks, natural gas, gemstones, gold, manganese, petroleum, phosphate rock, salt, silica, and zircon. With the exception of carbonate rocks and gemstones, the country's mineral resources were largely unexploited. To attract domestic and foreign mining companies to invest in the mining sector, the Law of Minerals Management and Mining of Cambodia was promulgated by the government on July 13, 2001.

ធនធានថ្ម Mineral Resources



Legend

Mineral Resources, Number of deposits

METALLIC	NON METALLIC	GEMSTONES	FUEL MINERALS	Water Body
◆ Iron, 18	● White clay and clay for cement, 6	● Corundum, 6	■ Coal, 2	■ Water Body
◆ Manganese, 2	● Fluorite, 1	■ Amethyst, 3	■ Lignite, 4	— Main Roads
◆ Antimony, 1	■ Graphite, 2	◆ Jet, 4	■ Peat, 1	--- Secondary Roads
◆ Molybdenum, 3	■ Limestone, 5	○ Pagodite, 1		— Provincial Boundary
◆ Tungsten, 1	■ Dolomite, 1			— International Boundary
◆ Chromium, 1	● Phosphate, 11			
◆ Tin, 2	▼ Silica, 9			
◆ Aluminium, 2	● Zircon, 7			
◆ Base metals, 12				
◆ Silver, 3				
◆ Gold, 19				

Data Sources:
 Minerals and Symbology: Department of Geology, MIME
 International and Provincial Boundary:
 Department of Geography 2005
 Water Body: JICA Dataset 2002

Atlas of Cambodia National Poverty and Environment Maps

Picture 12 Mineral resources in Cambodia Copyright © SCW 2006

B. Impact of mining investment on environment

The nature of mining processes creates a potential negative impact on the environment both during the mining operations and for years after the mine is closed, and it causes serious affect soil resources, water, air and bio-resources. The social effect is caused by the growth of house and other services within the mining investment area.

Pollution Mining exploitation operations often pollute the environment of surface water and groundwater. Rain water saturated into the fractures of rock formations becomes very polluted because it becomes sour (acid), muddy and flows into the rivers and destroys rivers and water sources nearby. Tiny elements such as bronze, cobalt, when leaking from mining well wastes and gathering in water, ground or plants, can become poisonous substances which cause diseases to humans and animals drinking or using the water in that area. Although ponds are specifically dug in order to collect the flow of water and soil, all problems are not minimized – they can only help mitigate a part of impacts.

Quantity of dusts created by fires, transportation and treatments may cause the death of surrounding plants. Chemical substances used in the process of mine extraction such as for drilling can be critical poisonous substances.

Land Abandonment Mine extraction activities my cause a large loss of lands due to pollution by chemical substances, fertilized soil layer destroying, and cause the permanent damage of earth. Large-scale mine extraction has caused land degradation because in some areas the earth is excavated while in some other areas wastes are disposed. These are the causes of a large loss of wildlife sanctuary.

Earth Collapse The presence of abandoned mining wells can be the cause of earth collapse in vertical line and horizontal line. These cause severe damage to buildings, roads and agricultural lands and change the surface water flow regime.

Noise The explosion and transportation cause loud noise which disturb the surrounding people and wildlife.

Energy The demand for lots of energy in mine extraction and transportation cause more environmental impacts such as acid rain and global climate change etc.

Impacts on Biodiversity Changes in the form of earth, earth crust, water and air due to mine extraction have both direct and indirect impacts on biodiversity. Direct impacts include a serious damage and loss of wildlife and plants due to mine extraction activities or exposure to poisonous soil or poisonous water from mining well while indirect impacts include changes in the cycle of total biomass foods, biodiversity, and changes in ecosystems due to the changes in quantity or balance of groundwater or surface water.

The following table shows which minerals have been found where:

Banteay Meanchey: Phosphate	Mondulkiri: bauxite, Copper-lead Zinc, alloy, gold
Battambang: Bauxite, gold, iron, Phosphate, rubies, sapphire	Pailin: rubies, sapphire
Kampong Cham: gold	Preah Vihea: Copper-lead Zinc, alloy, gold, jet, lignite, manganese, molybdenum, iron, sapphire, zircon, gems
Kampong Chhnang: Limestone	Prey Veng: fluorite
Kampong Speu: Copper, Copper-lead Zinc, alloy, marble, Phosphate, tin, tungsten	Pursat: antimony, chromium
Kampong Thom: amethyst, gold	Ratanakiri: copper, copper-lead zinc, alloy, gold, zirconium dioxide
Kampot: graphite, gold, iron, lignite, limestone, Phosphate	Siem Reap: gold, iron
Kandal: molybdenum	Stung Treng: Copper, amethyst, coal, dolomite, gold, iron, marble
Koh Kong: Jet, sapphire, silica	Sihanouk: lignite, silica
Kratia: copper, lignite	Takeo: molybdenum, tin

3.4 Climate change caused by overuse of natural resources

Climate change is a change in temperature, patterns of rainfall, snow and air for several decades or longer. Climate change can be caused by the following factors:

- Human activities which are the causes of variations in atmospheric layers. These activities include: burning fossil fuel, deforestation, burning forests, lands clearing for agricultural, construction, city expansion, and waste dump site.
- Natural factors such as a change in solar energy, slow changes in the earth's orbital characteristics, sea levels, air.

A. Greenhouse gas and its impact

In cool and cold weather areas, large greenhouses are built for growing crops because the roofs and walls are made of plastic or glasses which can allow the light to go through but prevent the

heat from emitting and maintain suitable heats inside the greenhouse in order for the crops to grow better. This phenomenon is called greenhouse effect.

Layers of the earth's atmosphere are considered as a large house. Humans living on the earth are considered as plants surrounded by coolness of external atmosphere. The earth is one of the planets in the solar system which can create its own greenhouse with some gases in the atmosphere. These gases are called the greenhouse gases which are considered as the glass roof and wall of a greenhouse retaining heats in the earth's atmosphere. In climate change science, scientists compare the similarities between the phenomenon in a greenhouse and the phenomenon occurring on the earth which is surrounded by layers of atmosphere. The increase in the earth's heat is similar to the increase in the heat of a greenhouse for growing crops.

B. Sources of Greenhouse Gases

Different types of greenhouse gases are created by nature and human activities.

- Greenhouse gases created by nature include: water vapour (H₂O), Carbone dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Ozone (O₃).
- There are 7 major types of greenhouse gases created by human activities. These include: Carbone dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydro fluorocarbon (HFC), Per fluorocarbon (PFC₂), Nitrogen Oxide (N...) and Sulphur hexafluoride (SF₆).

Major types of greenhouse gases are:

- Carbone dioxide (CO₂): Carbone dioxide is one of the greenhouse gases in the atmosphere which has larger amount than other greenhouse gases. Carbone dioxide is created by decayed organic substances, respiration of plants and animals, volcanoes, and fossil fuel erosion (coal, fuels, and natural gases) for operating machines and vehicles and the loss of trees.
- Methane (CH₄): In the atmosphere, the amount of Methane is smaller than Carbone dioxide but it has stronger effect to trap the heat. Methane is created by digging and extracting natural gases, landfill site, liquid waste, ruminant, rice field, burning biomass, leaking gas tube, and the separation of other organic substances without air.
- Nitrous oxide (N₂O): It is a greenhouse gas that has stronger effect than Methane in trapping the heat. It is created by the use of agricultural fertilizers, burning fossil fuel, volcanoes, decaying of dead animals or plants.
- Chlorofluorocarbon (CFS₅): It is a greenhouse gas that has strongest effect among others. In general, these gases are created by human activities in industry and home appliances; for example, using cold methane in refrigerators or air conditioners, spray cans, and the production of melting substances and so on.
- Water vapour (H₂O): It is a kind of greenhouse gas created by water cycle in the nature and it plays an important role in determining the earth's climate. Water vapour in the atmosphere makes the air humid.

C. Impacts of climate change and global warming

Climate change has several major consequences, including an increase in average temperature (global warming), a change in rainfall patterns and a rise in sea level. An increase in average temperature makes the ice in the poles, mountainous areas and Greenland areas melt which seriously affects the lives of human, animals and plants. A change in local rainfall patterns results in floods due to too much rainfall in some areas and droughts due to too less rainfall in some other areas which seriously affect a certain sectors, particularly agricultural sector. A rise in sea level is a result of sea water expansion and the contribution of land-based ice due to increased melting.

A change in local rainfall patterns, a rise in sea level and a rise in average temperature affects some key sectors as below:

- **Water Resources**

Climate change will result in a variation in water cycle. Atmospheric concentration will increase in some areas but decrease in some other areas. An increase in local drought results in shortage of water for consumption. On the contrary, an increase in rainfall patterns may result in plentiful water for consumption but at the same time may result in floods. Frequent floods and droughts will affect the quality of water and water vapour.

- **Agriculture**

Agricultural yields and products will be influenced by a high rise in temperature and a variation in rainfall patterns. A rise in rainfall patterns will result in soil erosion, fertile soil erosion due to flowing water and damages to crops. A rise in sea level will also result in the loss of cropping lands where there is a low altitude area along coastal areas.

- **Human Health**

Direct impacts of climate change on human health include: increased stress due to heat, increased blood vessel diseases, heart diseases, respiration diseases and airborne diseases. Common diseases in Tropics such as malaria and dengue fever will also be increased due to the increased mosquito shelters and other vectors. Food-borne and water-borne diseases will also be increased due to warmer temperature, decreased water supply and the spread of microbes.

- **Coastal Areas**

According to a forecast if the current global warming is still continuing, then the sea level will be increased by 15 to 95 centimetres by 2050. Coastal areas with low altitude and islets are most vulnerable to a rise in sea level.

D. Responses to Climate Change

There are two measures to be taken to respond to climate change. These include:

- a. Reducing greenhouse gas emissions
- b. Climate change adaptation

Reducing greenhouse gas emissions

Reducing greenhouse gas emissions (mitigation) is a key method for solving climate change problem, particularly for the long term. The key sectors involving in the emission of greenhouse effect include energy production, transportation, industry, agriculture, forest, and waste management. No sector or technique can solve the problem of greenhouse effect emission alone. All sectors can contribute to reducing greenhouse effect emission.

To stabilize the pressure of greenhouse effect in the air is necessary to decrease the emission of greenhouse effect and then be reduced gradually. Being late in implementing measures will reduce the chance to achieve the stability of low greenhouse effect concentration; on the contrary, it will increase the risk of severe impacts caused by climate change.

Climate change is a global issue, but there are many simple activities that each of us can do to contribute to dealing with it through changing attitude and way of life by focussing on the following activities.

- **Save electricity:** The supply and use of fossils the main source of greenhouse effect, especially carbonic gas. Therefore, when we use electricity, it means we contribute to releasing greenhouse effect into the air. In this sense, we can reduce the emission of greenhouse effect as well as cut down on the expense for electricity by turning off electric equipment when we do not use it.
- **Save water:** To save water, use and manage water effectively provides economic benefits and contributes to reducing the greenhouse effect. For example in places where people have access to a public clean water system promoting awareness on importance of saving water use is very important because the water has to be filtered and cleaned by machines that use energy.
- **The use of renewable energy or natural energy:** Renewable energy is created from the renewable sources, including solar power, biomass, heat from inside the ground, hydropower, the power of tide and wave which do not release greenhouse effect into the air and planting trees because the trees absorb carbonic gas from the air.
- **Reduction, re-use, and recycle** are effective to mitigate the environment pollution, keep natural resources, and cut down on the emission of greenhouse effect into air. For example, in houses we can reduce the quantity of waste in the dumping ground to contribute to mitigating greenhouse effect.
- **Transportation:** The fuel in vehicle engines releases carbonic gas into air contributing to climate change. Participating in activities to reduce the consumption of fuel in the transportation sector means reducing the greenhouse effect into air. For example, cut down on driving in unnecessary case and travel.

- **Education and knowledge:** The education and knowledge about the issues of climate change are very important to promote the awareness about the causes, impacts, responsive measures, and individual's roles in solving this issue. We can participate in providing education and knowledge and increasing the awareness about climate change by using simple methods – talking with our families, friends, and neighbours about climate change and greenhouse effect mitigation measures to share knowledge and encourage them to participate in activities to respond to climate change.

Adaptation to Climate change

Adaptation is possible adjustments, spontaneous or planned, of people, animal, plants, ecosystems to climate change to reduce adverse impacts, to take advantage of opportunities or to cope with the consequences of climate change in order to:

- Prevent losses, for example building dam against sea-level rise;
- Reduce losses to a tolerable level. An example could include the use of appropriate crops to ensure a guaranteed minimum yield under even the worst conditions;
- Spreading or sharing losses to ease the burden on those directly affected by climate change, for example through government disaster relief;
- Change a use or activity that is no longer viable under new climate conditions;
- Change the location of an activity to the more suitable one, for example re-siting an electricity power plant in a place where is close to the seaside; and
- Restore a site, such as a historical monument becoming vulnerable to flood damage.

Adaptation measure in different sectors

Agriculture As the unfavourable changes such as rainfall, hydrology, temperature, the duration of planting season, and climate are frequent and severe, it is necessary to take urgent measures effectively to respond to the impacts on agriculture sector. The impacts can be mitigated by implementing some activities below:

- Take into consideration the planting season, namely, planting and ploughing according to schedule.
- Change the kinds and species of crops suitable for the climate change.
- Improve the management of slopes and plan the use of soil; for example, the management of soil use, soil fertilizer management, and underground organic substance management.
- Implement the methods of diversified agriculture such as horticulture, aquaculture, intensive agriculture, vegetable garden, animal husbandry, and tree planting...

Water Sources The better and more effective water resource management can reduce the vulnerability of water consumers caused by the impacts of climate change. The clean water supply is very important to people's health and living. A number of acclimatization measures can be used to protect slopes, plants along the estuary, and reduce water pollution.

Human Health The acclimatization measures to respond to the negative impacts of climate change for people include the promotion of medical care service (especially contagious diseases), health check-up and sanitation program, providing knowledge and increasing public awareness, the improvement of environment management, the prevention of disasters, the promotion of quality control and pollution, research and technique for precaution (water purification and vaccination).

Coastal Area The choices respond to the impacts of climate change which can apply in the coastal area include the construction of dams to protect sea water, establishing the wet land area, the approval of new construction system, and the protection of ecological system under threats and consolidation of fisheries resources management.

Forests and Ecological System The measures which can help the ecological system to be acclimatized to the climate change include the protection of biodiversity, reforestation, the various measure to control wildfire, harmful factors and diseases, the selection of plant species, checking the number of animals, planting trees which are resistant to draught, the implementation of conservation, and confiscating forest by-products on a sustainable manner.

Using Renewable Energy or Green Energy

Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, biomass, geothermal heat, tides, waves where greenhouse gas is not emitted into the atmosphere.

- **Solar Energy**
Solar energy is energy generated from the heat or solar radiation and can be used to heat water in households or large airports and can also be used to produce hydroelectricity. Nowadays, the use of solar energy for household and commercial purposes is more popular.
- **Wind Power**
Wind is a clean power source and generally the use of wind to extract power has fewer impacts on the environment than the use of other powers. The use of wind power can minimize the amount of electricity resulted from burning fossil fuel and can minimize the amount of air pollution and the release of carbon dioxide into the atmosphere.
- **Hydropower**
Hydroelectric energy is produced from waterfall power. Fall and movement of water are parts of water cycle. Hydroelectric dams may have some environmental and social impacts. However, an appropriate environmental impact assessment, a proper design, and a comprehensive plan may help mitigate these impacts and provide economic benefits, including mitigating the use of fossil fuel.

- **Biofuel**
Biofuels are organic substances sourced from plants or manures which can be used as fuels. Agricultural crop wastes such as rice husks, manures can be burned to provide heat or produce electricity. Crop products such as palm oil, *Jatropha curcas*, cassava, sugarcane, etc. can be used to produce fossil fuel. Manures and organic waste can be used as the source of biogas for cooking, heating and generating electricity.
- **Geothermal Heat**
Geothermal heat is from thermal energy generated and stored in the Earth. It is a clean and sustainable energy. The resources of geothermal heat is found from shallow depth to hot water and hot rock at the depth of some kilometers from the Earth surface, and to the depth at which the temperature is extremely high and causes some rock to melt, which is commonly known as magma.
- **Tidal Energy**
Tidal energy, or tidal power, is a little known and little used energy source. Tidal energy is created by the relative motion of the Earth, Moon, Sun, and the gravitational interactions between them.
- **Wave Energy**
Waves are generated by the wind as it blows across the sea surface. Energy is transferred from the wind to the waves. Waves travel vast distances across oceans at great speed. The wind blows over the sea surface.

Chapter 4 Waste management

Waste includes all items that people no longer have any use which has already been discarded into the environment. Currently, more and more waste is created and this waste has a more harmful effect than the waste of previous times because nowadays people are using items made of plastic, metal and other synthesized chemicals. The disposal of waste into the environment, especially rivers and lakes will lead to water pollution and damage to fish and plants. Environmental or water source pollution will cause severe damage to public health.

4.1 Different kinds of waste and waste segregation

Waste can be divided into 2 types: biodegradable and non-biodegradable. These 2 types of wastes have 3 categories: solid, liquid and gas.

- A. Solid waste: any garbage that is solid sourcing from households, factories, construction sites, agricultural crop residues, hospitals, markets, commercial facilities.
Examples: branches and stumps, metals, cans...
- B. Liquid wastes: any waste water sourcing from human body, animals, households, sewage system, factories, farms...
Examples: toilet pipe, vapour, manures, urine...
- C. Gas wastes: any smokes or vapour emitted from stoves, fireplaces, industries, factories, burning...etc.
Examples: motorbike smoke, cigarette smoke.



Picture 14 Bringing your own shopping bag helps to reduce waste

4.2 When is waste a problem

Wastes of all kinds are a problem when quantities and concentrations of waste are too large for the immediate environment to absorb on an on-going basis. Waste becomes a hazard when it cannot be managed properly and can be harmful to human health and cause damage to the environment.

This can happen when:

- We dispose or release so much wastes that there is no place where it can be safely disposed.
- We throw out things that cannot naturally disappear over a period of time, for example, a plastic bag as compared to a banana peels.
- When we dispose waste in the wrong place.

Waste generation leads to air, soil, surface and groundwater pollution which affects the health of the environment and of the people in many ways.

- Solid wastes take up open space. Liquid effluents pollute waters and land. They are ugly to the eye. Gaseous wastes affect air quality. They are offensive the nose.
- Solid waste dumps attract flies, mice, cockroaches. These are a health hazard. These carry disease. They invite mosquitoes to breed. These can spread deadly sickness.
- Waste that is not segregated can contain organic material, hazardous and toxic material, and non-biodegradable material all mixed up together. When it rains, the water that runs off from the dump can carry toxic and infectious matter and pollute the surrounding land and water.
- Burning of plastic waste is very dangerous for human health. The toxins released by burning can cause damage to the brain and immune system.
- Domestic animals feed at the dump. People scavenge from the dump. They can contract serious diseases.

4.3 Biodegradable and non-biodegradable waste

In the natural environment there are small organisms and insects which can eat many of the waste people produce. For example, if we mix unwanted food scraps, paper or cardboard with soil the organisms in the soil will eat the food scraps until nothing is left.

Wastes which break down through natural processes are called biodegradable wastes. Wastes which cannot be eaten by these organisms are called non-biodegradable wastes. These wastes do break down, but the processes can take a very, very long time, sometimes thousands of years. When some non-biodegradable wastes do eventually break down, they breakdown into smaller component parts. Sometimes these smaller components can also cause pollution.

Waste Lasts How Long?	
Cigarette Butts	1 - 5 years
Aluminium Cans	80 - 100 year
Plastic Bags	10 - 20 years
Glass Bottles	1 Million years
Tin Cans	50 years
Plastic Bottles	Indefinite

4.4 The 3R's: Re-duc-ing, Re-using and Re-cycling

Our convenience-oriented lifestyle not only consumes a great deal of natural resources but also wastes them. Many resources are converted to products with very short life spans. For example, using petroleum, natural gas and coal to produce plastic containers and packages designed to be discarded after only one use wastes valuable resources and adds to the growing solid waste stream. By putting these items in the trash, we are throwing away valuable resources.

Our world has a limited supply of natural resources, including land used for landfills. One way to save natural resources is to re-use or recycle products to prevent that new natural resources are used to make new products. Sometimes we do not even realize that the products we use in our daily life are made from precious natural resources. Some of these, like trees are renewable, but others like petroleum, coal and oil are not. The more we use these, the more we deplete the earth's store of resources.

Just as waste cannot be thrown "away" and cannot disappear, the problem of waste also cannot just be wished "away". Managing waste ensures that wastes do not cause environmental and health problems when they are disposed of. There is no single, simple solution to managing the many kinds of waste. To effectively reduce waste management problems, communities need to consider an integrated management approach. This means using a variety of waste management practices to safely and effectively handle municipal and other wastes with least harmful impacts on health and the environment.

A number of actions are required for this;

Reducing- Using less of things, for example, don't throw away paper unless you have used both sides. Reduce the use of plastics by using a longer life bag or a woven basket. For example when we buy something from a shop which is already packaged in a box or wrapped in paper or plastic, we do not need to put it into another plastic bag. It is even better to bring your own cloth bag and avoid plastic altogether.

It is better to buy something from a shop which is wrapped or packaged in a bio-degradable material such as paper or cardboard than something which is wrapped or packaged in a non-biodegradable material such as plastic.

Reusing- There are many things that we can use again instead of throwing away, for example, use a plastic bottle again for storing honey or growing seedlings.

Recycling- This is the process where recyclable materials (e.g. Paper, plastic, glass, metal, aluminium, steel, food leftover, etc.) are converted into new products.

Reducing, reusing, and recycling, decrease both the demands on natural resources, as well as the rate at which they are consumed. Fewer resources are used, limited supplies are conserved, and regeneration of renewable resources can occur. In addition, less waste is generated, thereby reducing the amount of trash that must be landfilled incinerated. As the amount of trash buried or burned decreases, so, too, does the potential for water and air pollution which can occur as the result of burning or improper disposal of wastes.

Choices we make in our personal lives can and do affect the environment. By reducing, reusing, and recycling, we can help to conserve the earth and the life it supports for many generations to come.



Picture 15 Recycling waste

4.5 Plastics and packaging

Plastics are produced from chemicals extracted from oil, natural gas and coal. Oil, natural gas and coal are called natural resources which are formed under the earth over millions of years. Some natural resources cannot be replaced when they have been used up. These are called non-renewable natural resources. Oil and coal are non-renewable natural resources that eventually will be used up.

Plastics are widely used because of their characteristics - attractive, hard, soft, slippery, rubbery, flexible, good insulators of heat or electricity, light weight, non-rusting, easy to shape and colour, cheap compared to metal.

Plastics have applications in various fields. For example, in agriculture, Polyvinyl Chloride (PVC) as well as High Density Polyethylene (HDPE) plastic is used for making irrigation pipes, drums, and tanks; in electronic industry it is being used in making T.V. sets, refrigerator, air conditioners. Packaging, shopping bags, home durable items like toothbrush, comb, shampoo bottle, varied applications. Plastics can become a problem.

Hazards of plastics on land and in oceans:

1. Plastic waste blocks drains and gutters, stopping the flow of rainwater and sewerage, causing an overflow which becomes the breeding ground for germs and bacteria causing many diseases.

2. The toxic smoke which is released while burning plastic affects the health of people seriously.
3. Workers and people living near a plastic or resin factory are prone to certain kinds of cancer and birth defects.
4. Plastic bags that fly and land in agricultural land, retard the growth of the crops by wrapping around the plants.
5. Plastic waste that lie on the soil for long, stop the passage of oxygen, causing soil infertility.
6. Domestic animals like cows and goats are often found dead after eating bits of plastic that gets mingled with the grass they eat.
7. Sea animals and birds were died by eating and tangling with the plastic bags every year. The sea turtle, dolphin and other watered-animals often confuse the plastic bags as their food, therefore they were died by eating it.

Cambodia has a population of about 14,000,000 people, if everybody in Cambodia used four disposable plastic bags each day it would mean that 56.000.000 plastic bags are thrown away every day of the year. This is a lot of plastic bags!

Chapter 5 Pollution in Cambodia

5.1 Air pollution

A. Components of air pollution

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural or built environment, into the atmosphere. The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet earth. Stratospheric ozone depletion means destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. Air pollution has long been recognized as a threat to human health as well as to the earth's ecosystems.

A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets or gases. In addition, they may be natural or man-made. Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

B. Effects of air pollution

The World Health Organization states that 2.4 million people die each year (worldwide?) from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution. Cities around the world with high exposure to air pollutants have the possibility of children living within them to develop asthma, pneumonia and other lower respiratory infections as well as a low initial birth rate. Many different chemicals in the air affect the human body in negative ways. Just how sick people will get depends on what chemicals they are exposed to, in what concentrations, and for how long. Older people are highly vulnerable to diseases induced by air pollution. Those with heart or lung disorders are under additional risk. Children and infants are also at serious risk. Because people are exposed to so many potentially dangerous pollutants, it is often hard to know exactly which pollutants are responsible for causing sickness. Also, because a mixture of different pollutants can intensify sickness, it is often difficult to isolate those pollutants that are at fault. Many diseases could be caused by air pollution without their becoming apparent for a long time. Diseases such as chronic bronchitis, some forms of asthma, lung cancer, and heart disease may all eventually appear in people exposed to air pollution.

Air pollutants such as ozone, nitrogen oxides, and sulphur dioxide also have harmful effects on natural ecosystems. They can kill plants and trees by destroying their leaves, and can kill animals, especially fish in highly polluted rivers.

C. Preventive measures

There are various air pollution control technologies and land use planning strategies available to reduce air pollution. At its most basic level land use planning is likely to involve zoning for housing and industrial zone and other transport infrastructure planning such as city bus, public

train, cable car. In most developed countries, land use planning is an important part of social policy, ensuring that land is used efficiently for the benefit of the wider economy and population as well as to protect the environment.

Efforts to reduce pollution from transportation means and equipment use needs more regulations. Increasing fuel efficiency through the use of hybrid vehicles, conversion to cleaner fuels such as bioethanol, biodiesel.

D. Waste as a cause of air pollution

Improper waste management is one of the causes of air pollution in Cambodia. There are two common ways in which waste is disposed by Cambodian people: **burning waste** and **waste burial**.

Burning of waste In most towns and cities the landfill is operated by a private company. If people want their waste to be disposed of at landfill they must pay the private company to collect it and take it to the landfill. Often the private companies only collect waste from areas where there are restaurants, shops and markets. People whose waste is not collected by the private company usually burn their waste in a small fire outside their house. Burning waste can cause problems. When people burn waste, plastic or styro-foam on a fire the gas released into the air is contaminated with chemicals which are dangerous to breathe in and can cause illness such as cancer.

When the fire is not hot enough to completely burn the wastes, it will smoulder and release black smoke into the air. Black smoke released into the air from a fire is made up of millions of tiny particles which sometimes stay in the air for many hours. It is also very dangerous to burn aerosol can. These can explode in a fire and people can get very badly burnt if they are standing near the fire when a can explodes.

Some solutions for these problems are:

- Dry the waste before burning it, because wet waste causes lots of smoke.
- The waste dump burning place should be located in the highland area to avoid flooding in the rainy season.
- Separately segregate the waste because it is easy to deliver and to make compost fertilizer.
- For non-biodegradable waste it is better to bury than burn or recycle it to protect the environment and health of humans and animals.

Waste burial Most large towns and cities have large holes where the waste that people produce is taken for disposal. Many people think that burial the waste is an easy waste management because they just dispose the waste into the hole then bury it. In contrast, it is not a good way, waste burial causes negative impact on the environment.

Improper management of the dump site causes bad smells and dust.

There are some solutions for the problems above:

- Always properly bury the waste to protect from animals and prevent the bad smell
- The waste dump should be far away from the houses or town
- Use rotten waste to make compost fertilizer. Making compost fertilizer can help reduce the quantity of waste which also helps us to use waste dump for a long time and to stop scratching activities of animals.

5.2 Water Pollution

A. The importance of water

We live on a planet called earth. Sometimes it is called the "Blue Planet". This is because nearly seventy five per cent of the earth's surface is covered with water. Water is an essential component of all living things. Water plays a key role in determining the weather, helps to shape the land surface, and regulates the climate. Rocks channel water into streams; streams and rivers carry water across the land to the ocean. Trees draw water from the soil and transport it up into leaves and out again into the air. Clouds carry water across the sky. Nearly everything on earth is directly or indirectly connected with water.

Roughly 70% of an adult body is made up of water. A human being needs an average of 2 litres of water per day to replenish water that is lost by human activities such as breathing, perspiration and urinating. People can survive 2 or 3 weeks without eating food, but they cannot survive without water for more than 2 to 3 days.

B. Sources of water

Water on the earth has an area of approximately $\frac{3}{4}$ of the earth. There are 2 types of water: salt water and fresh water.

Salt water sources

About 97 % of all water on the earth is salt water and cannot be used for drinking, watering crops, or used in industry. Salt water is found in seas and oceans; salt water is also a surface water.

Fresh water sources Fresh water is one of the most important resources we have. We drink it, we cook with it and we wash with it.

Fresh water supplies are mainly stored either in lakes, rivers, streams on the earth's surface (as surface water) or in the soil beneath the ground (as groundwater).

Fresh water has low salt concentration – usually less than one per cent (1000mg/l) of dissolved salts.

Much of the available fresh water is becoming scarce throughout the world for a number of reasons:

- the rising world population is increasing the overall demand for water;
- as people's standard of living increases their demand for water increases; and
- existing water sources are being contaminated by pollution.

The main sources of water are:

- surface water
- rainwater
- groundwater and
- glacial water.

Surface water is the water that is collected in streams, rivers, lakes, ponds, reservoirs, dams, seas and oceans. Surface water is easiest to use because it can be scooped up into containers, pumped or diverted for irrigation. Traditionally this is the main source of water for Cambodian people's daily use in spite of its risks for people's health.

Rainwater is water that falls from the clouds and is collected from the roofs of houses and channelled into jars. If it is stored in clean jars with a proper cover, it can provide drinking water for many months of the year. Rainwater is an important source of water for Cambodian people.

Ground water is water that is found underground in the cracks and spaces in soil, sand and rock. Groundwater is stored in--and moves slowly through--layers of soil, sand and rocks. These underground stores of water are a very important source of water. In fact some dry countries have no rivers, and groundwater is the only supply.

Ground water has become a very vital water source for Cambodian people because thousands of wells have been drilled around the country to supply water consumption of people.

Groundwater has 2 major advantages:

- Clean water source which has very little poisoned substance.
- It can supply longer water availability than other water sources.

Glacial water is water that is frozen and generally is found in very cold countries such as Antarctica and Alaska. This water is ice and cannot move. In the future this water may become an important source of water if other sources of water become too polluted to use. The world contains enormous reserves of water, but people cannot use most of them. Approximately, 97% of the world's water is salt water and cannot be used for drinking, irrigation or industry. The remaining 3% is fresh water but there is a big problem with using this because it is trapped in ice. Large amounts of fresh water are located in very deep ground layers and cannot be accessed easily. Groundwater and ice contain 2.997 % of this 3%. So all the enormous amounts of water on the planet there is only a very small proportion, about 0.003 % can be used by people.

For example, if you could put all the worlds' water in a 1 litre bottle, only one teaspoon would be available to drink.

Currently more families invest in their own family well, and in a growing number of small towns and large villages it is becoming possible to get a private connection to a piped water supply. Cambodia is fortunate that it has vast quantities of water passing through it, and also stored in the Tonle Sap Lake system. It is a fact that many parts of the world have a shortage of safe fresh water, therefore the water resources in Cambodia must be managed carefully.

C. Water cycle

The water cycle describes the continuous movement of water on, above and below the surface of the earth. There are two overlapping water cycles operating in nature:

- 1) Global water cycle, which does not involve life, and
- 2) Biological water cycle, which involves the entry of water into living beings

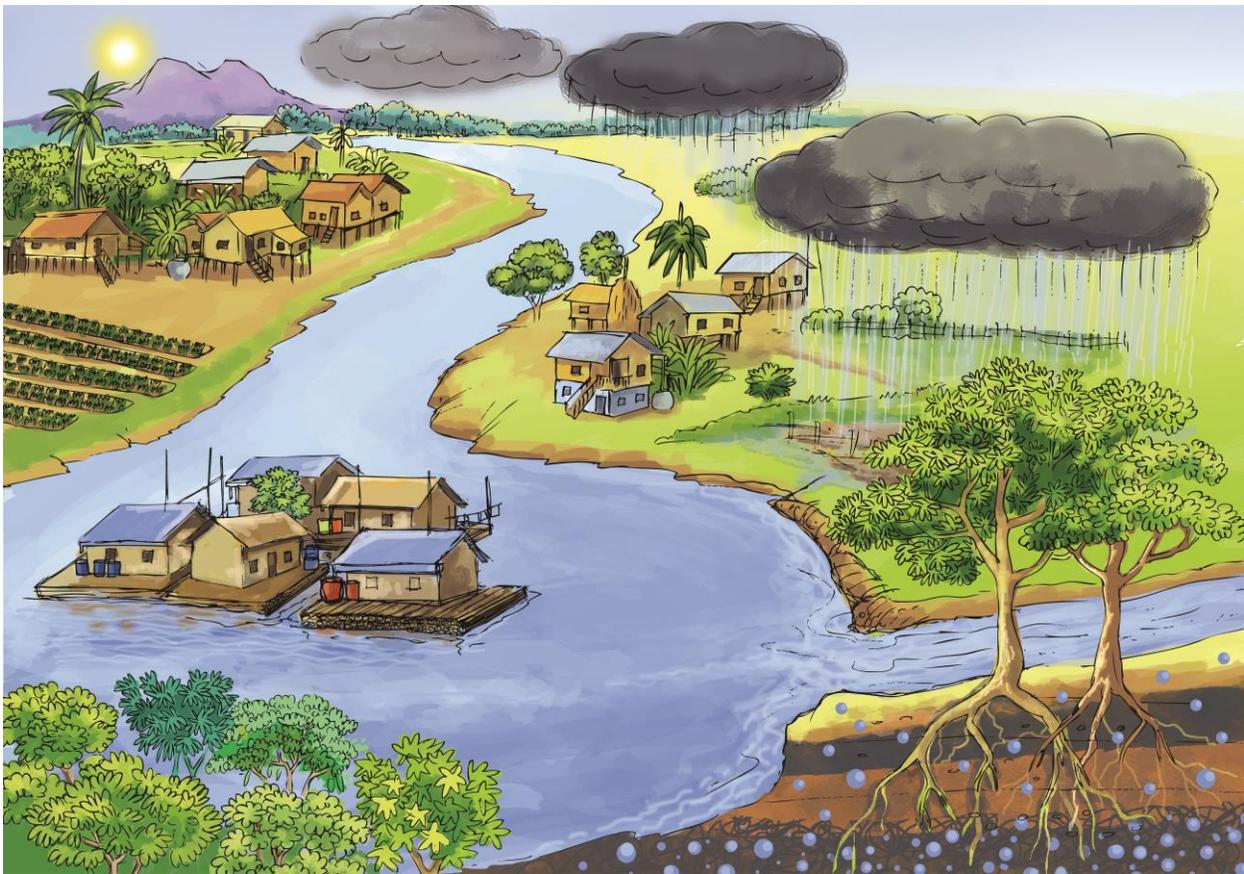
Global Water Cycle

Water evaporates from water bodies like seas and oceans, lakes and rivers and releases into the atmosphere in the form of vapour. After that the condensation of vapour becomes cold and forms clouds and water. This water falls on the soil or falls directly into the ocean in the form of rain, snow or hailstorm. If this water falls on the soil, it also flows into the rivers, streams and finally joins the sea. A large amount of water remains underground as well as in the form of perennial snow in the Polar Regions and mountain peaks.

Biological Water Cycle

Water enters into living beings and returns to the surrounding environment; it is a comprehensive cycle but different from the global water cycle. During the period of being alive, aquatic organisms take water from their surroundings and release in the form of fluid excretion, manure and vapour. Water returns to the environment after the death and decay of organisms. Terrestrial animals absorb water by eating feeds and by drinking water while plants absorb water from the soil. These organisms retain some amount of water in their bodies while the rest of water is released into the environment. Water in plants is emitted into the air through their leaves which may allow increased atmospheric humidity.

Water movement or the water cycle (oceans, seas, rivers, streams... which are water reservoirs) has impacts on the climate through direct evaporation and living organisms. Tropical forests help maintain atmospheric humidity and allow plenty of rains fall. Water is released into the water cycle after the death and decay of terrestrial organisms.



Picture 16 Water cycle Copyright © Live & Learn

There are six stages in the water cycle:

1. **Transpiration** Plants draw water in at the roots where it moves up to the leaves, and then evaporates. This process is called transpiration and is responsible for much of the water that enters the atmosphere. If plants are removed, particularly trees, then this part of the water cycle is disrupted, there is less transpiration and therefore less rain.

2. **Evaporation** Energy supplied by the sun helps water to rise up (evaporate) from trees and water surfaces such as lakes and oceans, into the atmosphere.
3. **Condensation and Rain** These drops of water in the atmosphere form into (condense) clouds. The sun also provides the energy which drives the weather systems to move the water vapour (clouds) inland (otherwise, it would only rain over the oceans). Once water condenses, it gets heavier, gravity takes over and the water is pulled to the ground as rain water.
4. **Runoff and Infiltration** Rain water runs off the land and flows into rivers, lakes and oceans. Rainwater can also soak into the soil, subsoil and rock to become groundwater. The water moves down into the ground because of gravity, passing between particles of soil, sand, gravel, or rock until it reaches impervious rock. This area becomes filled, or saturated with water. This groundwater may be very near the ground's surface or it may be hundreds of feet below. Wells that are sunk in the ground tap into this groundwater, or sometimes groundwater makes its way to the surface and forms a spring -- another source of drinking water for a village.
5. **Groundwater** Most groundwater is clean, but it can become polluted or contaminated. It can become polluted from sewage, or when people apply too much fertilizer or pesticides to their fields. When pollutants leak, spill, or are carelessly dumped on the ground they can move through the soil to contaminate water. Because of its deep in the ground, groundwater pollution is generally difficult and expensive to clean up. Sometimes people have to find new places to dig a well because their own becomes contaminated.
6. **Storage** Huge quantities of water are stored in rivers, oceans, lakes and glaciers.

D. Water pollution in Cambodia

Water pollution can have very severe impacts on human health. More than 1.23 billion people in developing countries cannot access to safe water and 1.47 billion people do not have adequate sanitation facilities. In developing countries, contaminated water kills at least 25 million people each year that 60 % of them are children.

A shortage of safe drinking water is a major problem in Cambodia, especially in rural areas. There is an abundance of surface water such as pond, lake and canal, but they are often contaminated. In Cambodia only nineteen per cent of the population can access to safe drinking water which means that eighty-one per cent of the population is at risk of getting many sicknesses from drinking contaminated water.

A risk is posed by chemical contamination with compounds such as arsenic, fluoride or nitrate. Not all chemicals in water cause disease, but some may make the water taste bad enough that people stop using it, and switch to another source which may be of worse microbial quality. This happens for example with iron and manganese, both of which can be found in Cambodia's ground water. In this way, even chemicals that do not pose a direct risk to health may still end up causing health risks indirectly.

Microbial contamination means that the water contains bacteria and viruses which can cause diseases.

Waste and chemical substance can produce many viruses in water. Waste is generated by community people and factories. Waste flows into water sources can cause negative effect on human health and environment.

The effects of microbial contamination are usually immediate, while problems caused by chemical contamination are chronic; they take a long time to appear, and may be hard to get rid of. Children, older people and people with a weakened immune system are most likely to be affected by water of low quality. Every year many people die, and many working days are lost through disease caused by lack of clean water source not using a latrine, and not practicing simple hygiene behaviour such as hand washing with water soap.

In Cambodia, many water sources are polluted namely river, ground water and rain water, however, groundwater contains less chemical substances than surface water.

River pollution

Rivers in Cambodia are facing pollution problems because of unawareness of people on the importance of clean water for them to survive. The following activities are affecting the water in the rivers:

- Disposing waste and defecate
- Building the latrine near or on the water consumption source.
- Building houses or restaurants on or close to the water consumption source without installing proper pipe system.
- Cleaning car, animal and wash up the clothes nearby water sources.
- Water pipes lead polluted water into the rivers.
- Burning and burial the waste nearby the river. These activities cause water easy to polluted and unsafe for lives.



Picture 17 River pollution Copyright © Live & Learn

Ground water pollution

Some groundwater sources are polluted by its own natural way. Salty water from sea runs to replace the fresh water, when fresh water is pumped up from the rock layer.

Serious pollution problem start to happen because of human activities such as using chemical fertilizer and pesticides in gardening, oil, washing cars, motorbikes, clothes using soap. Leaking of sewage systems and toilets can also cause the groundwater to be polluted. It can take many years to find out that underground water is polluted.

The biggest risk to health comes from the occurrence of inorganic arsenic in a number of areas along the major rivers. After drinking groundwater (well water) with arsenic for a number of years, people can develop a disease called Arcenicosis which eventually results in death.

Rainwater pollution

Most of people think that rain water is safe and clean enough for drinking. In fact, it is not true in all circumstances. In areas where there are factories, a lot of modern transportation means and machinery the rain will become polluted (acid rain) which is harmful for human health.

Even if the collected rainwater is clean people have to make sure that the rainwater container is safe and clean. The roof of the house needs to be cleaned regularly as well as the water container. People have to make sure that they boil rainwater before drinking, and preferably filter after boiling.

E. Preventive measures

There are enough renewable sources of fresh water available in Cambodia for everybody to have plenty, with approximately 35,000m³ of water per person per year at the current population. So while that quantity of water available is not an issue, the quality of this water is something that needs careful attention as not all water is fit for drinking (or other purposes) without some form of treatment.

Microbial contamination can be treated by boiling, adding chlorine to the water or using a home treatment system like a ceramic filter.

Cambodia has national drinking water quality standards, which set down the maximum allowable concentration of many chemicals. For example, drinking water cannot contain more than 0.05 mg/l of arsenic. Drinking water quality is an area of growing attention, and many measurement and mitigation programs are being implemented by UN agencies, NGOs and others, often in cooperation with the Ministry of Rural Development or the Ministry of Industry, Mines and Energy. These programs aim to identify the scale of any water quality issues, develop alternatives, and address the programs at the source or the home.

Chapter 6 River Environment

A river is a system of water storage which mainly comes from mountainous and highland areas.

6.1 Mekong River

The Mekong River – Tonle Sap Lake system dominates the water cycle of Cambodia. The Mekong River rises in the Tangha Shan Mountains in the Tibetan Plateau and flows through Burma, Laos, Thailand, Cambodia and Vietnam. In Cambodia, it flows through 5 provinces namely Strung Treng, Kratie, Kampong Cham, Kandal and Prey Veng.

The Mekong River is reported to be between 4200 kilometres and 4900 kilometres long and is the twelfth longest river in the world. Around 500 billion m³ of water flows down the Mekong River each year making it the third largest river in the world. 86% of the land of Cambodia lies within the catchment of the Mekong River.

A. Importance of Mekong River

The Mekong River provides lots of advantages to people who live along it. It is stock of food security, agricultural land, irrigation scheme and waterway. It is also a major habitat for biodiversity, especially the big fish such as Kul Raing, Reach and the endangered Irrawaddy Dolphin.

B. The benefits of a dam

A dam has both positive and negative impacts on humans and environment. The benefits of a dam include:

- mitigating hazards caused by floods at the lower areas of the dam by controlling water flow current;
- providing water supply which can be controlled for multiple uses, including for irrigation;
- providing hydroelectric power resulting from the water flowing across the turbine;
- water reservoirs on the upper part of a big dam can be used for leisure and fishing purposes.

C. Consequences of hydro dams construction in the Mekong River

As the countries of the Mekong Basin develop economically, their demand for energy is growing. Hydropower is seen as both a potential source of this needed energy and as a means for economic growth in and of itself.

But some dams may end up doing more harm than good. Dams on the mainstream of the lower Mekong would be particularly destructive. Serious impacts include:

- **Delta instability:** The reduction of sediments as they are trapped by dams would make the Mekong Basin more vulnerable to sea level rise and saline intrusion brought on by climate change.
- **Decreases in fish diversity:** Dams in the mainstem will impede migration of fish and other aquatic animals potentially reducing productivity of the fishery by 60%.
- **Damage to livelihoods:** Over 75% of rural households in the Lower Mekong Basin are involved in fisheries. Any impact on the ecological balance of the river also threatens the sustainability of the aquatic resources they depend on.

Although — for now — the lower Mekong River remains free of large dams, the same cannot be said for its upper reaches. There is little doubt that dams in the upper Mekong are having an impact on downstream hydrology and ecology.

If built, the proposed Don Sahong Dam would be the first dam on the Mekong mainstream in the lower basin area. It is located less than two kilometres upstream of the Laos–Cambodia border. This dam will very likely influence one of the few remaining pods of Irrawaddy river dolphins in the Mekong, the dam would likely spark a decline of its main food source and disrupt its habitat. Such damage would be devastating to a species already on the brink of extinction in this river. Moreover, the Don Sahong Dam would damage fisheries that are central to people's food security by impeding fish migration. And it could harm the local economy and its developing tourism industry.



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Picture 18 Hydro dam

Of course, the region's growing electricity needs are often cited for the necessity of building more dams. It's true that the dams already in place along the Mekong provide much needed renewable power to millions. More research is necessary on the use of other sources of green energy like solar power, wind energy.

6.2 Tonle Sap Lake

A. Geography of Tonle Sap Lake

The Tonle Sap Lake, also known as the Great Lake, lies in the centre of Cambodia and is connected to the Mekong River at Chaktomuk by the Tonle Sap River. The Great Lake is the largest permanent freshwater lake in Southeast Asia. The Tonle Sap – Mekong River system has a unique feature.

Tonle Sap Lake and its branches form waterway system which is unique because it receives water from whole flat area and flooded water from Mekong River as well. Tonle Sap River is located between four river section and Kompong Chhnang length 95 to 100 Km and connected with Mekong River and Tonle Sap Lake.

Tonle Sap Lake is shaped like a violin or ellipse with the size of 68,000 Km². In dry reason its size is approximately, 3,000 Km² and in rainy reason about 10,000 Km².

Tonle Sap Lake is surrounded by 6 provinces: Siem Reap, Kompong Thom, Kompong Chhnang, Battambang and Banteay Meanchey.



Copyright © Osmose

Picture 19 Tonle Sap Lake

- The big part of the lake is located in the North with length of 74 Km and width 32 Km
- The small part of the lake is located in middle with length of 35 Km and width 22 Km
- Muddy field is a big field with many small islands and the growth of stunted plants. This field has length about 40 Km and width 12 Km.

During the dry season (November to June), many rivers enter into the Tonle Sap Lake. Some originate from the Kravanh mountain chain: Stung Bahour, Stung Pursat, Sangker, Stung Mongkol Borey. Others originate from the Dangrek mountain chain: Stung Sen, Stung Sreng, and Stung Sisophon.

Water flows out of the lake during this time into the Tonle Sap River and out to the Mekong Delta.

In the dry season, water flows from Tonle Sap River into Mekong River (during that time water flows from the North to the South) and in rainy season, water flows from Mekong River into Tonle Sap River (during that time water flows from the South to the North).

During the rainy season (July to October), the water level in the Mekong rises and the Tonle Sap River reverses the direction of its flow into the Tonle Sap Lake. So in the rainy season the Tonle Sap Lake has many input rivers but no output river. The surface of the lake ranges from 2,500 km² the low water level season to more than 10,000 km² at the high water level season. Depth varies from one meter to ten meters.

In rainy season the lake itself looks like a very deep sea but in dry season it looks like a huge pond with muddy soil and shallow.

B. Importance of Tonle Sap Lake

The Tonle Sap - Mekong River system is very important to Cambodia as it provides water for human uses (drinking, food, cooking, washing, cleaning), agriculture and irrigation, industry, energy, transport and recreation/tourism. It is also an important fishery and habitat for some endangered species.

In rainy season, it has many big boats, especially carrying goods from North-West to Phnom Penh capital city. In dry season, only small boats can be journeyed because the water is very shallow.

Today, there are approximately 120 population are living around Tonle Sap Lake and they are fishermen and farmers. Tonle Sap Lake has a lot of irrigation system advantaged for agriculture sector.

The fishery yield that comes from the fresh water source in Cambodia is among the highest in the world due to high temperatures of the Great Lake and the annual flooding. The areas of the flooded forests around the Tonle Sap Lake are very important for the reproduction of fish. The flooded area provides microorganisms for the fish to eat, and it is a reproduction area for some fish species and a good shelter for juvenile fish.



Picture 20 A fisherman is throwing his net on Tonle Sap river along Phnom Penh Copyright © Jean Loncle

The freshwater fish stocks are vital to the human population and also for a variety of other fish-eaters, including the largest remaining water bird colonies in Southeast Asia and some other endangered species such as Hairy-nose Otter, the Fishing Cat, the Irrawaddy dolphin and the critically threatened Siamese crocodile.

Tonle Sap Lake and its branches supply water for farming and it produces energy easily. Moreover Tonle Sap Lake is a huge reservoir that can absorb big amounts of water from the Mekong River which helps the lowland areas to escape from flood in the rainy season.

C. Main environmental problems of the Tonle Sap Lake

In the last decades there are many environmental issues caused mostly by human activities. Main issues that happen are decreasing of natural resources, pollution and the disappearing of some biodiversity in the Tonle Sap Lake.

These environmental problems happened in each country and in all over the world. In Cambodia there are also complicated environment issues such as deforestation, soil erosion, mine and chemical pesticide use.

Tonle Sap Lake is essential and value heritage in the world because it provides a lot of natural resources including freshwater, animals, fish, forest, silt soil.... Recently, these natural resources are being greatly suffered such as decreasing of natural resources and pollution (air, water and land) and the destroying of some bio diversities.

Tonle Sap environment problems are caused by highly and rapidly increasing of population. We are aware that human's ambition is never satisfy. Therefore, they always do activities according to their thoughtless feeling or view.

For example:

- Destroy or burn down flood forest for catching animals or making charcoals
- Use electricity for shocking the fish
- Kill wild animals
- Use chemical pesticide
- Throw waste into water source...

Tonle Sap Lake is rich the most of fish in the world. Currently, however it is under threatening of destroying ecosystem. Overwhelmingly fishing is very strong impact to the stock of fish in the lake. The increasing of silt soil along main rivers affect to the movement of fish and increasing muddy soil in the lake itself make water hotter which cause decreasing of fish quantity. The strongly increase of muddy soil is caused by deforesting in north part of Tonle Sap reservoir and around big lake as well as mining activities in West of Battambang Province. The increasing of muddy soil can cause dirty water or low quality of water. Using low quality water can cause health problems, loss of flood forest and some species of bird and creatures. Throwing waste both solid and liquid and using chemical pesticide cause water pollution as well.

D. Protection and preservation of the Tonle Sap Lake

Tonle Sap Lake is an area that provides a lot of natural resources to Cambodian people. Therefore we must be actively involved in saving and conserving our Tonle Sap Lake. There are a number of ways that can support the Tonle Sap Lake conservation but the most effective way is community fishery, because it is a major concept that can help in many important ways as mentioned below.

- To protect illegal cutting down the flooded forest and to stop illegal fishing especially in the prohibited fishing season through patrolling under the support of and in cooperation with local fishery officers based on the regulations of the community fishery and other legal ways.
- Natural resources conservation of Tonle Sap Lake through active involvement of community fishery members.
- Educate people and promote awareness on the importance of participation in the Tonle Sap Lake conservation at local level.
- Ensure the sustainable conservation through boundary demarcation for the community fishery to get assigned a specific territory and sovereignty from the fishery administration department of the Ministry of Agriculture, Forestry and Fishery.

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References

Books

The Atlas of Cambodia, National Poverty and Environment maps, Save Cambodia's Wildlife with support from Danida Phnom Penh, 2006

Earth Science and Environment book, grade 11, MoEYS, published in 2008

Earth Science and Environment book, grade 12, MoEYS, published in 2011

Environmental Education Handbook, Teacher's Resource, Standards VI-VIII, Centre for Environment Education (CEE) India, 2005.

Activities from "Environmental Education Handbook" copyrights © 2005:

- Who am I? (page 11)
- Web of life (page 25)
- How much water for us? (page 40)
- Forget me not (page 81)
- Life time (page 82)
- Use and throw (page 85)
- School compost pit (page 182)
- Plastic bag free school (page 184)

Environmental Education for Primary School level, Committee of Inter ministry focussing on Environmental Education, published by Department of Environmental Education Information and Extension, 2005

Environment Education Handbook: Understanding our environment, Ministry of Environment (2008).

Environment Manual, compiled, revised, verified and edited by Noel Lou Brian (English version) and Mr. Ponlork (Khmer version 2000)

Green games, Centre for Environment Education (CEE) India, copyrights © 1997

Activity from "Green games" third edition 2006:

- Oh deer (page 15)

Fundamentals of Environment, compiled and translated in Khmer by Mr. Sporn Vin, July 2003

Lextionary for forestry, Mr.Ouk Siphon, department of agricultural legalisation of Ministry of Agriculture, Forestry and Fishery, 2008

Manual guide for teachers on Tonle Sap Lake Environmental Education, cooperation between MoEYS and Live & Learn, published in 2006

Policy for Curriculum Development 2005-2009, Ministry of Education, Youth and Sport

Safety of Land use, grade 9, organised by Ministry of Education Youth and Sport, ECOSORN 2009

Science book, biology and earth science, grade 7, MoEYS, published in 2007

Science book, grade 8, MoEYS published in 2010

Science book, biology and earth science, grade 9, MoEYS, published in 2008

Science book, biology and earth science, grade 10, MoEYS, published in 2007

Teacher's book for Environment Educator, prepared by MoEYS in cooperation with Osmose, Mlub Baitong, FAO, Sam Veasna Center (SVC), Save Cambodia's Wildlife (SCW), copyright 2007, second publication.

Understanding Climate Change, Manual for secondary schools, Department of Climate Change, Ministry of Environment, 2001.

Understanding Environment, Chokar Kiran B., Pandya M., Rachunathan M., Centre for Environment Education, 2004

Webpages with organisation as author

<http://www.forteachersforstudents.com.au/ClimateChange>

<http://www.globaltrade.net/international-trade-import-exports/f/market-research/pdf/Cambodia/Mining-and-Quarrying-Mining-Support-Services-Mining-sector-in-Cambodia.html> (*Sector Report - Mining in Cambodia 2009, produced by Reingsey Oum, Trade and Investment Officer, British Embassy Phnom Penh*)

<http://minerals.usgs.gov/minerals/pubs/country/2009/myb3-2009-cb.pdf>
Mineral Yearbook-Cambodia 2009, USGS

http://wwf.panda.org/what_we_do/foodprint/water/dams_initiative

<http://www.recoftc.org/site/Community-Forestry-in-Cambodia>

<http://www.unesco.org/csi/pub/papers3/sande3.htm>

<http://www.unescobkk.org/education/esd-unit/characteristics-of-esd>

<http://www.unicef.org/lifeskills>