TONLE SAP
INFORMATION GUIDE

បោះពុម្ពដោយអង្គការ ការអប់រំស្តីពីការរស់នៅជាមួយបរិស្ថាន (Live & Learn)

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ការចេញផ្សាយនេះគឺជាផ្នែកមួយនៃគំរោងគ្រប់គ្រងបរិស្ថានបឹងទន្លេសាប (TSEMP) និងយុទ្ធនាការផ្សព្វផ្សាយ
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INTRODUCTION

The environment has once again become the talking point of the world: the potential impacts of climate change that were once questioned are now being accepted. In-line with this the consequences of not managing our environment and not reducing our consumption are becoming more apparent and more critical. For the moment climate change is in the international media and political spotlight. While the media attention is focused on climate change, it is important to maintain attention on other environmental issues, those that everyday citizens can confront, and must learn to manage. Building a sense of understanding of what we have, how it is linked and why it is important to manage and protect, is an area we need to focus our collective attention on.

The mass media has a growing audience of people who have an increasing interest and concern with the environment. We should take the opportunity to not only share the issues of the environmental crisis but also to empower the people to take action, usually by behaviour changes such as disposal of litter, walking instead of driving. The media must take a leading role in raising community awareness and educating the population. We need to develop an environmental consciousness among the population, which will guide our management decisions as we search for a sustainable future.

Education and learning are the key ingredients in becoming more sustainable. In response to a growing understanding that the environment is being negatively impacted by human activities, education has become more focussed on showing how to reduce our impact on the environment, how to repair the damage we have done and how to plan and develop for a more sustainable future. This mode of education falls under many headings grouped under the term of environmental education. Environmental education has been actively promoted in a range of

international forums for the past thirty years. Significantly, the United Nations Millennium Development Goals also promote the use of education in moves toward sustainable development. Most recently, the United Nations General Assembly proclaimed the Decade of Education for Sustainable Development for the period 2005 – 2014, 'emphasizing that education is an indispensable element for achieving sustainable development.'

Prior to the conflict Cambodia was a regional leader in literacy and higher education, and in 1925 it was also the first to establish an area "protected" for its environmental value. Unfortunately, the years of conflict eroded this good base. Environmental education in Cambodia has had a relatively short history, firstly incorporated into Government policies with the establishment of the Ministry of Environment (MoE) in 1993. Since this time it has gained increasing support and acknowledgment as an important tool in reducing a variety of environmental problems that are currently affecting the country. Donor communities especially, have identified the importance of education in helping to repair the damaged environment, and to manage and protect in order to safeguard the future of the Cambodian environment.

There is integration of environmental education into some formal education: however overall, non-formal activities

make up the bulk of environmental education in Cambodia. Partnering with journalists to communicate complex environmental issues to a wider audience has great potential. Accurate and balanced reporting by journalists can directly increase understanding and discussion on the need for sustainable development. It is very positive that throughout Cambodia there are increasing frequency of articles and reports on the environmental situation, but still more are needed and more understanding of the local environment needs to be shared.

In the agreement, dated 6th June 2005 the Ministry of Environment (MoE) of the Royal Government of Cambodia appointed Live & Learn Environmental Education (L&L) to carry out the National Environmental Education & Awareness Campaign (NEEAC) under Component One of the Tonle Sap Environmental Management Project (TSEMP). TSEMP is funded by the Asian Development Bank (ADB) under Loan 1939 CAM (SF), as part of the overall Tonle Sap Initiative. The Tonle Sap Lake has great significance in Cambodia and is iconic: referred to by some as 'the heart of Cambodia'. Unfortunately, this natural icon is under increasing pressure from unsustainable human activity. The environment is being heavily degraded and without intervention and behaviour change, the whole fragile ecosystem is in danger of collapsing. The NEEAC aims to improve knowledge

of environmental issues at various levels of Cambodian society, with a special focus on the whole ecosystem of the Tonle Sap.

As part of a strategic approach, we are seeking to better promote journalists understanding of and access to relevant materials on the Tonle Sap Environment. This 'Tonle Sap Information Guide' has been developed for journalists in response to the interest being shown on the Tonle Sap Lake, and the lack of existing resources available for journalist: especially in Khmer.

The 'Tonle Sap Information Guide' is a collection of a wide variety of relevant environmentally – focused information for journalists. It will serve as a valuable reference point for researchers and writers and anyone else interested in the

Tonle Sap Lake. The guide starts with some facts, dates and frequently asked questions about the Tonle Sap Lake. This section will help to stimulate ideas for journalists to develop related articles and reports, and will guide them to other relevant information in the guide.

Secondly, the guide gives an overall view of Protected Areas and the Tonle Sap Biosphere Reserve. It then focuses on: the five seasons of the Lake, and the Flooded Forests and Wetlands. The Tonle Sap Lake is the largest of Cambodia's protected areas, and with one third of the population based in this area it is also one of the most significant. The significance of the Tonle Sap Lake has been recognized internationally with its designation as a Biosphere Reserve and designated Ramsar Wetland. The seasons of the lake and unique flow are described, as is the importance of the flooded forest. Wetlands of Cambodia are also covered in this section.

The third section focuses more on the Tonle Sap Lake as a natural resource, describing: fisheries, community fisheries, forest management and water quality. The importance of the Tonle Sap as a resource should not be underestimated. The lake's rise and fall corresponds with an abundance of the main food staples of Cambodia: fish & rice. Tonle Sap Lake provides up to 70% of Cambodia's protein diet. Integrated management and protection of the Tonle Sap lake environment is of utmost importance to sustain the resources of the lake.

Biodiversity is the topic of the fourth section. Topics covered include: fish, birds, reptiles, mammals and a specific focus on the Boeng Tonle Chmaa bird and fish breeding grounds. Maintaining biodiversity is essential to maintain the health, integrity and productivity of the ecological system. That ecological system relies on the intricate linkages and interdependence of all species in the system, and on the continuing environmental health of the system. The people of Cambodia especially, rely on this diverse, interdependent, functioning system because it is the interactions between species and within that environment which produces the food resource so important for the country's growing population. Ecosystems require management and protection to maintain their health and productivity.

Section five looks at the bigger picture of the Millennium Development Goals and Environmental Education. At an international level there are major efforts to coordinate actions toward sustaining the environment. The Millennium Development Goals (MDGs) are one such approach but they must be supported by a range of activities in order for them to be successful. Environmental Education plays an important role in the promotion of environmental management and is designed to assist in the movement of people to a more sustainable way of life.

The entire guide is then further supported with a glossary of useful terms, abbreviations and acronyms and a directory of relevant organizations. The lack of agreed terms is a major impediment to the effective documentation and translation of important environmental information in Khmer. The glossary used has been developed by merging the Mekong River Commission glossary and Environmental Terms Dictionary and is hoped to help bring some clarity and consistency in this respect

The longest journey starts with the first steps in the right direction. We hope this 'Tonle Sap Information Guide' starts the journey in the right direction for journalists and others involved in educating the public about our beautiful but fragile environment. We look forward to seeing & hearing more about the importance of the Tonle Sap Lake in the future.

FACTS

THE TONLE SAP LAKE AND TONLE SAP BIOSPHERE RESERVE

GEOGRAPHY

- Is the largest freshwater lake in South East Asia, covering over 1.6 million hectares;
- 1993 a Royal Decree designated the Tonle Sap as a Multiple-Use Protected Area;
- Tonle Sap is included in WWF's Global 200 list of significant areas of critical conservation importance;
- Has been internationally recognized in 1997, as a Biosphere Reserve; with 3 core areas (Prek Toal, Boeung Tonle Chhmar & Steung Sen) under the UNESCO Man and Biosphere Program;
- Includes the biggest continuous area of savannah swamp forests and Flooded Forest in the whole of Asia;
- Flooded Forest provides a vital breeding ground for seasonal breeding, nursery grounds and forage areas for fish that migrate to the Mekong River.
- Rice production in the Tonle Sap floodplain makes up about 12% of Cambodia's annual harvest
- The Tonle sap is designated an environmental hotspot of global significance
- The Tonle Sap basin extends over 80000 square kilometres, or 44% of Cambodia's total land area;
- 32% of Cambodia's population live within the Tonle Sap Basin;

HYDROLOGY

- Unique hydrology of the Tonle Sap
- The Tonle Sap is connected to the Mekong River by the 100-kilometre long Tonle Sap River. Each year the Tonle Sap river reverses its flow as floodwaters from the Mekong push into the Tonle Sap and fills up the lake;
- 250,000–300,000 hectares in the dry season to 1.0–1.6 million hectares in the wet season
- 1–2 meters above mean sea level in the dry season to 8–11 meters above mean sea level in the wet season
- 20% of the Mekong River's floodwaters are absorbed by the Tonle Sap lake and river
- 62% of the Tonle Sap's water originates from the Mekong River
- 38% of the Tonle Sap's water originates from the Tonle Sap basin

FISHERIES

- The Tonle Sap has one of the most productive fisheries in the world, and is estimated to account for about 60% of Cambodia's production of freshwater fish;
- Fisheries and other aquatic resources are conservatively estimated at a value of US$233 million per year;
- Fish diversity is high but most fish catches in Cambodia are dominated by 10 species;
- More than 400 community fisheries organisations have been established in villages around the lake to help manage the Tonle Sap natural resources;
- The Tonle Sap yields about 230,000 tons of fish per annum, this is considerably lower than previous years where the annual fish harvest was up to 400,000 tons ;
- The Tonle Sap provides up to 80% of the protein diet of Cambodians;

FLOODED FOREST

- Flooded Forests are structurally and floristically different from any other freshwater swamp forests elsewhere in the world
- The flooded forest contains about 200 plant species
- The flooded forest extended over more than 1 million hectares originally, 614,000 hectares in the 1960s, and 362,000 hectares in 1991. Current estimates put the area of flooded forest at less than 240,000 hectares

PEOPLE

- Most people living on and around the Lake are 'highly dependant' on fish and other aquatic resources.
- Less than 10% of rural people living on and around the Lake have safe drinking water or a toilet.
- 1.2 million people live in the area bordered by Highways No. 5 and No. 6, about 3 million live in the five provinces that abut the lake and about 340000 live in the immediate surrounds of the lake;
- About 37% of people living in the provinces surrounding the lake live under the official poverty line;
- Almost half of the villages have almost half of their populations living below the poverty line;
- Illegal fishing methods include: poison, explosives, electro-fishing, small net mesh sizes;
- It is estimated that more than 80% of households do not have access to safe domestic water;
- Malaria, dengue fever, acute respiratory infections, and tuberculosis are endemic
- Half of the children under 5 are malnourished;
- 70% of children do not finish primary school, compared to national average of less than 60&

BIODIVERSITY

- Is home to the world's largest snake harvest, largely fuelled by the explosive growth in crocodile farms;
- Has the biggest colonies of globally endangered waterbirds in South East Asia: also an important site for many other threatened species;
- Once had many large mammals such as elephants, wild buffalo, and deer but these have disappeared;
- More than 200 species of plants occur in the Tonle sap;
- The Tonle Sap contains at least 225 species of fish, 42 species of reptiles, 225 species of birds, and 46 species of mammals.

02

KEY DATES

1863

- Authorities introduce fishing lots as a system of feudal patronage. Revenues are paid to the French to keep the Siamese at bay.

1884

- The fishing-lot system is abandoned following rebellions by peasants protesting the loss of their fishing grounds.

1908

- A new system of fishing lots emerges with fishing seasons, fish sanctuaries and restrictions on some types on fishing gear. Local villages are given access to fishing grounds and a research institute is set up. French colonial authorities used revenues to develop public infrastructure such as roads and railways until independence in 1953.

1956

- Fishery Law promulgated. Conflicts resurface and King Norodom Sihanouk later disbands some fishing lots.

1960s

- Owners and managers of some fishing lots are reportedly killed in disputes with local officials and villagers.

1970

- The United Nations Educational, Scientific and Cultural Organization (UNESCO) launches its Man and the Biosphere (MAB) program.

1971

- An international conference in Iranian city of Ramsar adopts the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, more commonly known as the Ramsar Convention.

1973

- Lon Nol bans fishing lots.

1975

- Most fishing abandoned as Khmer Rouge takes control of Cambodia.

1987

- Fisheries Management and Administration Law promulgated. The new law defines fishing grounds as public property and divides the capture of freshwater fish into large, medium and small-scale categories.

1993

- Ministry of Environment established.
- Royal Decree on the Designation and Creation of National Protected Areas System.

1994

- Agencies such as the United Nations Food and Agriculture Organisation (FAO) initiate efforts to develop fisheries co-management.

1995

- Cambodia, Laos, Thailand and Vietnam sign Agreement on the Cooperation for Sustainable Development of the Mekong River Basin.
- Conflicts over fishing, water and land rights start to escalate between fishing and farming communities, owners and employees of fishing lots, local authorities, police and military authorities.

1996

- National Assembly adopts Law Establishing the Ministry of Environment and Law on Environmental Protection and Natural Resources Management.
- Cambodia accedes to the Ramsar Convention.
- UNESCO approves a strategy and framework for a global network of biosphere reserves following an international conference in the Spanish city of Seville in 1995.

1997

- UNESCO designates the Tonle Sap as a biosphere reserve.
- Ministry of Environment initiates a pilot project in Prek Toal, leading to the construction of Cambodia's first environmental research station.

1998

- UNESCO establishes the Southeast Asia Biosphere Network. In addition to Cambodia, the network includes China, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand and Vietnam.

1999

- Prime Minister Hun Sen says fisheries are in a state of "anarchy" following years of conflict over fishing lots.
- Cambodia designates three wetlands as globally important under the Ramsar Convention – Boeung Chma in Kompong Thom, the Mekong River north of Stueung Treng and Koh Kapik and nearby islands in Koh Kong.
- National Assembly passes Law on the Creation of the Ministry of Water Resources and Meteorology (and Law on Water Resource Management?)
- Sub-decrees on Pollution Control and Solid Waste Management issued.
- Draft Wetlands Action Plan formulated.

2000

- Prime Minister Hun Sen announces the release of 8,000 hectares of fishing lots for community management and promises to remove corrupt officials.
  At this stage, Cambodia's 239 fishing lots spanned more than a million hectares, yielding about $2 million in concessions to the government. Most lots released were small and were worth less than 30 million riel each

2001

- Cambodia becomes the first country in Asia to set up a Community Fisheries Development Office. Located in the Department of Fisheries, the office aims to encourage local communities to play a greater role in managing fisheries.
- The government asks the FAO in Siem Reap to help set up village fishery management committees around the Tonle Sap.
- Sub-decree of the Establishment, Role and Functions of a Secretariat for the Tonle Sap Biosphere Reserve. The secretariat is headed by a secretary from the Cambodian National Mekong Committee and three deputies from the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment and the Ministry of Water Resources and Meteorology.
- National Assembly adopts Land Law
- The Mekong River Commission, China and Myanmar sign the Agreement on the Provision of Hydrological Information on the Lancang/Mekong River in the Flood Season.
- The Asian Development Bank (ADB) approves the Tonle Sap Environmental Management Project. The $20 million projects aims to strengthen management of natural resources, organise communities and conserve biodiversity.
- Prime Minister Hun Sen hosts the Greater Mekong Subregion summit with the leaders of China, Laos, Myanmar, Vietnam and Thailand as well as the president of the Asian Development Bank. During the summit, an Inter-Governmental Agreement on Regional Power Trade was signed.

2003

- National Assembly adopts Law on Forestry.

2005

- Sub-decree on Community Fisheries Management issued. Fishing lots are defined as public property with regulated community access. Community fishery areas have "territorial use rights" with access to non-community members as well.
- Chinese Prime Minister Wen Jiabao hosts the second summit of leaders from the Greater Mekong Subregion. The leaders agree to accelerate cooperation in the agricultural sector and acknowledge that environmental degradation is a serious threat to the region.

2006

- National Assembly adopts new Fishery Law.

03

FREQUENTLY-ASKED QUESTIONS

WHAT?

What are biosphere reserves?

Protected areas of the world's main ecosystems that are recognised internationally through the United Nations Educational, Scientific and Cultural Organisation (UNESCO). The UN agency describes them as "living laboratories" for testing integrated management of land, water and biodiversity. The reserves are nominated by national governments and remain under their jurisdiction.

What are the three functions of biosphere reserves?

Each reserve is supposed to help conserve landscapes, ecosystems, species and genetic variation while fostering sustainable economic and human development. A third function is to support research, monitoring, education and the exchange of information. The reserves are not covered by international convention but must simply meet a set of criteria allowing them to fulfill these three functions.

What are core areas, buffer zones and transition areas?

Each reserve has at least one core area as a securely-protected site with limited human activity. A clearly-identified buffer zone protects the core area from a flexible transition area where human settlement and agriculture is more intense.

What is the Tonle Sap Biosphere Reserve?

A protected area of almost 1.5 million hectares comprising the lake itself, flooded forest areas and flooded grasslands, mainly on the eastern shore. In the rainy season, the lake swells to as much as 1.6 million hectares, more than six times its dry season area which is as little as 250,000 hectares.

What are the threats to the Tonle Sap Biosphere Reserve?

Over-exploitation of forest resources, fish and wildlife. Specific threats include dry-season encroachment and clearance of the flooded forest. The overall threat is the increasing resource needs of Cambodia's expanding population.

What is the Southeast Asia Biosphere Reserve Network?

A regional network of reserves launched in 1998 comprising China, Indonesia, Japan, Laos, Malaysia, Myanmar, the Philippines, Thailand and Vietnam as well as Cambodia. The UNESCO office in Jakarta hosts a website for the network. Cambodia hosted the network's third meeting in Siem Reap in 2003. Laos hosted the fourth in 2005.

What is the Tonle Sap Environmental Management Project?

A $20 million project jointly financed by the ADB, United Nations agencies and the Royal Government of Cambodia. The board of the Asian Development Bank (ADB) approved the project in 2002. The project has three parts – strengthening the management of natural resources, organising communities and conserving biodiversity in the reserve.

WHO?

Who is behind the biosphere program?

UNESCO oversees the program which had 482 reserves in 102 countries by 2005. An advisory committee examines nominations for reserves and makes recommendations to an International Coordinating Council which usually meets every two years. Based in Paris, the council has 34 members who elect a chairman and five vice-chairmen

Who controls the hundreds of biosphere reserves worldwide?

The reserves are governed by a UNESCO strategy and global framework but are controlled by the countries where they are located. The reserves are not covered by international convention but must simply meet a set of criteria allowing them to fulfill these three functions.

Who is responsible for the Tonle Sap Biosphere Reserve?

The reserve is administered by a secretary from the Cambodia National Mekong Committee and three deputy secretaries from the Ministry of Environment, the Fisheries Department of the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Water Resources and Meteorology.

Who is responsible for the Tonle Sap Environmental Management Project

The project is overseen by a steering committee headed by Agriculture, Forestry and Fisheries Minister Chan Sarun. The day to day running of the project is overseen by the Ministry of Environment with the ADB playing advisory and coordinating roles.

Who is financing the management project?

Most of the $20 million project is being financed by an ADB loan for $10.9 million, with the Cambodian government providing the equivalent

of $3.9 million in local currency. The United Nations Global Environment Facility (GEF) has offered a separate $3.9 million grant and the United Nations Development Program (UNDP) is providing a grant of $623,000. The ADB is offering a further $540,000 as a technical assistance grant.

WHY?

Why is Tonle Sap Biosphere Reserve important?

The reserve reaffirms the lake's place as a biodiversity reservoir of global significance and also recognises its unique ecological, environmental, social and cultural importance. The Tonle Sap is the largest freshwater lake in Southeast Asia, supporting one of the most productive fisheries in the world, directly providing livelihoods for about 11 percent of Cambodia's population. More than a million people live in the reserve, mainly in the buffer zone and transition area. Fishing is the main activity but the flood plain is also used to produce rice and vegetables. The main goal of the reserve is to study and promote indigenous ecological knowledge. Nearly 100 water bird species can be found, including a dozen of international significance. In addition to fish stocks and rare water birds, the area is also known for crocodiles, turtles, macaques, capped langurs, otters, and water snakes. About 10 percent of the area is covered by tall-tree forest, mainly along streams and wetter places.

WHERE?

Where are the reserve's three core areas?

On the northern and eastern shores of the lake. The biggest core area is in Prek Toal in Battambang province. The two other core areas are in Kompong Thom province: Boeung Chhma and Steung Sen. Prek Toal and Boeung Chhma are important breeding and feeding grounds for endangered species of large water birds. Steung Sen features trees rare to the flood plain.

Where is the buffer zone?

The buffer zone covers the entire lake and extends to the outer limits of the flooded forest. It stretches deep into Battambang province and also covers large areas of Kompong Thom and Pursat provinces and smaller areas of Kampong Chhnang and Siem Reap. The buffer zone is the same area designated by Royal Decree as a "multi-purpose protected area" in 1993.

Where is the transition area?

The area spans Banteay Meachey province in the north to Kompong Chhnang province in the south. In Battambang, Pursat and Siem Reap provinces, the border follows National Routes 5 and 6 and extends to limited stretches of the two highways in Kompong Chhnang and Kompong Thom provinces. The area includes parts of the towns of Kompong Chhnang, Pursat Battambang and Siem Reap as

PHOTO: WCS

well as Sisophon but not the provincial capital in Kompong Thom.

WHEN?

When did UNESCO's biosphere initiative take shape?

In 1970, when the agency launched its "Man and the Biosphere Program" to establish protected areas for important ecosystems. The call for such a program was made at a UNESCO conference in 1968.

When did UNESCO approve its strategy and global framework for biosphere reserves?

In 1996 following a conference in Seville in 1995.

When was the Tonle Sap Biosphere Reserve established?

In 2001, when the government set up a secretariat for the reserve as a focus of environmental management. UNESCO designated the lake and its flood plain as biosphere reserve four years earlier in 1997.

When was the ADB's Tonle Sap Basin Strategy formulated?

The strategy dates back to 2003 and is supporting the ADB's country strategy and program from 2005 to 2007. The bank said in 2005 that the basin strategy – which has "informing and listening" among its key operating principles – would be the basis for setting priorities and planning assistance to Cambodia over the next five to 10 years.

Sources: ADB, UNESCO, Cambodia National Mekong Committee

04

PROTECTED AREAS

Protecting nature is a source of concern in Cambodia.
Fragile ecosystems are affected by the country's socio-economic, physio-geographic and climatic conditions. Most wildlife biologists believe the best way to prevent the loss of wild species is to establish and maintain a system of reserves, parks, wildlife sanctuaries and other protected areas.

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 percent 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 and 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 World Conservation Union (IUCN).

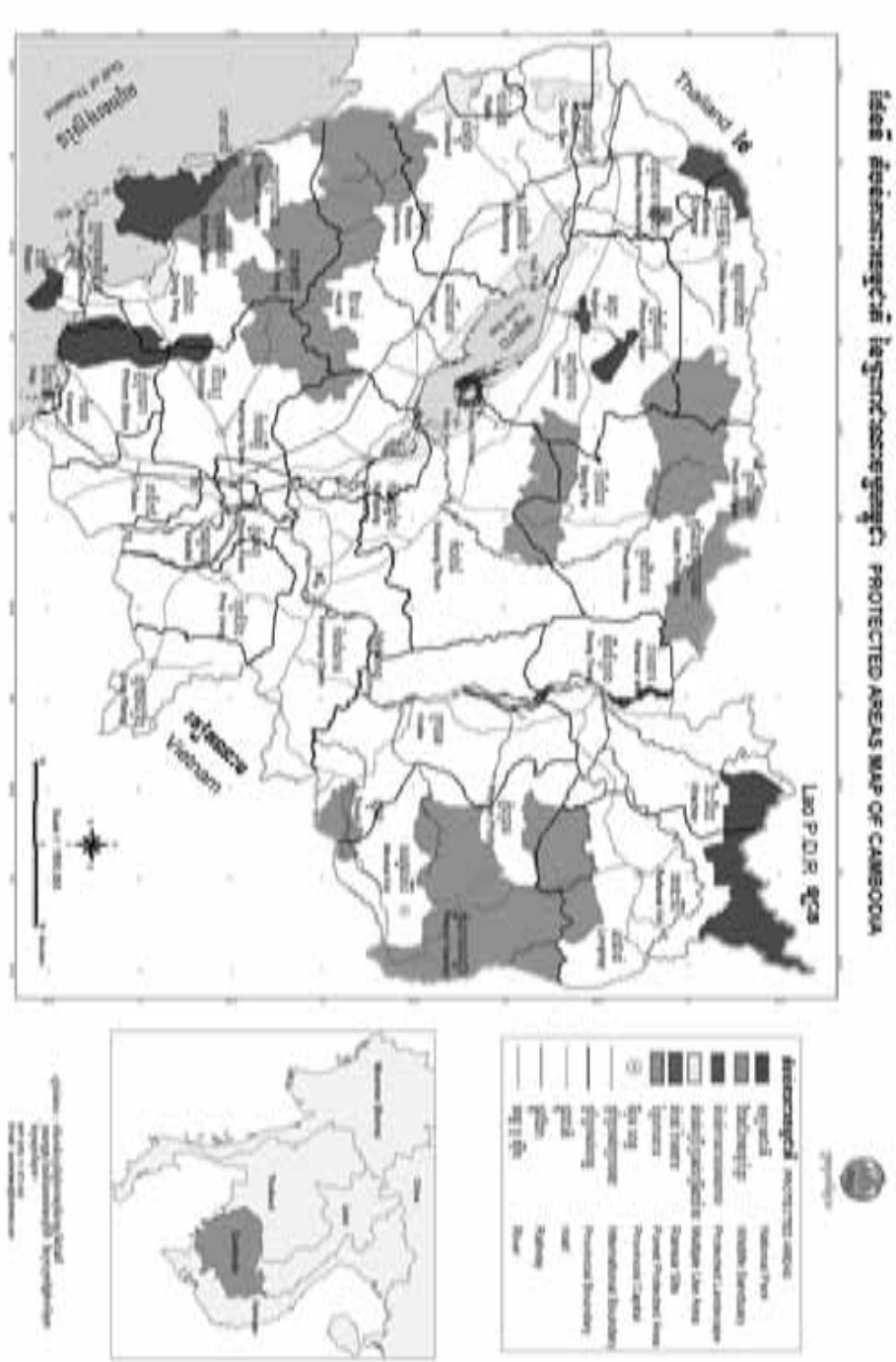
Protected areas play a big role in developing tourism, protecting watersheds and providing sanctuaries for wild plants and animals.
When an area is protected, it is easier to carry out wildlife surveys (on tigers and elephants, for example) and collect primary data on ecology and human uses as well as seasonality and access. Field information can be shared among stakeholders through workshops.

By early 2001, the Ministry of Environment had recruited and deployed 525 rangers at 59 stations to patrol protected areas.
The ministry's Department of Nature Conservation cooperates closely with a number of conservation organizations to promote capacity building, environmental education, community livelihood development and on-site protection.

A platform-based protection system for bird colonies in the Prek Toal Core area was tested in 2001 and has since been expanded to cover all known colonies in the area. The coverage of the breeding population of all key species of large waterbirds in the area is nearly 100 percent.

Several protected areas are subject to threats.
These include unrestricted grazing unmanaged fishing, illegal logging, collection of fuel wood and non-timber forest products, habitat degradation and disturbances resulting from other human activities.

Sources: Asian Development Bank, Jady Smith and Frederic Goes.



05

TONLE SAP BIOSPHERE RESERVE

Under a program launched in 1970, the United Nations Educational, Scientific and Cultural organisation (UNESCO) designated the Tonle Sap Lake and its flood plain as a biosphere reserve in 1997.

The reserve spans almost 1.5 million hectares and covers the lake and most of the surrounding area bordered by National Routes 5 and 6. By 2005, it was one of 482 biosphere reserves in 102 countries. The Tonle Sap Biosphere Reserve is administered by a secretary from the Cambodia National Mekong Committee and three deputy secretaries from the Ministry of Environment, the Fisheries Department of the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Water Resources and Meteorology. The three ministries also administer the Tonle Sap Environmental Management Project (TSEMP) jointly financed by the Asian Development Bank (ADB), the Royal Government of Cambodia and United Nations agencies.

The reserve comprises the lake itself, flooded forest and flooded grasslands, mainly on the eastern shore.

During the rainy season, the lake swells to as much as 1.6 million hectares, more than six times its dry season area which can be as little as 250,000 hectares. Almost two-thirds of the water comes from the Mekong River with more a third originating from the basin, notably the Steung Sen and the Steung Pursat tributaries. About 10 percent of the area is covered by tall-tree forest, mainly along streams and wetter places.

The flooded forest of the Tonle Sap is biggest continuous area of savannah swamp forest and flooded forest in the whole of Asia.

By 1997, it was estimated to have shrunk to 350,000 hectares, about a third of its original area.

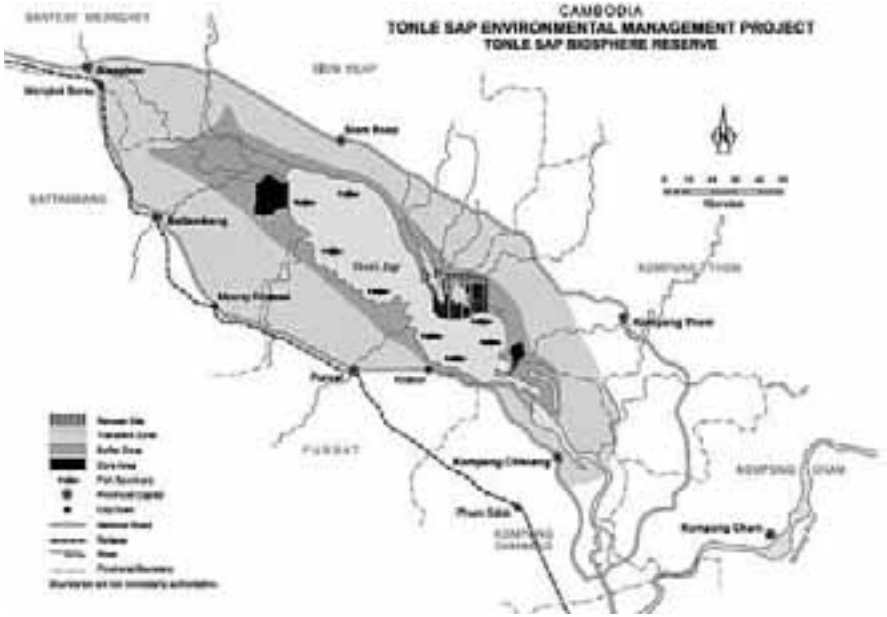
The flooded forest is crucial for fish, water birds and reptiles.

The biosphere has three 'core areas'– in Prek Toal in Battambang province and Boeung Chhma and Steung Sen in Kompong Thom province.

Almost 100 species of water birds are found in these three areas which cover an area of more than 42,000 hectares. More than 400 species of fish have been identified in these areas which are also known for crocodiles, turtles, macaques, otters and water snakes. The core areas comprise 21,342 hectares in Preak Toal and 14,560 hectares in Boeung Chhma which is also an internationally-recognised wetland under the Ramsar Convention (see below) Both are important breeding and feeding grounds for endangered species of large water birds. Steung Sen spans 6,355 hectares and features trees rare to the flood plain. The Ministry of Environment estimates less than 20,000 people live in or near these areas – about 10,000 in Prek Toal, about 2000 in Boeung Chhma and almost 7,000 in Steung Sen.


PHOTO: ELEANOR BRIGGS WCS


PHOTO: ELEANOR BRIGGS WCS



A 'buffer zone' covers the entire lake and extends to the outer limits of the flooded forest.

It stretches deep into Battambang province and also covers large areas of Kompong Thom and Pursat provinces and smaller areas of Kampong Chhnang and Siem Reap. Excluding the three cores areas, the buffer zone covers 541,482 hectares and is the same area designated by Royal Decree as a "multi-purpose protected area" in 1993. The zone includes about 60 floating villages and a population estimated at almost 70,000 people.

The buffer zone is surrounded by a 'transition zone' bordered by National Routes 5 and 6 in Battambang, Pursat and Siem Reap provinces.

It extends to limited stretches of the two highways in Kompong Chhnang and Kompong Thom provinces, stretching from south of Kompong Chhnang to Sisophon in the north. Covering 899,600 hectares, the transition zone includes parts of the towns of Pursat and Siem Reap but not Kompong Thom. The population is estimated at 1.6 million.

Fishing is the main activity but the flood plain is also used to produce rice and vegetables.

The main goal of the reserve is to study and promote indigenous ecological knowledge.

REGIONAL BIOSPHERE RESERVE NETWORKS

Cambodia is part of the Southeast Asia Biosphere Reserve Network launched in 1998.

Other members are China, Indonesia, Japan, Laos, Malaysia Myanmar, the Philippines, Thailand and Vietnam. The UNESCO office in Jakarta hosts a website for the network, also known as SeaBRnet. Cambodia and UNESCO organized the third meeting of the regional network in Siem Reap in 2003 with assistance from Japan. Laos hosted the fourth meeting in 2005.

Other regional networks include the European **Biosphere Reserve Network launched in 1987 and the East Asian Biosphere Reserve Network launched in 1994.** Regional networks also exist for biosphere reserves in African and Arab countries as well as Latin America, Spain and Portugal.

IMPORTANT CAMBODIAN WETLANDS

The Convention on Wetlands was adopted in Ramsar, Iran, in 1971. Under the Ramsar convention, countries designate wetlands that are globally important in terms of ecology, botany, zoology and hydrology. By 2005, the Ramsar List of Wetlands of International Importance had 1,462 sites covering more than 125 million hectares in 146 countries.

Cambodia has three Ramsar sites covering 54,600 hectares, all designated on June 23, 1999. The biggest is Boeung Chma and the associated river system and floodplain in Kompong Thom, an area of 28,000 hectares. About half of this site forms one of the three core areas of the biosphere reserve. A second site covering 14,600 hectares is located in the middle stretches of the Mekong River north of Stueung Treng. The third site is Koh Kapik and associated islands, spanning 12,000 hectares in Koh Kong province. The international community recognises the three sites as having "significant value" for Cambodia and humanity as a whole.

In 1999, parties to the Ramsar convention agreed to a framework and guidelines for developing an international network of wetlands. Under the framework, sites designated for the Ramsar list should be "important for the conservation of global biological diversity and for sustaining human life through the ecological and hydrological functions they perform." In 2000, the secretary general of the Convention on Wetlands called for a "new era of common existence" to replace the "parallel existence" of Ramsar sites and biosphere reserves. Under such a parallel system, 33 wetlands designated as Ramsar sites were also located within or coincided with the UNESCO reserves.

TONLE SAP BIOSPHERE RESERVE

UNESCO'S BIOSPHERE RESERVE NETWORKS

Biosphere reserves date back to 1968 when a UNESCO conference called for a program to set up land and coastal areas representing the world's main ecosystems. The UNESCO initiative took shape in 1970 when the Paris-based agency launched its "Man and the Biosphere" program establishing protected areas known as biosphere reserves. In 1995, an international conference in Seville agreed on a strategy for biosphere reserves and a framework for a global network. UNESCO approved the Seville Strategy and the Statutory Framework of the World Network of Biosphere Reserves in 1996.

Nominated by governments, the reserves are internationally recognised but are controlled by the countries where they are located.

UNESCO describes the reserves as "living laboratories" for testing integrated management of land, water and biodiversity. Each reserve is supposed to help conserve landscapes, ecosystems, species and genetic variation while fostering sustainable economic and human development. A third function is to support research, monitoring, education and the exchange of information. The reserves are not covered by international convention but must simply meet a set of criteria allowing them to fulfill these three functions.

Each reserve has a core area, a buffer zone and a transition area. The core areas of biosphere reserves have to be legally established and provide long-term protection to the landscapes, ecosystems and species it contains. Normally, the core area is not subject to human activity, except research and monitoring and traditional use by

local people. Buffer zones surrounding core areas may be subject to research into managing natural vegetation, croplands, forests and fisheries to improve production while conserving nature and biodiversity – including soil – as much as possible. These zones may also be used for education, training, tourism and recreation. Transition areas extending outwards from the buffer zones may contain human settlements, agriculture and other activities. Core areas are mostly public lands, but may also be privately owned or belong to non-governmental organisations. In many cases, the land in buffer zones and transition areas belongs to the local community or is privately owned.

Several biosphere reserves encompass national parks, nature reserves and other internationally-recognised sites under the World Heritage and Ramsar conventions.

Local communities and those involved in agriculture, forestry and fisheries are seen by UNESCO as the main beneficiaries of biosphere reserves along with scientists, governments and the world at large.

To be designated as a biosphere reserve, an area should normally be "representative of a major bio-geographic region" with landscapes, ecosystems or animal and plant species or varieties that need to be conserved.

The area should big enough to have a legally-defined core area devoted to long-term protection, a clearly-identified buffer zone and an outer transition area. Public authorities, local communities and private interests should be involved in planning and managing the reserve. In the case of large natural areas which straddle national boundaries, UNESCO encourages transboundary reserves that are jointly managed.

A UNESCO Advisory Committee examines all nominations for biospheres and makes recommendations to an International Coordinating Council which usually meets every two years.

Set up in Paris in 2000, the council has 34 members who elect a chairman and five vice-chairmen. In 2004-2005, Mexico chaired the council with Austria, Ghana, South Korea, Russia and Tunisia serving as vice chairmen. UNESCO member states not represented on the council can send observers to the meetings, as can other UN agencies such as the United Nations Environment Program (UNEP) the Food and Agriculture Organisation (FAP), the World Maritime Organisation (WMO) and the World Health Organisation (WHO). The International Council of Scientific Unions (ICSU), the International Social Sciences Council (ISSC) and the World Conservation Union (IUCN) may act as advisory bodies to the council.

THE NATIONAL MEKONG COMMITTEE'S ROLE

Overall responsibility for the Tonle Sap Biosphere Reserve and the Tonle Sap Environmental Management Project rests with the Cambodian National Mekong Committee. The committee advises the Council of Ministers on developing, managing and preserving water and related resources of the Mekong River in cooperation with provincial and municipal authorities as well as central government agencies. Cooperation with donors and national committees in Laos,

Thailand and Vietnam is based on the principles of "equitable and reasonable benefit" for all four members of the Mekong River Commission.

The committee represents 10 ministries.

These are the ministries for water resources and meteorology; environment; agriculture, forestry and fisheries; foreign affairs and international cooperation; industry, mines and energy; planning; land management, urbanisation and construction; rural development and tourism.

The chairman of the executive committee is Water Resources and Meteorology Minister Lim Kean Hour. The three deputy chairmen are Environment Minister Mok Mareth, Public Works and Transport Secretary of State Tram Iv and former Agriculture Forestry and Fisheries director general Sin Niny.

A general secretariat coordinates the day to day activities and advises the chairman of the executive committee.

The secretariat comprises the Tonle Sap Biosphere Reserve Secretariat and three departments with responsibilities for administration and finance (including public relations), policy and planning, and projects. The projects department has four bureaux (agriculture, water resources, waterways and tourism, and environment) and two units with responsibility for Mekong River Commission's water utilisation and

environment programs. The secretary general of the National Mekong Committee is Hou Taing Eng, who is also undersecretary of state at the Ministry of Planning. His three deputies are Pich Dun, Te Navuth (Ministry of Water Resources and Meteorology) and Kol Vathana (Ministry of Environment) who also heads the secretariat of the Tonle Sap Biosphere Reserve. The three deputy heads of the secretariat are Neou Bonheur, deputy director of the Natural Resource Protection and Conservation Department of the Ministry of Environment; Sam Neou, deputy director of the Fisheries Department of the Ministry of Agriculture, Forestry and Fisheries; and Ang Norin, deputy director of the Water Resources Management and Conservation Department of the Ministry of Water Resources and Meteorology.

Sources: Asian Development Bank, Cambodia National Mekong Committee and United Nations Educational, Scientific and Cultural Organisation.

06

FIVE SEASONS OF THE TONLE SAP

MID-LATE DRY SEASON

Ke Makara Khumpieh Misnir Maesa Ousophea

In the mid to late dry season (*peakandal chong rotdeu prang*) between January and April, large-scale commercial fishing takes place in all fishing lots and main waterways around the Tonle Sap. Extensive burning of grasslands and shrublands occurs.

As the floodplain dries up, there is a concentration of "black fish" – species like *trey roh, trey chdau* and *trey kranh* which live in water that has been darkened by chemicals from dissolved vegetation. Such fish can tolerate such acidic water that lacks oxygen. Most can breathe air and move overland to find new waterbodies. Some can even bury themselves in the mud and wait until the next flood.

On the open lake, terns and gulls feed in large numbers. In the flooded forest areas, the mid to late dry season is the main breeding time for large waterbirds such as storks, ibises, pelicans, herons and egrets. Turtles and pythons also breed in flooded forests and shrublands at this time of the year, as do grassland birds like bustards and quails.

EARLY MONSOON SEASON

Ke Ousophea Nithokna Kakada

When the rains arrive in the early monsoon season *(dam rotdeu vohsa)* in May and July, the annual "flood pulse" begins as the Tonle Sap River reverses its flow. White fish start migrating from the Mekong River to the Tonle Sap where they will feed, nest and spawn over the coming months before returning

to the Mekong towards the end of the year. Such fish spend most of their lives in white turbid water of running rivers and include *trey chlang, trey damrei, trey pra*, *trey sanday*, *trey kahe*, *trey pour* and *trey promah*. During this season, black fish start migrating to their nesting and spawning habitats.

The early monsoon marks the departure of breeding colonies of large waterbirds such as storks, pelicans, herons and egrets from the flooded forest areas. It also signals the arrival of wet-season breeders such as rails, crakes and bitterns in the grasslands around the Tonle Sap.

In the flooded forest and shrubland areas, trees and shrubs begin flowering at this time of the year and fruit production starts. In the outer floodplain, deepwater rice crops start to germinate.

The early monsoon also marks the start of the world's biggest watersnake harvest.

MID MONSOON SEASON

Ke Saehah Ganya Tokla

As the rains continue in the middle part of the monsoon season *(peakandal rotdeu vohsa)* between August and October, the Tonle Sap lake expands to its maximum size. Fish nesting, spawning and feeding continues and juveniles start growing. This is also the breeding period for watersnakes in the flooded forest and shrubland areas.

Cormorants and darters return to their nest colonies in the flooded forest and start breeding. Trees and shrubs continue flowering and producing fruit.

PHOTO: ELEANOR BRIGGS WCS

In the outer floodplains, August to October is the main growth phase for deepwater rice crops. Fish control rice field pests.

The first peak in the watersnake harvest takes place during this season.

LATE MONSOON SEASON

Ke Tokla Vicheka

As the level of the Mekong River drops and the Tonle Sap River reverses its flow during the late monsoon season *(chong rotdeu vohsa)* in October and November, the floodwaters recede. Large-scale fishing begins in all fishing lots and main waterways. White fish start migrating out of the lake towards the Mekong.

In the flooded forest and shrublands, new leaves sprout and watersnakes continue to breed.

Floating grasses grow and deepwater rice enters its ripening phase.

EARLY DRY SEASON

Ke Vicheka Thnou Makara

The fall in food waters accelerates and large-scale commercial fishing continues on the Tonle Sap during the early part of the dry season *(dam rotdeu romhai)* from November to January. The outward migration of white fish, notably

PHOTO: ELEANOR BRIGGS WCS

trey riel, reaches a peak during this cooler season.

Terns and gulls flock to feed on the open lake. In the flooded forests, cormorants and darters complete their breeding. Young birds develop wing feathers that are large enough for flight. Large waterbirds like storks, ibises, pelicans, herons and egrets return to their nesting colonies. Terrestrial-breeding species such as floricans and quails migrate back to the grasslands and farming areas. Birds from northern Asia and Europe also migrate to the Tonle Sap to avoid the northern winter. Such "winter visitors" include raptors, chats, heronries hirundines, warblers, pipits and wagtails.

During this season, the annual rice harvest and the second watersnake harvest takes place.

Source: Wildlife Conservation Society

07

FLOODED FOREST

The flooded forest of the Tonle Sap is vital for seasonal breeding, nursery grounds and forage areas for fish that migrate to the Mekong River.

Despite its depletion, it is still by far the greatest continuous area of savannah swamp and inundated forest in Asia and the largest remaining example of this type of habitat in Southeast Asia.

With shrub lands, stunted swamp forests, gallery forests and submerged and floating aquatic vegetation, the flooded forest provides many important benefits for both people and animals.

Scientists have recorded about 200 plant species, the flora as a whole is distinct from that of other Mekong wetlands, especially with regard to woody species.

The productivity of Tonle Sap fisheries is one of world's highest.

This is generally attributed to the flooded forest which not only provides shelter and protection for animals but also plays an important role in the reproduction of biological resources which interact as a giant food chain.

Forest products such as fruit, seeds and foliage fulfill animal nutrition needs.

Near Prek Toal, the flooded forest sustains the most significant colonies of water birds in Indochina – and perhaps the whole of Southeast Asia. It is probably Cambodia's pre-eminent site for conserving freshwater biota.

While no dams are planned for the Tonle Sap area, an Asian Development Bank (ADB) report in 2005 warned that dams elsewhere in the Mekong Basin could alter the hydrological relationship with the lake.

Habitat clearing and conversion for agriculture is a "significant" conservation issue, with increased fertilizer use and runoff into the lake adversely affecting fish and local people.

Trees are cut to make fishing gear, including drift fences and fish traps. Fishing pressure is high because of intensive and even illegal methods.

"Depletion of fish stocks does not only deplete fish populations but also have cascading effects throughout the trophic structure of the ecosystem," the ADB report warned.

Intensified fishing can only take place if the flooded forest is maintained or expanded and fish stocks enhanced by enforcing controls and expanding breeding programs.

Encroachment in the form of harnessing water resources, logging for timber and firewood or clearing forests for crops threatens to destroy the viability of forested catchment areas. Such activities may also leading to erosion, loss of soil fertility, downstream siltation, flooding and turbidity of water bodies.

Sources: ADB, Inland Fisheries Research and Development Institute.

08

WETLANDS

WETLANDS

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.

The legal framework for managing wetlands rests with legislation vested in government agencies responsible for resource use, land use and environmental conservation. These include the Fishery Law of 2006, the Land Law of 2001 and the Environmental Law of 1996. Other legal instruments include the Sub-decree on Community Fisheries Management of 2005 and the Royal Decree on the Designation and Creation of a National Protected Area System of 1993. But the legislation does not deal comprehensively with managing and conserving wetlands, leading to conflicts over their use and depletion of their resources. Management and conservation plans are meanwhile hindered by the absence of an agreement on how to classify wetlands. In response to these shortcomings, a Wetlands Action Plan was drafted in 1999 but had still not been adopted as of mid-2006

In the absence of the draft being approved, the WorldFish Center undertook a two-year study on the legal and institutional framework governing Cambodian wetlands and valuing their resources. Coordinated by the Department of Fisheries, the study took place in 2002 and 2003 and was part of part of regional research that also included Laos, Thailand and Vietnam. Published in 2006, the study described the various uses of Cambodian wetlands and found that policy makers tended to underestimate their value.

Rice farming in Cambodian wetlands falls into four categories – wet season rice, flood-recession rice, dry-season rice and floating rice. Wet-season rice takes place in higher lands that may be flooded during the wet season. Also known as rain-fed lowland paddies, this type of cultivation accounts for most of Cambodia's paddy area. Flood-recession rice is grown after the water recedes – normally on the margins of flooded areas of the Tonle Sap, Bassac and

Mekong River systems – and contributes about nine percent of the rice crop. Where irrigation is available, flood-recession and dry-season rice fields may be used for farming more than once a year. Floating rice is grown deeper in flooded areas, especially in flooded forests of the Tonle Sap, and represents about seven percent of the total rice crop.

Cash crop farming takes place along the Mekong riverbank, on islands and around the floodplain of the Tonle Sap, especially in Kompong Thom and Siem Reap. Typical cash crops planted in large fields include corn, beans, peanuts, sesame, tobacco, sugar cane, cassava, sweet potatoes, castor oil and jute. Crops like pumpkins, gourds, cucumbers, watermelons and tomatoes are cultivated in between the major cash crops or in smaller fields.

Wet-season rice involves fewer chemicals than dry-season rice and other crops. Minimal use of chemicals has allowed many fish, crabs, snails, molluscs and frogs to reside in wet-season rice fields in Pursat. As for dry-season rice, a survey by the Cambodia-Australia International Rice Research project found that 80 percent of farmers used pesticide and almost 40 percent observed dead fish after their application. Despite the availability of chemicals, it is not clear how much is being used or how much chemical residue is being discharged into the environment.

Fishing and aquaculture are among the major uses of wetlands in Cambodia. In 1997, it was estimated that 88 percent of the people in 170 villages around the Tonle Sap depended on fishing or related activities. Total fish production is estimated at more than 500,000 tonnes a year (see separate section on Fisheries). The production of edible aquatic animals from rice fields has been estimated at about 100,000 tonnes. Aquaculture – mainly cage culture around the Tonle Sap – has been estimated to account for about 10 percent of total fish production. Other cultivated aquatic animals include crocodiles, eels, frogs, freshwater shrimp and water snakes. Pond farming mainly takes places in Kandal and provinces further away from the Tonle Sap.

Wetlands also supply water for drinking, washing, bathing and irrigation. Most people living in floating villages around the Tonle Sap use water directly from the lake. Water from the lake is also used to irrigate rice fields around the Tonle Sap.

Timber and other forest products from wetlands have both household and commercial uses. Timber from flooded forest areas may not be of high quality but can be used to build sheds and small houses or for cooking and processing fish. A report in 2001 estimated that fish-processing households in Balort used up to 40 cubic metres of wood every year to smoke fish and that such wood could be bought for between $2.50 and $3.00 a cubic metre. A separate report in 1997 found that as many as 80 percent of villagers in Peam Seima in Battambang province were cutting as much as a cubic metre of fuel wood each day for commercial purposes. The same report estimated that local household consumption of fuel wood for cooking was as much as eight cubic metres a year. Non-timber forest products include bamboo, which is used to make rafts. Reeds, thatch and leaves are used for roofing, plants are used for fishing gear and water hyacinth is used for making hammocks and growing mushrooms. Plants and parts of animals found in wetlands are also used in traditional medicine.

PHOTO: ELEANOR BRIGGS WCS

Cambodian wetlands are attracting growing numbers of tourists. In the Tonle Sap Biosphere Reserve, a management centre for the Prek Toal core area opened with accommodation facilities in 2005 and another centre is scheduled to open in the Boeung Chhmar core area in 2006. In 1998, it was estimated that Prek Toal tourism facilities could generate between one and two million dollars a year once they reached full capacity, with about 10% going to the local community.

Wetlands are important for water transport and human settlement. The Ministry of Public Works and Transport estimates the length of navigable waterways across Cambodia expands from 855 kilometres in the dry season to 1,544 kilometres in the wet season. Houses on stilts and floating structures are seen in large clusters around the Tonle Sap. Floating structures can be permanent or seasonal, with the location of entire villages moving between the dry and wet seasons.

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.

Livestock depend on wetlands for food. Cattle, including oxen and water buffaloes, feed on grass and other vegetation that grows in wetlands while ducks and geese are mainly fed in rice fields. Pigs and some other poultry feed on water spinach, grass and rice grown in wetlands.

Wetlands help to dilute pollution and transport waste. In the absence of treatment facilities in Cambodia, most sewage and other forms of urban and industrial pollution end up in rivers and wetlands. In floating villages, all liquid and solid waste is discharged directly into the water. Chemical fertilisers and pesticides also end up in wetlands where some is trapped in plants and the rest flushed away by annual floods.

Small water bodies and the river system itself help to absorb excess water after heavy rainstorms and during the annual flood. The Tonle Sap lake has been estimated to absorb 28 billion cubic metres water from the various rivers in its own catchment area and almost twice as much from the Mekong River every year.

Flooded forest areas are used as storm barriers. During the wet season, people move their floating houses close to the flooded forest to avoid damage from wind and waves.

Wetlands can be a source of energy – not just from fuel wood and charcoal but from also hydropower. So far, however, Cambodia has only built a few small hydropower plants. Dams have a major impact on fish migration – which is why a fish pass is being built as part of irrigation dam rehabilitation project in Stung Chinit in Kompong Thom province. The structure is the second of its type in Asia and was expected to start operating during the 2006 wet season.

Wetlands also have cultural values. These are often expressed in celebrations such as the annual water festival and ceremonies marking the start of the fishing season and the end of the rice harvest.

The study found that it was difficult to value wetlands in economic terms because of different ways they were perceived by different groups and a poor understanding of their ecological functions. It found that wetlands were especially important to the livelihoods, subsistence and welfare of poor people. But it also found that it was difficult to assess their value to the poor as products and services either did not enter the market economy or were poorly appreciated. In the absence of monetary values, the study noted that wetlands could be valued in terms of their percentage contribution to people's livelihoods. Incorporating economic valuations of wetlands into policy would, it argued, encourage the sustainable use of resources and help reduce poverty.

Sources: WorldFish Center, Mekong River Commission

09

FISHERIES

Cambodia's richness in fish resources has long been recognised and may have been a factor in attracting Chinese, Portuguese, Japanese and Dutch traders before the French arrived in the 19th century. During the French colonial period, authorities introduced fishing leases and lots as well as the country's first fishery laws. In 1910, Cambodia reportedly exported about 50,000 tonnes of fish products. By the 1920s and 1930s, Chinese traders operating in Cambodia were estimated to be exporting 25,000 tonnes of dried fish a year to Indonesia alone.

Pressure on fishery resources has intensified in line with the growth in Cambodia's population. In 1940, total fish production was estimated at 120,000 tonnes. Since then, the country's population has tripled, boosting fish catch estimates to at least 400,000 tonnes a year by 2000. More recent estimates suggest that the annual catch is probably about 700,000 tonnes. In terms of value, fisheries output rivals rice production as the single biggest contributor to gross domestic product (GDP), which measures a country's total output of goods and services.

Cambodia has the most intense freshwater fishery in the world in terms of the amount of fish caught per inhabitant. Based on the conservative catch estimate of 400,000 tonnes, the fishery itself is the fourth-biggest in the world after China, India and Bangladesh. Using the higher estimate, Cambodia ranks second only to China in freshwater fisheries.

Most of the catch comes from small-scale family fisheries **(see box on page 46).**

The Department of Fisheries said in 2003 that overall fish production was "probably higher than ever" and warned that individual catch rates had been declining, along with the average value of each kilogram caught. "Larger species are declining in catches which are now becoming dominated by smaller short-lived and rapidly-reproducing species which tend to be of lower value," the department said. Figures from the mid-1990s show that individual catches had dropped to 192 kilograms a head, down 45 percent from 347 kilograms a head in 1940.

SMALL, MEDIUM AND LARGE

Under a law dating back to 1987, fishing in Cambodia falls into three categories – small, medium and large scale – based on the size of 52 types of fishing gear and the potential revenues they can yield. The Department of Fisheries has classified another 100 types of gear that are not covered by the law and are therefore illegal.

Small-scale fishing, amounting to between half and two thirds of the overall catch every year, is family oriented and involves most households around the Tonle Sap. It is usually carried out with small gear like gill nets and bamboo fence traps. No license is required for small-scale fishing which can take place all year round. Of all households involved in fishing, about 90 percent are believed to be small-scale operators. In 1995, they numbered about 85,000 with the average catch estimated at 700 kilograms for each household. More than two thirds of the harvest was from Kompong Chhnang and Battambang provinces. Ricefield fisheries around the Tonle Sap can yield up to 100,000 tonnes a year, amounting to almost a quarter of the country's entire catch.

Medium-scale fishing, which absorbs about a quarter of the annual catch, is commercial and only allowed between October and May. Licenses are not required and gill nets are the main type of gear used. In 1995, about 9,000 households around the Tonle Sap were engaged in medium-scale fishing with the average catch for each household estimated at 5.3 tonnes.

Large-scale operations, about a fifth of the total catch, are industrial in scale and mainly involve fishing lots that are leased for two years. The fishing gear used such as fences, pens and arrow-shaped traps can cover large areas. In 1995, the average catch for each fishing lot was estimated at 54.1 tonnes.
The bagnet fishery on the Tonle Sap north of Phnom Penh (see page 50) is also defined as large-scale fishing.

Source: Department of Fisheries

Tonle Sap fisheries are estimated to account for about 60 percent of Cambodia's total production of freshwater fish. The WorldFish Centre estimated in 2005 that 1.25 million people in the five provinces around the lake relied on fish and other aquatic resources for their food and livelihoods. Based on a survey of Kompong Chhnang and Siem Reap provinces, this was up from an estimate of 1.17 million people in a separate study published by the Mekong River Commission in 1998. The earlier study found that the five Tonle Sap provinces had about 195,000 fishing households located in 145 fishing communities around the lake.

In a 2006 report, the Inland Fisheries Research and Development Institute of the Department of Fisheries conservatively estimated the value of fisheries and other aquatic resources of the Tonle Sap at $233 million a year. The report based its figures on incomes for an estimated 209,000 households dependent on aquatic resources in Kompong Chhnang, Siem Reap, Battambang, Pursat and Kompong Thom. The combined incomes were estimated at $215 million a year, or $172 a head based on an average household of six people. To this was added $13 million which represented the estimated value of fish consumed at home rather than sold, amounting to $63 a year for each household. A further $5 million was estimated for the collection of aquatic plants and animals considered as common property. Annual consumption of fish around the Tonle Sap is estimated at 76 kilograms a head, the highest rate in Cambodia and also one of the highest in the world.

PHOTO: ELEANOR BRIGGS WCS

VALUE OF TONLE SAP AQUATIC RESOURCES ($ MLN)

Annual income estimates for aquatic-resource dependent households plus estimated values of home fish consumption and aquatic animals and plants collected each year in Kg Chhnang (KGC), Pursat (PST), Battambang (BTB), Siem Reap (SRP) and Kg Thom (KGT)

	KGC	PST	BTB	SRP	KGT	TOTAL
Income levels						
≤ $1000	16.2	13.7	15.2	12.8	12.7	70.6
$1,001–2,000	7.1	11.6	9.5	8.0	7.9	44.1
$2001 – 5000	4.9	19.8	13.3	11.2	11.1	60.3
> $5000	3.1	12.2	9.3	7.8	7.7	40.1
Total income	31.3	57.2	47.3	39.9	39.4	215.1
Home fish consumption	1.8	3.6	2.8	2.4	2.4	13.0
Aquatic animals and plants						5.0
Total value	**33.1**	**60.8**	**50.1**	**42.3**	**41.8**	**233.1**

Source: Department of Fisheries

The report found that most people living around the Tonle Sap were "highly dependent" on fish and other aquatic resources. It estimated that 150,000 households – almost three quarters of all dependent households – were in the poorest category with annual incomes of $1,000 or less, averaging $470 a year or about $78 a head. Involved in small-scale subsistence fishing and farming, such households rely heavily or entirely on aquatic resources for their livelihoods. But they accounted for only 32 percent of total incomes. By contrast, the richest 12 percent earning more than $2,000 a year were estimated to account for almost half of the income generated by all Tonle Sap households relying on aquatic resources. Such households, the study said, are likely to be headed by fishing lot owners or those involved in medium-scale fishing.

TONLE SAP HOUSEHOLDS DEPENDING ON AQUATIC RESOURCES

Number of households averaging six people in Kg Chhnang (KGC), Pursat (PST), Battambang (BTB), Siem Reap (SRP) and Kg Thom (KGT)

Income level	KGC	PST	BTB	SRP	KGT	Total
≤ $1000	39,742	24,630	32,384	27,309	26,924	150,988
$1,001–2,000	5,746	8,479	7,196	6,069	5,983	33,473
$2001 – 5000	1,915	5,653	4,048	3,414	3,365	18,395
> $5000	479	1,615	1,349	1,138	1,122	5,703
Total	47,882	40,376	44,978	37,929	37,394	208,560

Source: Department of Fisheries

The Department of Fisheries stressed that such a "stark" disparity in Tonle Sap incomes was a "serious issue that needs to be addressed" given the high reliance on aquatic resources among the poorest households. "Their livelihood concerns, such as secured access to resources and basic rights to food security, jobs, education and health care, should be emphasised in discussions about the sustainable management of Tonle Sap fisheries and aquatic ecosystems," it said. The main ethnic origin of Tonle Sap households is Khmer, with Chinese, Vietnamese and Cham as minority groups.

The report noted that the annual value attached to Tonle Sap aquatic resources did not include their ecological or social values. Moreover, it stressed that fisheries and other aquatic resources were only part of the overall wetlands of the Tonle Sap that comprise rivers, streams, lakes, rice fields, flooded forests and other areas. The report argued that the vast combined value of Tonle Sap wetlands should be taken into account in considering people's livelihoods and their dependency on resources.

Sources: Department of Fisheries, Mekong River Commission

BAGNET CATCH HITS NEW RECORD IN 2006

One of the most important fisheries in the Tonle sap system is the bagnet fishery on the river north of Phnom Penh which targets trey riel as they leave the lake between October and February every year. The bagnet fishery usually accounts for between four and five percent of Cambodia's annual fish catch. But during the 2005-6 season, the catch almost doubled to a record 30,000 tonnes, the highest since systematic monitoring of the fishery started in 1995. The Mekong River Commission reported in mid-2006 that the dramatic increase in the bagnet catch may have been caused by crackdown on illegal fishing by the Department of Fisheries in 2004 and 2005. Another factor may have been an abundance of fish during the previous season, which was possibly enhanced by favourable environmental conditions.

Source: Mekong River Commission

PHOTOS: MITCHELL ISAACS

10

COMMUNITY FISHERIES

Under the Sub-decree on Community Fisheries Management issued by Prime Minister Hun Sen in mid-2005, people who live in or nearby fishing grounds can voluntarily set up community fisheries. Members must be Khmer citizens and reside in the village where the fishing ground is located. They have to be committed to:

- managing inland fisheries and related ecosystems where fishing lots have been cancelled;
- managing fish resources in a sustainable and equitable manner;
- increasing understanding and recognition of fish resources through protection and management;
- providing a legal framework for community fisheries; and
- improving living standards and reducing poverty

Community fisheries can be financed by member contributions and donations as well as aid from the government, international agencies and non-governmental organisations. Other financing must be lawful.

Members are obliged to follow instructions from the Department of Fisheries and help set up conservation areas. They are also responsible for guaranteeing equal rights to all members, implementing bylaws, making plans and reaching management agreements with the department.

Members have the right to accompany officers in fishing, seizing evidence of fishing violations and detain offenders. But they cannot build anything inside community areas without permission from the Department of Fisheries. Nor can

they partition or privatise community areas or enter into any agreements with outsiders – including agreements involving scientific research.

Each community fishery is supposed to be run by a committee of five, seven or 11 members elected by secret ballot for a term of five years. The person who wins the most votes becomes chief of the committee and the member coming second serves as deputy chief. Local fisheries officers and commune council members can be invited to observe the election but their presence is not needed for the vote to take place.

Committees are the only bodies authorised to seek department approval of community fishing-area agreements lasting no more than three years. To draft an agreement, the committee can seek technical assistance from fisheries officers and other individuals. Agreements require a map on the scale of 1:50,000, a list of committee and other members, bylaws and regulations, and a statement of objectives. Draft agreements must be exhibited in prominent public places and in government offices in the local commune and district for 30 days. Commune, district and provincial officials are responsible for dealing with any objections. The Department of Fisheries is responsible for approving requests for renewing agreements within 30 days of expiry. Agreements are automatically renewed if the department does not provide notification within 30 days.

Fishing-area agreements can be cancelled before they expire if the community damages local fishery resources by failing to implement the agreement or by violating its by-laws or regulations. Agreements can also be cancelled if the government decides that the area can be put to better public and social use, although this need six months written notice and requires the department to discuss community losses with the committee. A fishing-area agreement can also be cancelled at the request of the committee and two thirds of the members.

Committees that have had their fishing-area agreements approved can request technical assistance from fisheries officers to prepare a management plan. Such plans are valid for the same period as fishing-area agreements but have to be reviewed by provincial and district fisheries offices every year. Committee members are supposed to be involved in following up, monitoring and evaluating management plans. To ensure sustainability of fishing areas, the Department of Fisheries may require management plans to be revised in accordance with other legal instruments related to fisheries.

The Department of Fisheries has warned that the transition to new forms of rights is "always accompanied by fresh conflicts, new alliances, windows of opportunity and a variety of threats. In Cambodia's transition to community fisheries, many of these possibilities are likely to emerge," it says. "It will be wishful thinking to imagine that once legal status is attained, the new rights to communities will be respected by all members of society." Being aware of the possibility of new social tensions and helping people to resolve conflicts locally will therefore be a major task – not only for government agencies but also civil society organisations involved in developing community fisheries.

Source: Department of Fisheries

11

FOREST MANAGEMENT IN SIEM REAP

FOREST MANAGEMENT IN SIEM REAP

Both local people and outsiders have long been using the natural resources of Siem Reap province without considering how sustainable harvesting and other practices are. Such activities partly reflect an "open-access" system whereby resources are considered public property or belonging to adjacent villages. Excessive use of resources is acute in flooded areas around the Tonle Sap. Despite efforts by local authorities and non-governmenal organisations, the unsustainable use of agricultural, fishery and forestry resources has continued largely unabated.

In the agricultural sector, farmers have been clearing flooded forests to plant rice and mung bean crops. An estimated 400 hectares of flooded forest on the northern shore of the lake have reportedly been cleared to grow rice on dry land. Such encroachment into the flooded forest is not regulated.

In the fisheries sector, production has been eroded by illegal fishing and the destruction of flooded forest areas which are important spawning and rearing habitats. Illegal activities include fishing during the spawning season, electro-fishing and fishing with large-scale seine nets. In Prek Sramoach, a village in Sonikum district, the catch of some local fishermen reportedly dropped from 10 kilograms a day to only three kilograms a day over a period of two years.

In the forestry sector, the recent pace of logging for export markets and collecting wood for the domestic market cannot be sustained. Forest cover around the Tonle Sap has been seriously reduced by logging as well as clearing of flooded forest. Illegal logging is widespread and while logging is regulated, nobody is responsible for controlling firewood collection.

To address concerns about unsustainable practices, government agencies, foreign donors and non-governmental organizations have been promoting various models of community management. One project initiated by the United Nations Food and Agricultural Organisation (FAO) focussed on Thnorl Dach, an area of 2,660 hectares in Sonikum district where natural resources were being destroyed or depleted. In addition to 830 hectares of flooded forest, the area included 789 hectares of grassland and 500 hectares of lake (Prek Srot Mouch). Dry rice agriculture covered 417 hectares and lotuses covered a further 125 hectares.

The project found that local people did not know how to manage natural resources and did not feel responsible as they were not involved in deciding how they were allocated. For example, they were never consulted about illegal fishing regulations but were supposed to be responsible for enforcing fines. The lack of responsiblity was compounded by people from neighbouring areas who could access the flooded forest without worrying about the adverse impacts of depleting the resources.

To address these problems, the commune and district chiefs as well as the provincial governor approved a new community management structure for local people who use the resources. All government agencies in charge of managing natural resources also approved the model, which sought to conserve and manage the resources with benefits flowing to the local community. Under the community management model, all Cambodians living in or close to the project area have the right to take part in managing

PHOTO: ALLAN MICHAUD WCS

local resources through an elected committee. Statutes and regulations had to be endorsed by local authorities and government agencies.

The first stage for adopting the new rules came in 1997 when the Ministry of Agriculture, Forestry and Fisheries designated Khnorlk Dach as a pilot research station. Subsequent research looked into the history, economics and natural resources of the community, leading to a workshop to develop management plans. The Department of Fisheries approved related regulations in 1999.

Community initiatives undertaken since have included replanting flooded forests and studying which types of fishing gear are not sustainable. Other priorities included reducing illegal fishing and the clearing of flooded forest. Reducing the number of brick kilns fuelled by wood collected from the flooded forest is another priority, along with educating local people to protect natural resources.

Source: Mekong River Commission

FOREST MANAGEMENT IN SIEM REAP

12

ACCESS TO DRINKING WATER AND SANITATION

FIVE PROVINCES AROUND THE TONLE SAP LAKE

KOMPONG CHHNANG

	TOTAL	URBAN	RURAL
Safe drinking water (%)	**19.3**	**51.9**	**16.2**
Of which:			
Piped water	0.8	3.7	0.6
Tube/pipe well	17.4	41.1	15.1
Bought	1.1	7.1	0.5
Unsafe drinking water (%)	**80.7**	**48.1**	**83.8**
Of which:			
Dug well	52.9	25.9	55.5
Spring, river stream, lake/pond rain	24.3	19.8	24.7
Other	3.5	2.4	3.6
Total	**100**	**100**	**100**
Toilet within premises (%)	**6.0**	**29.9**	**3.7**

Source: Ministry of Planning, General Population Census of Cambodia 1998

PURSAT

	TOTAL	URBAN	RURAL
Safe Drinking water (%)	**12.3**	**33.3**	**8.3**
Of which:			
Piped water	2.9	11.0	1.3
Tube/pipe well	3.5	1.1	4.0
Bought	5.9	21.2	3.0
Unsafe drinking water (%)	**87.7**	**66.7**	**91.7**
Of which:			
Dug well	53.3	31.1	57.5
Spring, river stream, lake/pond rain	29	34.7	28.0
Other	5.4	0.9	6.2
Total	**100**	**100**	**100**
Toilet within premises (%)	**8.5**	**20.8**	**6.2**

Source: Ministry of Planning, General Population Census of Cambodia 1998

BATTAMBANG

	TOTAL	URBAN	RURAL
Safe drinking water (%)	**21.7**	**57.0**	**14.2**
Of which:			
Piped water	4.1	17.5	1.3
Tube/pipe well	7.8	4.9	8.4
Bought	9.8	34.6	4.5
Unsafe drinking water (%)	**78.3**	**43.0**	**85.8**
Of which:			
Dug well	37.8	22.3	41.0
Spring, river stream, lake/pond, rain	39.1	20.1	43.1
Other	1.4	0.6	1.7
Total:	**100**	**100**	**100**
Toilet within premises (%)	**19.9**	**56.2**	**12.2**

Source: Ministry of Planning, General Population Census of Cambodia 1998

SIEM REAP

	TOTAL	URBAN	RURAL
Safe drinking water (%)	**13.4**	**47.1**	**6.8**
Of which:			
Piped water	0.6	1.7	0.4
Tube/pipe well	12.2	44.9	5.8
Bought	0.6	0.5	0.6
Unsafe drinking water (%)	**86.6**	**52.9**	**93.2**
Of which:			
Dug well	69.7	38.0	76.0
Spring, river stream, lake/pond, rain.	10.9	7.0	11.6
Other	6.0	7.9	5.6
Total	**100**	**100**	**100**
Toilet within premises (%)	6.6	28.1	2.4

Source: Ministry of Planning, General Population Census of Cambodia 1998

KOMPONG THOM

	TOTAL	URBAN	RURAL
Safe drinking water (%)	**3.6**	**15.3**	**2.1**
Of which:			
Piped water	1.7	7.2	1.0
Tube/pipe well	1.4	6.1	0.8
Bought	0.5	2	0.3
Unsafe drinking water (%)	**96.4**	**84.7**	**97.9**
Of which:			
Dug well	77.5	45.9	81.6
Spring, river stream, lake/pond, rain	16.2	31.3	14.2
Other	2.7	7.5	2.1
Total	**100**	**100**	**100**
Toilet within premises (%)	13.1	35.2	**10.3**

Source: Ministry of Planning, General Population Census of Cambodia 1998

ACCESS TO DRINKING WATER AND SANITATION

NATIONWIDE TARGETS TO IMPROVE ACCESS TO SAFE DRINKING WATER BY 2015

Source: Ministry of Planning, Cambodia Millennium Development Goals Report, 2003

The Ministry of Planning said in 2003 that the country overall was on track to meet its Cambodian Millennium Development Goal target for 50 percent of people in rural areas to have access to safe drinking water by 2015. But Cambodia is expected to fall short of its 80 percent target for urban dwellers by about 10 percentage points. In 2000, the Ministry of Planning said access to safe drinking water was about 54 percent in urban areas, twice as high as the 27 percent rate in rural areas.

WATER QUALITY AND SANITATION

The United Nations Children's Fund (UNICEF) estimates that less than 30 percent of Cambodia's rural population has access to safe water and less than 10 percent to adequate sanitation. These are among the lowest rates in the world. With little public investment to ensure sustainable quantity or to monitor quality, the great majority of rural and poor households still rely on groundwater, rainwater or surface water.

Others have noted that few people use latrines, clean water jars or boiled drinking water and that few wash their hands properly. This contributes to the high prevalence of water-related diseases, especially among the rural poor, and to a very high under-five mortality rate. Consuming water that is unsafe due to the presence of water-borne diseases and pollutants is detrimental to health, productivity and learning capacity.

HEALTH – WATER & SANITATION FACTS UNICEF 2002	
Cambodians using improved drinking water	34 %
Urban population using improved drinking water	58 %
Rural population using improved drinking water	29 %
Cambodians with adequate sanitation	16 %
Urban population with adequate sanitation	53 %
Rural population with adequate sanitation	8 %

Recognising the dire state of the country's water quality and sanitation, the Royal Government of Cambodia approved the Sub-Decree on Water Pollution Control in 1999. The sub-decree aims to minimise water pollution and improve wastewater management for sustainable water quality suitable for human use.

The government also approved the Sub-Decree on Solid Waste Management in 1999 after a controversy over hazardous waste disposal in Sihanoukville. The sub-decree mainly focuses on household waste and hazardous waste.

Sources: UNICEF and ADB

13

DIVERSITY OF FISH AND OTHER AQUATIC ANIMALS

DIVERSITY OF FISH AND OTHER AQUATIC ANIMALS

The Mekong River has more than 1,000 species of fish of which about 500 are found in Cambodia including more than 200 in the Tonle Sap. With such diversity, fish occupy all available aquatic habitats and eat many types of food. For a country with such a high level of fish production like Cambodia, biodiversity is crucial as it can act as a "safety valve" each season.

Fish species range from a tiny rice fish (*oryzias mekongensis*) of only two centimetres to the Mekong giant catfish (*trey reach*), the world's largest freshwater fish which can grow to three metres long. More familiar are catfishes, river carps, snakeheads and climbing perch. Inland waters are also home to garfish, longtoms, frogfish, pufferfish, eels, sharks, rays and many others. The hundreds of species cover many families with a diversity of form, feeding habits and modes of reproduction.

Although some species spawn on the floodplains, many migrate upstream to Mekong tributaries in northeast Cambodia, Laos and Vietnam to release their eggs. After spawning, they swim to flooded areas where they can gorge on the abundant food until the waters start falling. The flooded forest areas around the Tonle Sap are particularly rich feeding grounds.

Inland waters also support many kinds of other aquatic animals. These include crocodiles, clams, snails, snakes, turtles, frogs, tadpoles and shrimps as well as various birds and insects like waterbugs. Cambodians eat between 50,000 and 100,000 tonnes of such aquatic species very year.

Despite high biodiversity, most fish catches in Cambodia are dominated by about 10 species. One survey in the mid-1990s recorded between 44 and 75 species in the catches of large and medium-sized fisheries. But 10 species accounted for about 40 percent of the total catch. In fishing lots, the main species caught were giant snakeheads (trey chdao), small river carp (trey riel), soldier river barbs (trey chkok) and river catfish (trey pra). For the bagnet fisheries north of Phnom Penh, the dominant species apart from trey riel were pelagic river carp (trey slak russey) and shark minnows (trey kros). Other dominant species recorded in the catches were river barbs (trey ach kok), small-scale carp (trey pruol), Java barbs (trey chhpin prak) and striped snakeheads (trey roh).

Fish that stay on the plain, like snakeheads (trey roh and trey chdao), are known as "black fishes" as they live in water that has been darkened by chemicals from dissolved

vegetation. Black fishes can tolerate acidic water that is lacking in oxygen. Most can breathe air and move overland to find new waterbodies. Some can even bury themselves in the mud and wait until the next flood. Apart from snakeheads, common black species of black fishes in Cambodia include climbing perch (*trey kranh*), walking catfish (*trey andaing*), snakeskin gouramy (*trey kanto*) and swamp eels (*oontong*). All of these species can survive out of water for long periods.

Species that leave flooded feeding areas of the floodplain and swim towards rivers as floodwaters recede are known as "white fishes" as they spend most of their lives in white turbid water of running rivers. These range from the common lowland river catfish (*trey chlang*) to the highly-prized marbled goby (trey damrei) which is often exported to markets like Hong Kong and Singapore. Other whitefish species include river catfish (*trey pra*), giant sheatfish (trey sanday), red-tailed tinfoil barbs (*trey kahe*), black-spot catfish (*trey pour*) and small-scaled croakers (*trey promah*).

The Mekong River has nine fishes on the World Conservation Union's "red list" of threatened species including six that used to be important for Cambodian fisheries. The Mekong giant catfish (*trey reach*) is "critically endangered" which means it faces an "extremely high risk" of extinction in the wild. Among the five fishes listed as "endangered" and facing a "very high risk" of extinction in the wild are Julien's barb (*trey trawsak*) and Laotian shad (*trey kbork*). The other three species threatened are in the "lower risk" category and include the Indochina featherback (trey krai). The red list also includes the thicklip barb (*trey trawsak sor*) and the giant catfish (*trey po pruy*) in the "data deficient" category which indicates that these two species may also be threatened but that more information is required

The abundance of these six species has declined sharply as a result of overfishing and changes to habitat, hydrology and passage. If the impact of fishing is managed, stocks can recover if the environment is intact – a big challenge considering the thousands of dams and other structures that have been built on the Mekong with many more planned. In the past, agencies responsible for water management in Mekong region largely ignored fisheries. To prevent more fish species being added to the red list and others becoming extinct, careful screening and comprehensive mitigation and environmental management will be crucial in the future

Source: Mekong River Commission

14

BIRD DIVERSITY

PHOTO: ELEANOR BRIGGS-WCS

BIRD DIVERSITY

Birds are the most widely studied and best known group of animals in the Tonle Sap Biosphere Reserve. Since 2001, the Wildlife Conservation Society (WCS) has been carrying out conservation and monitoring activities in two bird communities of great global significance.

In the Prek Toal core area in Battambang, the society has been counting and protecting large colonies of waterbirds since the late 1990s, with increasingly sophisticated monitoring since 2003. In grasslands and farming areas of the floodplain in Kompong Thom and Siem Reap, scientists have been monitoring and researching Bengal floricans (ksap) and other species since 2001.

The Tonle Sap has the biggest colonies of globally endangered waterbirds in Southeast Asia and is also an important site for many other threatened species. By 2005, scientists had recorded 210 bird species of which 17 were either threatened or near threatened (see box). For seven waterbird species threatened with extinction, Prek Toal is either the largest or only nesting site in Southeast Asia. Endangered species – those facing a very high risk of extinction in the wild – included the Bengal florican (ksap) and the greater adjutant (trodok thom). Less threatened but still vulnerable are the lesser adjutant (trodok toik), spot-billed pelican (tung propes), the milky stork (reneal sor) and the masked finfoot (popoel teuk) which all face the risk of extinction in the wild as well. Species close to being threatened included the painted stork (roneal poar), the black-headed ibis (kangno kloun sor), the oriental darter (smaogn) and the black-necked stork (angkot khmao, also known as dambon kragnou). Prek Toal is the only site in Southeast Asia where this last species is known to breed. The core area also supports up to 30 percent of the global population of most of the other species.

Several other large waterbird species that breed around Prek Toal have populations that are globally significant. Accounting for more than one percent of the Asian populations, these include the little cormorant (kaek teuk touch), the Indian cormorant (kaek tuk mothym), the great egret (kok kroung thom) and the Asian openbill (changkiel kchang).

PHOTO: ALLAN MICHAUD-WCS

HOW THREATENED IS THREATENED?

Bird Life International, a conservation group based in Britain, is the listing authority for birds that appear on the international Red List of species threatened with extinction. Compiled by the World Conservation Union (IUCN) since 1994, species are evaluated according to biological factors such as decline, population size and distribution as well as the area of geographic distribution. In 2006, the list had more than 16,000 globally-threatened species (of which 7,725 were plants and 8,394 were animals). Birds accounted for 12 percent of the species threatened.

More than 800 species already extinct fall into two groups:

EXTINCT (EX)
No reasonable doubt that the last individual has died

EXTINCT IN THE WILD (EW)
Surviving only in cultivation or captivity, or well outside its past area of geographic distribution

THE THREE "THREATENED CATEGORIES" ARE:

CRITICALLY ENDANGERED (CR)
Extremely high risk of extinction in the wild

ENDANGERED (EN)
Very high risk of extinction in the wild

VULNERABLE (VU)
High risk of extinction in the wild

OTHER CATEGORIES ARE:

NEAR THREATENED (NT)
Close to becoming vulnerable or endangered without ongoing conservation efforts

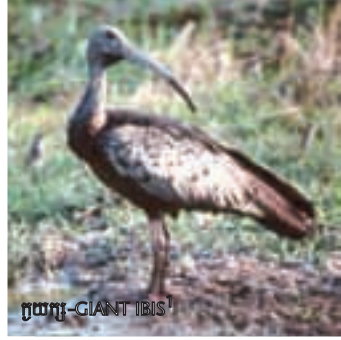
LEAST CONCERN (LC)
Neither threatened or near threatened category including widespread and abundant species

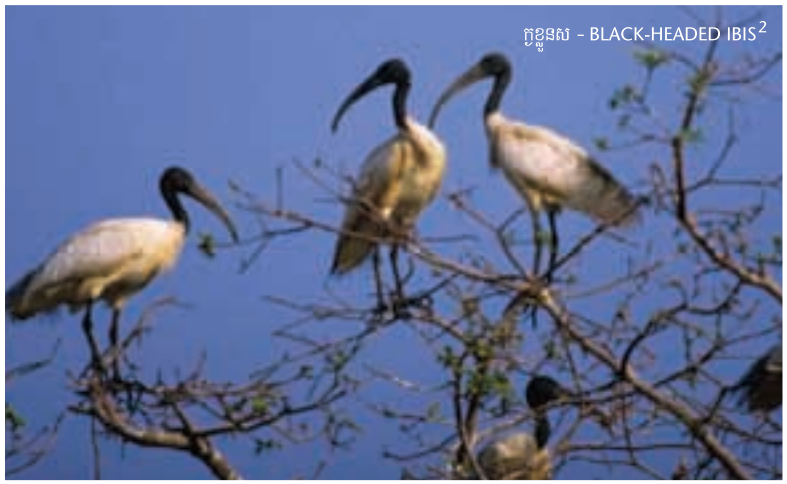
DATA DEFICIENT (DD)
Inadequate information to make an assessment

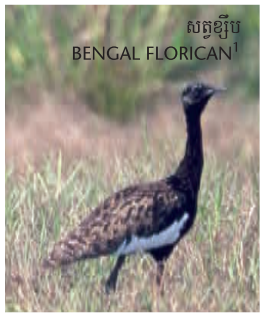
NOT EVALUATED (NE)
Not yet evaluated

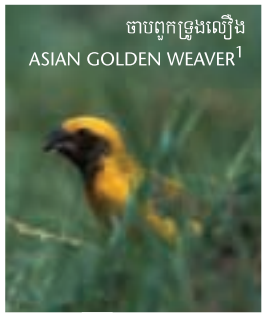
Source: World Conservation Union

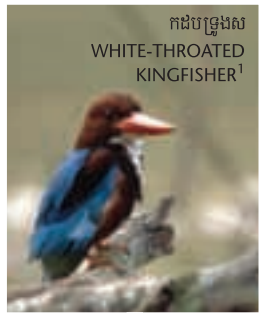
*PHOTO CREDITS: [1]ALLAN MICHAUD WCS, [2]ELEANOR BRIGGS WCS, [3]WCS











The Tonle Sap also has substantial numbers of other large waterbirds that are either extinct or threatened in neighbouring countries. These include the grey heron (*krasar prapes*) which is already extinct as a breeding species in Thailand. Others include the woolly-necked stork (sat kor sor) and the great cormorant (*kaek teuk thom*), both critically-endangered in Thailand, and the purple heron (*krasar thnoung*) which is less threatened but also endangered in Thailand. All of these species are at risk of becoming extinct in Laos as well.

Each of the large waterbird species uses Prek Toal only during its breeding season. After breeding, most birds fly to other parts of Cambodia including the Sarus Crane Reserve in Ang Trapeang Thmor in Banteay Meanchey province and the northern plains. Small numbers reach southern Laos, northeast and central Thailand and southern Vietnam.

CRITICALLY-ENDANGERED SPECIES

• White-shouldered ibis (*kangno kloun khmao*)

Up to 20 were sighted in Kompong Thom on different occasions between 1999 and 2004. Extinct in Thailand.

ENDANGERED SPECIES

• Bengal florican (*ksap*)

The eastern Tonle Sap floodplain has the largest known breeding population in Southeast Asia and possibly the world. Monitoring of males at three sites between 2002 and 2004 indicated between 64 and 122 individuals.

• Greater adjutant (*trodok thom*)

With 54 breeding pairs in 2003-4, the Prek Toal core area had the second-largest colony in the world with more than 10 percent of the global population. Critically endangered in Thailand.

VULNERABLE SPECIES

• Lesser adjutant (*trodok toik*)

Prek Toal has the largest known breeding population in Southeast Asia, with about 10 percent of the global population. Numbers rose from 149 nesting pairs in 2003-4 to 209 pairs in 2004-5. Critically endangered in Thailand.

VULNERABLE SPECIES

• SPOT-BILLED PELICAN (*TUNG PROPES*)

Prek Toal has the largest single colony in the world. The estimated 900 to 1,100 pairs in 2005 represented about 20 percent of the global population. Critically endangered in Thailand.

• Milky stork (*roneal sor*)

Up to 10 pairs are estimated to breed in Prek Toal, making it the only known inland breeding population on the Southeast Asian mainland. With only 10 birds remaining in Malaysia, Cambodia may soon have the only population Southeast Asia.

• Sarus crane

Flocks of up to 30 have been seen in the outer floodplain grasslands around Stung Sen, Santuk and Baray in Kompong Thom province as they migrate from their breeding grounds in the northern plains to the Ang Trapeang Thmor reserve in Banteay Meanchey. Since 2002, a growing non-breeding population has been spending the dry season in the Prolay grassland in Stung Sen. By 2005, this population exceeded 30 individuals. Extinct in Thailand.

NEAR-THREATENED SPECIES

• Painted stork (*roneal poar*)

Prek Toal supports a breeding population of about 1,000 pairs, or 20 percent of the global population. Endangered in Thailand.

• Black-headed ibis (*kangno kloun sor*)

Although numbers cannot be counted reliably because they nest in thick shrubland, Prek Toal supports the largest breeding colony in Southeast Asia. Post-breeding counts in the Sarus Crane Reserve in Banteay Meanchey peaked at 1,600 in 2003. If half of these were breeding adults, the 400 pairs would represent between 8 and 15 percent of the global population. Endangered in Thailand.

• Oriental darter (*smaogn*)

Numbers have risen dramatically from 280 nests counted in 2001 to 1,870 nests in 2004-5. Further increases may pose management problems. Critically endangered in Thailand.

Sources: Wildlife Conservation Society, Tonle Sap Biosphere Reserve Secretariat

15

REPTILE DIVERSITY

PHOTO: ALLAN MICHAUD WCS

REPTILE DIVERSITY

The Tonle Sap may be the single most important wetland for reptile conservation in Southeast Asia. The biosphere reserve is believed to support internationally-significant populations of at least eight species that are either threatened with extinction or close to being threatened (see threatened categories on page 70). These include the critically-endangered Siamese crocodile, the near-threatened Burmese python and six species of freshwater turtle, including the endangered yellow-headed temple turtle.

The reserve is also home to the world's largest snake harvest, largely fuelled by the explosive growth in crocodile farms around the Tonle Sap in recent years. Between mid-2004 and the beginning of 2005, an estimated 3.8 million snakes were caught with rainbow watersnakes accounting for between 72 percent and 80 percent of the overall catch. The second most abundant species was the Tonle Sap water snake which accounted for half the catch in the southern part of the reserve. Over exploitation is likely to threaten this species which is native to the lake and believed to be Cambodia's only endemic reptile. Other species are the puff-faced watersnake and Bocourt's watersnake. Both are targeted for their skins which are exported to Thailand, Vietnam and China. In 2004, the skin of a Bocourt's watersnake could fetch up to 10 dollars a piece. This species is also traded live for its meat and is considered locally rare as a result of excessive harvesting.

PHOTO: ALLAN MICHAUD WCS

CRITICALLY-ENDANGERED SPECIES

• Siamese crocodile

Wild populations have recently plummeted as eggs, young and adults are harvested to stock crocodile farms. At least 105 crocodiles were collected from the Tonle Sap between 1998 and 2002. Very small numbers are believed to exist in the three core areas as well as Dei Ronet, Fishing Lot No.6 and the flooded forest area next to Prek Toal. Some “wild” crocodiles may, in fact, be animals that either escaped or were released from crocodile farms. These may include Cuban crocodiles and a hybrid species that are also farmed.

• River terrapin

The discovery of two shells buried in lake sediment in 1985 confirmed that this species used to occur in the Tonle Sap but recent surveys have found no evidence of its continued existence around the lake. The species has been designated as Cambodia’s national reptile.

ENDANGERED SPECIES

• Yellow-headed temple turtle

Cambodia is probably the most important country in the Lower Mekong Basin for this turtle, considered the third most common species in the Tonle Sap. It occurs in Prek Toal and has been recorded in markets in Chong Kneas and Kompong Thom. It has also been reported by hunters in Kompong Chhnang province including Kompong Leng commune.

• Asian giant soft-shell turtle

Cambodia probably supports a regionally-important population of this enigmatic species, possibly the most important in Southeast Asia. The species is often reported in the Tonle Sap but there are no confirmed specimens or photographs.

• Elongated tortoise

The species has recently been seen in markets in Kompong Chhnang but there are no specimens or photographs to confirm its occurrence in the Tonle Sap.

*PHOTO CREDITS: [1]ALLAN MICHAUD WCS, [2]ELEANOR BRIGGS WCS, [3]WCS


អណ្តើកក្របីក្បាលលឿង
YELLOW-HEADED TEMPLE TURTLE[3]

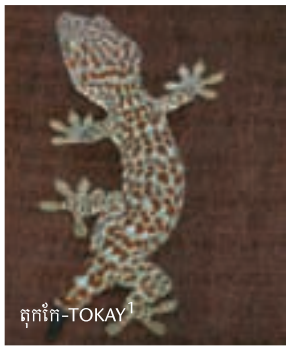

ក្រពើត្រី-SIAMESE CROCODILE[1]


ត្រកួត
BENGAL MONITOR[3]

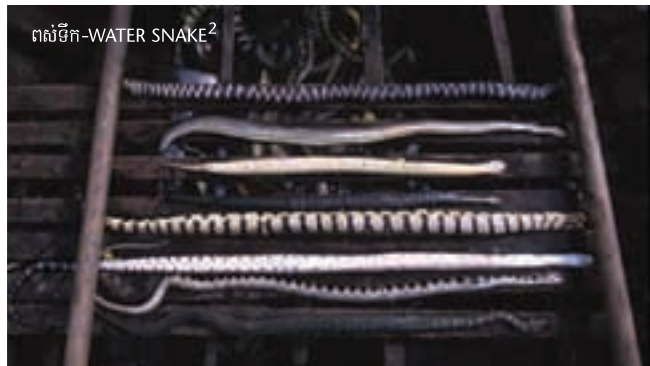

កន្ត្រែង
WATER DRAGON[1]


ពស់ថ្ពាន់តូច-BURMESE PYTHON


1


តុកកែ-TOKAY[1]


កន្ធាយអាស៊ី-AIATIC SOFTSHELL TURTLE[1]


ពស់ទឹក-WATER SNAKE[2]

VULNERABLE SPECIES

• Asian box turtle

The second most common turtle in the Tonle Sap is becoming harder to find in the wild. It has recently been recorded in Prek Toal and a captive individual has been photographed in Sary village in Kompong Thom province. It is believed to be still widespread in the lowlands of Cambodia, which probably supports the largest population in Indochina.

• Black marsh turtle

The Cambodian population may be the largest in Southeast Asia. Around the Tonle Sap, it occurs in ponds away from the lake itself. The turtle is not favoured for its meat, which is considered foul-smelling and even inedible.

• Great Asian pond turtle

Recently reported in Kompong Chhnang province, this species is thought be scarce.

• Malayan snail-eating turtle

The most numerous turtle around the Tonle Sap, this species is favoured for its meat and is also used for traditional medicine. It occurs in floating ricefields in Kompong Thom between August and December, and is believed to inhabit flooded forests outside this period.

• Asiatic soft-shell turtle

Although regarded as common around the Tonle Sap, its numbers have seriously declined and the species is rare in Kompong Chhnang. The turtle is strongly favoured for its meat.

NEAR-THREATENED SPECIES

• Burmese python

In the Stung Sen and Boeung Chhma core areas, this species is heavily hunted for its skin, meat and blood for both domestic and export markets. In the Prek Toal core area, some fishermen use special nets to catch pythons while others use their hands. Females make their nets on the ground in dense scrub during the dry season, typically laying 20 to 30 eggs.

Sources: Wildlife Conservation Society, Independent Journalism Foundation

16

MAMMAL DIVERSITY

PHOTO: ALLAN MICHAUD WCS

MAMMAL DIVERSITY

The mammals of the Tonle Sap have not been well studied and no specific surveys have been conducted for any species. Incidental observations have been made during bird and reptile surveys. Other records come from rangers in Prek Toal, market specimens and captive animals.

Large herbivores such as elephants, wild buffalo and deer have disappeared from the wild around the Tonle Sap, possibly as recently as only 10 years ago. It is highly likely that the Tonle Sap floodplain used to be an important seasonal habitat for such mammals. It also seems likely that the disappearance of the Irrawaddy dolphin (trey psaut) from the lake is very recent.

Among the mammal species that still occur around the lake, some are globally threatened (see threatened categories on page 70). In addition, some may occur in numbers that are internationally significant.

VULNERABLE SPECIES

• Smooth otter

In 2002, hunters near Kbal Toal near the Prek Toal core area caught an individual, which is the only confirmed record of the species in the biosphere reserve.

• Fishing cat

Local people frequently report this species. In 2002, tracks were recorded by dried up pools in the outer floodplain of the Prek Toal core area and separate tracks were recorded in Kruos Kraom.

• Pygmy slow loris

Fishermen and hunters have reported the species in the Prek Toal area. Authorities confiscated a loris from a hunter in Prek Toal in 2000 but the species was not confirmed.

*PHOTO CREDITS: [1]ALLAN MICHAUD WCS, [2]ELEANOR BRIGGS WCS, [3]WCS, [4]CARLY STARR, [5]NICK COX WWF

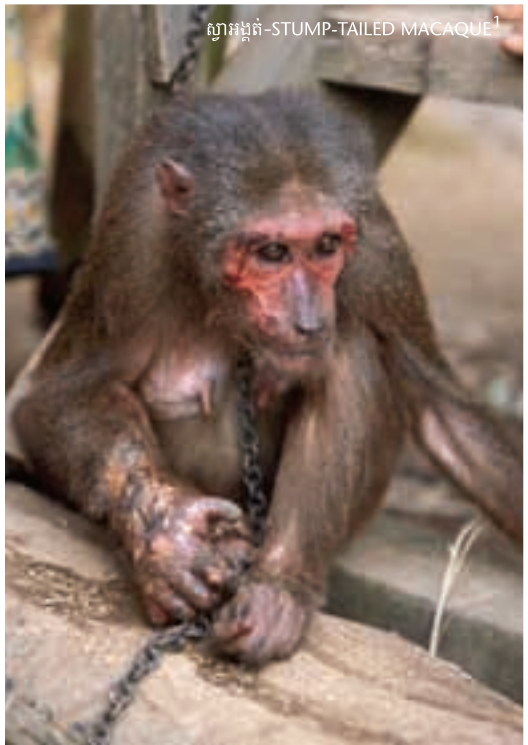

ទោចម្កុដ-PILEATED GIBBON[1]


ស្វាត្រៃស-PIG-TAILED MACAQUE[3]


ខ្ទីង-LARGE INDIAN CIVET[3]


ជ្រើង-FLYING-FOXES[1]


រញ្ជី-SLOW LORIS[4]


ស្វាអង្គត់-STUMP-TAILED MACAQUE[1]


ភេ-OTTER[5]


សំពោចកញ្ជើង-YELLOW-THROATED MARTEN

NEAR-THREATENED SPECIES

• Long-tailed macaque

This monkey is widespread and common in taller flooded forest and scrubland areas around the Tonle Sap, especially along the shore of the lake. The population has probably declined as a result of hunting to supply captive breeding facilities in Cambodia as well as China and Vietnam. Authorities have seized consignments of up to 170 individuals from hunters and traders in Prek Toal and Kompong Thom, especially during the wet season. Captive individuals are also seen in many of the floating villages around the lake.

DATA-DEFICIENT SPECIES

• Germain's silver leaf monkey

PHOTO: ALLAN MICHAUD WCS

Although currently not listed by the World Conservation Union as globally threatened, some believe this monkey may qualify as a vulnerable or even endangered species in the future. The species occurs in the Prek Toal and Boeung Chhmar core areas as well as the Veal Sangrai bird sanctuary. The relative importance of the Tonle Sap population is not yet clear.

• Hairy-nosed otter

Two of the four confirmed records of this species come from the Tonle Sap – two individuals in Prek Toal and a third in Peam Bang village near the Boeung Chhmar cora area. Local villagers say the species may be close to extinction in the Prek Toal area.

Source: Wildlife Conservation Society

17

BIODIVERSITY IN BOEUNG CHHMAR

PHOTO: ELEANOR BRIGGS WCS

BIODIVERSITY IN BOEUNG CHHMAR

Boeung Chhmar is one of three core areas of the Tonle Sap Biosphere Reserve and also a globally-recognised wetland under the Ramsar convention (see page 24). The biological diversity of the lake and surrounding creeks is valuable for conservation, education and local people.

Two rivers flow into the area from Cambodia's northern plateau. These are the Stoung River with a catchment area of 1,895 square kilometres and the Chikreng River with a catchment of 1,920 square kilometres. Seasonal water fluctuations and plants within the creek system make the area ecologically rich in terms of nutrients and harvestable products.

Boeung Chhmar is made up of four distinct habitats. The lake and associated waterways cover about 4,000 hectares. Other habitats are the flooded forest area next to the Tonle Sap and flooded shrub areas with brushes along with grassland and savannah areas which include reeds, rushes and small species of bamboo.

A survey of plants around Boeung Chhmar has recorded 190 species from 67 families. Vegetation is generally found in waterways, creek

PHOTO: ALLAN MICHAUD WCS

levees and swamps. Water hyacinth (kamphlaok) is abundant along waterways and is commonly found with several other species including utricularia aurea (*saraey*). The area also has many tall trees of up 15 metres that can survive the annual flood such as Barringtonia actangulata (*daem reang teuk*), Terminalia cambodiana (*daem ta ue*) and Diospiros cambodiana (*daem phtuol*) The shrubland area of the swamps include meadows of the low-growing Polygonum barbatum (*kantean hae*).

Boeung Chhmar is an important animal refuge. Mammals reportedly include long-tailed macaques, capped langurs, fishing cats, otters and civets. Large colonies of waterbirds, including globally-threatened species, have also been observed, especially in the dry season. Significant species include spot-billed pelicans, greater and lesser adjutant storks, giant ibises, milky storks, African darters and Asian openbills.Twenty-three species of snakes have been identified and monitor lizards have also been reported. Turtles used to be abundant but are now rare. There seem to have been no studies on fish, amphibians or invertebrates in the area, although dragonflies and damselflies are highly diverse and terrestrial insects are abundant in the swamps, especially grasshoppers and crickets.

Unsustainable practices – illustrated by the decline in large species of fish and smaller catches – may undermine the value of Boeung Chhmar resources and damage long-term sustainability. Efforts to protect the area's resources require an integrated approach involving all stakeholders, especially local people, with a focus on fisheries management and sustainable farming. Local awareness of the importance of the flooded forest needs to be raised and alternative livelihoods and sources of energy need to be developed. At the same time, initiatives are required to reduce the extraction of local resources and promote "non-extractive" alternatives.

PHOTO: ALLAN MICHAUD WCS

PHOTO: ELEANOR BRIGGS WCS

18

MILLENNIUM DEVELOPMENT GOALS

MILLENNIUM DEVELOPMENT GOALS

Under the Millennium Declaration signed by all 189 members of the United Nations General Assembly in 2000, the government is supposed to ensure the country's environmental sustainability. One of the 25 targets to be met by Cambodia by 2015 is to "integrate the principles of sustainable development into government policies and programs and reverse the loss of environmental resources." A progress report released by the Ministry of Planning in 2004 indicated that this was one of only three targets that would "probably" be met by 2015. The report said the there was "strong" support for meeting three other targets (decreasing the spread of HIV/AIDS and halving the number of people without sustainable access to safe drinking water and improved sanitation). But support was only "fair" for meeting the environmental targets for which are being measured by 14 specific indicators.

In a foreword to the report, Prime Minister Hun Sen highlighted the importance of meeting the environmental goals. "Cambodia's natural resources must remain the focus of our attention if we are to pass on this tremendous legacy of a rich environmental heritage to the next generation," he said.

The report found that Siem Reap and Kompong Thom were among the nine "worst off" provinces in terms of drinking water, sanitation, forest coverage and dependency on wood for fuel. The situation was "moderate" in Pursat, Kompong Chhnang and Battambang. None of the provinces around the Tonle Sap fell into the "best off" category which comprised Svay Rieng, Prey Veng, Kandal, Kratie and Koh Kong as well as the municipalities of Phnom Penh, Pailin and Sihanoukville.

Forest coverage nationwide is projected to fall below the target of 60 percent between 2005 and 2015. Despite replanting since 1985, the report noted that forest coverage fell from 73 percent of the country's total land area in 1969 to less than 59 percent in 1997. With almost two million hectares of forest lost by 2002, the annual rate of decline since the 1960s has been running at around 0.5 percent.

For increasing access to safe drinking water and improving sanitation, the outlook was mixed. The report found that the government was on track to meet its target for 50 percent of rural households to have access to safe drinking water by 2015 but would fall short of its 80 percent target for urban households. On the other hand, efforts to improve sanitation were well ahead of target with projections showing that 100 percent of urban people and 55

percent of rural people would have access to improved sanitation by 2015. To achieve the targets, the World Bank has estimated that 600 million dollars will have to be invested on water and sanitation. Under the Rural Water and Sanitation Strategy adopted by the Council of Ministers in 2003, everybody in rural areas is supposed to have sustained access to safe water supplies and sanitation services by 2025. The strategy, which is being carried out by the Ministry of Rural Development, also envisages that all people in rural areas will be living in a "hygienic environment" by 2025.

TARGETS FOR ENSURING ENVIRONMENTAL SUSTAINABILITY

INDICATOR	BENCHMARK	2005	2010	2015
Forest coverage (% of total land)	60 *	60	60	60
23 protected areas (mil ha)	3.3	3.3	3.3	3.3
Six forest protected areas (mil ha)	1.35	1.35	1.35	1.35
Rangers in protected areas	600	772	987	1,200
Rangers in six forestry protected areas	500	500	500	500
Fishing lots allocated to communities (%)	56	58	60	60
Number of community fisheries	264	364	464	589
Fish sanctuaries (thousand ha)	264	581	581	581
Households depending on fuel wood (%)	92	70	61	52
Rural people with safe water (%)	24	30	40	50
Urban people with safe water (%)	60	68	74	80
Rural people with improved sanitation (%)	8.6	12	20	30
Urban people with improved sanitation (%)	49	59	67	74
Titled land (%)	15	16	32	65

** benchmark based on average forecast coverage between 1992 and 2002*

Source: Ministry of Planning

Energy substitution is a key challenge for meeting the environmental targets. The government aims to reduce the dependency on wood for fuel from 92 percent of households to 52 percent by 2015. Rural people rely almost exclusively on wood for energy. Investment in the production and distribution of cheap alternatives is therefore considered a priority.

Other challenges include strengthening community management of natural resources and government management of public land as well as coordinating government agencies and donors. The Ministry of Planning report noted that a "significant overlap" between ministries had led to conflicts between authorities, and that the responsibilities of various ministries should be clarified. The report called for better coordination among government agencies, between the government and donors and also among donors themselves.

Reducing population growth and improving the government's capacity to manage the environment are also important. The report noted that Cambodia suffered from a "dearth of technical capacity" which was compounded by the multi-sectoral nature of environmental issues ranging from land management to biodiversity and forest management. The report also highlighted the need to carry out strategic and political commitments.

▲ Water hyacinth briquettes are a good use of an invasive plant species. Fuel efficient stove – less wood, same output.

▲ A biodigester. The family adds animal manure to the bag, which then breaks down to produce gas which can be used for cooking.

The report said Cambodian laws were "not well implemented due to political influence, uncontrolled development and wealthy people's interests." To ensure transparency and accountability and to combat

▲ Floating garden in Siem Reap.

corruption, it called for justice, military and police reforms.

The Ministry of Planning concluded that better management of natural resources could help fuel Cambodia's development by helping to reduce poverty, develop rural areas and create jobs. In addition to improved management and strengthened institutional capacity to implement the Convention on Biodiversity, the report called for performance standards for water and sanitation to be enforced. Monitoring of strategies and laws needed to be reinforced, along with co-management of fuel wood resources. The report also called for environmental assessments of hydropower schemes in protected areas and frameworks to improve the security of land tenure with campaigns to raise awareness of land rights. To reduce the dependency on forest resources, the report called for the promotion of alternative livelihoods for people living near protected areas. To promote investment in the energy, water and forestry sectors, the report highlighted the importance of transparent and equitable laws that are enforced. It also stressed the need for greater recycling of materials by industries.

Source: Ministry of Planning

▲ Mushrooms can be grown in the roof.

19

ENVIRONMENTAL EDUCATION

ENVIRONMENTAL EDUCATION

Environmental education around the Tonle Sap has been targeting local communities, teachers and primary school students but is still in its infancy. Providers include Osmose and the Food and Agriculture Organisation (FAO) of the United Nations in Siem Reap along with Mlup Baitong, Save Cambodia's Wildlife and Live & Learn Environmental Education in Phnom Penh. In the absence of formal assessments of these initiatives, it is difficult to determine their impact including which tools have been successful and which need further development to bring about real change.

In 2003, the FAO collaborated with Osmose, Save Cambodia's Wildlife and Mlup Baitong to publish 1,000 copies of a training manual with 14 themes. In late 2004, they reviewed the manual based on teacher feedback. By late 2005, Osmose had trained about 40 teachers to use the manual and Mlup Baitong had trained another 32 to use parts of it to run extra-curricular 'eco-clubs' for primary students in Kompong Speu province. Save Cambodia's Wildlife used extracts to train more than 200 teachers in Kampot, Koh Kong, Pursat, Kratie, Mondolkiri, Ratanakiri and Stung Treng. Mlup Baitong and Osmose pay teachers to include environmental education alongside school lessons. Mlup Baitong also broadcasts radio programs from the Women's Media Centre twice a week in a format that includes two 15-minute segments on environmental issues and a one-hour show that receives call-ins. The impact of these programs has not been successfully measured.

In Siem Reap, fishing techniques and livelihoods from around the Tonle Sap are on display at the Greater Environment Chong Khneas Office (Gecko Centre) established by the FAO in 1999. The fixed floating structure also has some small exhibits on biodiversity. While the target audience was supposed to include local fishing communities and tourists, most visitors have been students living nearby. About 5,000 students had visited the centre as of late 2005. By this time, groups of 16 primary students were visiting the Gecko Centre once a week for a one-hour session adapted from the training manual. The centre had also developed a video on protecting flooded forests as well as posters and signs to support the education program.

The FAO also trains monks and has developed an environmental training manual centred on Buddhist themes. Twenty monks in four pagodas had undergone such training by late 2005. Mlup Baitong also carries out environmental education through pagodas.

Among other initiatives, Cambodia Family Development Services (CFDS), Soutien a l'Initiative Pour l'Aide a la Reconstruction (SIPAR) and Forum NGO have also developed educational materials. These are on a smaller scale and are mostly posters and stories for community use. The Community Sanitation and Recycling Organisation (CSARO) meanwhile works on recycling projects in Phnom Penh and Japan International Cooperation Agency (JICA) has been involved in environmental awareness training for government officers.

The provincial environment departments in Battambang and Pursat have also produced posters. These were developed with the Ministry of Environment's Department of Nature Conservation and Protection and Department of Environment as well as the Technical Co-ordination Unit in Prek Toal. The ministry itself has an Environmental, Communications and Information Unit that focuses on community efforts for "Clean Up the World Day" and a quarterly newsletter.

The Tonle Sap Environmental Management Project (TSEMP) under the Cambodian National Mekong Committee has two key activities related to environmental education. One involves Live and Learn, which carried out an 18-month National Environmental Education and Awareness Campaign (NEEAC) that started in mid-2005. Involving both national and local stakeholders, the campaign is focused on the environmental, economic and social aspects of the Tonle Sap as a provider of food with special hydrology and specific threats. The campaign produced a status report on Cambodia's environmental education, sponsored radio programs and theatrical performances, and established a one-year internship program with Rasmei Kampuchea in the five Tonle Sap provinces. The other key activity involves the Tonle Sap Conservation Project (TSCP) of the UNDP and the Global Environmental Facility of the United Nations. This project has an environmental awareness, education and outreach program through schools and environmental training centres. These include management centres for the three core areas of the Tonle Sap Biosphere Reserve (Prek Toal, Boeung Chhma and Stueng Sen) and floating centres in Kompong Chhnang and Pursat as well as the Gekco Centre in Siem Reap.

Source: Live and Learn Environmental Education

20

GLOSSARY OF TERMS

សន្ទានុក្រម

ការបន្សាំ

Adaptive ជាទូទៅ គឺជាប្រភេទសត្វ ដែលអាចបន្សាំខ្លួន ឬរស់នៅដោយសំរបសំរួលខ្លួនទៅនឹងការប្រែប្រួលបរិស្ថានរបស់វា ។ កាលណាប្រភេទទាំងនេះកាន់តែអាចផ្សាំទៅនឹងលក្ខខណ្ឌរស់នៅ និងការចិញ្ចឹមជីវិតកាន់តែខ្លាំង នោះលំនៅដ្ឋានធម្មជាតិ និងភាពធន់ទ្រាំរបស់វាទៅនឹងការរំខានផ្សេងៗក៏កាន់តែធំដែរ ។ នៅក្នុងការគ្រប់គ្រងបរិស្ថានពាក្យ "ការបន្សាំ" គឺមានន័យថា យុទ្ធសាស្ត្រ ដែលមានលក្ខណៈរលូន ហើយអាចបញ្ចូលព័ត៌មានថ្មីៗទៅក្នុងយុទ្ធសាស្ត្រ ឬ គោលនយោបាយគ្រប់គ្រងមួយដែលបានពិនិត្យឡើងវិញ និងបង្កើនគុណភាព ។

ការវាយតំលៃ

Assessment "ការសំដែងចេញយ៉ាងច្បាស់លាស់នូវតំលៃបរិស្ថានដ៏ពិតប្រាកដបានកំណត់ ដែលចាំបាច់ត្រូវការពារ ។

Endpoints

សេសសេសមនេត នេដផ្សិនត

គឺជាសេចក្តីអធិប្បាយ ឬគោលដៅពាក់ព័ន្ធទៅនឹងលក្ខខណ្ឌអេកូឡូស៊ី (ដូចជា ឥទ្ធិពលនៃការបង្កកំណើតលើសាពាំង្គកាយក្នុងទឹក) ដែលចាំបាច់ត្រូវធ្វើការវាយតំលៃ និងការពារ ។ Assessment endpoints ជារឿយៗតែងតែផ្សារភ្ជាប់ទៅនឹងការឆ្លើយតបនឹងភាពតានតឹងបរិស្ថាន (Environmental stresses) របស់ប្រភេទនៅក្នុងអេកូឡូស៊ី ដែលជាអ្នកទទួលរងឥទ្ធិពល (Ecological receptor species) ប៉ុន្តែពួកវាក៏មានផ្នែកខ្លះ ដែលពឹងអាស្រ័យទៅលើលក្ខណៈអេកូឡូស៊ីទាំងនោះ ដែលគេដឹងថា មានតំលៃខ្ពស់សំរាប់មនុស្ស ។

កំហាប់ជីវៈ

Bioconcentration:
គឺជាដំណើរការនៃការប្រមូលផ្តុំធាតុគីមី ទៅក្នុងសាពាំង្គកាយរស់នៅក្នុងទឹក ដោយផ្ទាល់ពីទឹក ។ ដំណើរការនេះ រួមមាន ការស្រូបយក (តាមរយៈស្រកី ឬជាលិកាស្បែក) និងការបញ្ចេញចោល ។

ការបំបែកធាតុ

Decomposition: គឺជាដំណើរការជីវៈមួយប្រភេទ ដែលពាក់ព័ន្ធទៅនឹងការចំពារ ឬបំបែកសរីរាង្គដ៏ស្មុគស្មាញ អោយទៅជាចំរង់ងាយ ដោយសាពាំង្គកាយមួយចំនួន ដែលគេអោយឈ្មោះថាការបំបែកធាតុ ដូចជា បាក់តេរី និងផ្សិតជាដើម ។

ការបញ្ចេញទឹក/ការបង្ហូរទឹកចេញ

Drainage
Drainage basin: (សូមពិនិត្យមើលឬអាចនៅត្រង់ពាក្យ " Catchment ") ។

រំហួត

Evaporation: ការបាត់បង់មូលេគុលទឹក ដោយសារដំណើរប្រែប្រួលពីភាវរូបភាវ ទៅជាឧស្ម័ន ។ ជាទូទៅ ជាលទ្ធផលនៃការបាត់បង់ទឹកនៅពេលដែលវត្ថុភាវនេះត្រូវបានបំលែងទៅជាចំហាយ ។

ការប៉ះពន្ធឺ

Exposure: ប្រតិកម្មដោយផ្ទាល់ រវាងភ្នាក់ងារគីមីភ្នាក់ងារជីវៈមួយប្រភេទ និងប្រព័ន្ធជីវៈមួយ (គោលដៅ ឬផ្នែកនៃបរិស្ថាន ដែលទទួលរងឥទ្ធិពល) ។

ការសំដិល

Exposure គឺជាការប៉ះគ្នាដោយផ្ទាល់នៃភាពតានតឹងបរិស្ថាន (Environmental stressor) ជាមួយនឹងផ្នែកនៃបរិស្ថាន ដែលទទួលរងឥទ្ធិពល (Environmental receptor) ។

និរន្តរភាពជំរក

Habitat sustainability: តួលេខដែលត្រូវបានគេប្រើប្រាស់ក្នុងការកំណត់គុណភាពខ្ពស់បំផុតនៃលំនៅដ្ឋានធម្មជាតិ index នៅក្នុងតំបន់មួយ ។ វត្តមាននៃប្រភេទក្នុងស្រុក និងប្រភេទនាំចូលពីក្រៅផ្ទៃដីនៃលំនៅដ្ឋានធម្មជាតិ និងកិរិតនៃផលប៉ះពាល់គឺជាកត្តាសំខាន់ក្នុងការកំណត់ភាពស្ថិតស្ថេរក្នុងរយៈពេលវែងនៃលំនៅដ្ឋានធម្មជាតិនៅក្នុងតំបន់មួយ ។

ការផ្លាស់ទី

Migratory ការផ្លាស់ទី ដែលជាធម្មតា គឺអាចអោយគេព្យាករណ៍បាន (អាស្រ័យទៅលើប្រភេទដែលរស់នៅក្នុងទឹកនីមួយៗ) ពីតំបន់ ឬអាកាសធាតុមួយទៅតំបន់ ឬអាកាសធាតុមួយផ្សេងទៀត ដោយសារមូលហេតុនៃការស្វែងរកចំណីអាហារ ឬបន្តពូជ ។ល។

កន្លែងសារធាតុចិញ្ចឹម

Nutrient sink: តំបន់ដីសើមដែលមានមុខងារជាឃ្លាំងស្តុកដីជាតិ ឬធាតុគីមីទាំងឡាយ ។

ការធ្វើអាជីវកម្មហួសកំរិត

Overexploitation : ការធ្វើអាជីវកម្ម ឬ ប្រើប្រាស់ធនធានធម្មជាតិលើសពីសមត្ថភាពដែលបានផ្តល់របស់វាក្នុងការកកើតឡើងវិញ ឬទ្រទ្រង់និរន្តរភាពដោយធម្មជាតិរបស់វា ។

ការបំពុល

Pollution

Pollution-tolerant taxa :បានដល់ការប្រើប្រាស់សត្វឥតឆ្អឹងកង ដែលរស់នៅក្នុងបរិស្ថានទឹក ជាកត្តាត្រួតពិនិត្យការប្រែប្រួល ។ Pollution tolerant taxa គឺជាប្រភេទទាំងឡាយណា ដែលគេចាត់ទុកថាអាចទ្រាំរស់នៅ និងលូតលាស់នៅក្នុងបរិស្ថាន ដែលមានវត្តមាននៃសារធាតុពុល ។ ភាពច្រើនលើសលប់ Pollution-tolerant taxa (ដូចជា សត្វឈើង) ជាប់ពាក់ព័ន្ធទៅនឹង ការថយចុះនៃចំនួន Pollution-sensitive taxa ដែលជាទូទៅត្រូវបានគេចាត់ទុកជាភស្តុតាងនៃការខូចខាតគុណភាពទឹក ។

កំណកអាកាស

Precipitation: រាល់ទ្រង់ទ្រាយនៃទឹកទាំងអស់មិនជាអង្គធាតុរាវ (ភ្លៀង) ឬអង្គធាតុតាន់ (ព្រិល ឬ ទឹកកកសំឡី) ដែលធ្លាក់ពីបរិយាកាសទៅដល់ដី ឬគំរបស្លឹករុក្ខជាតិ ។

កំទេចកំណ (កករ)

Sediment

Sediment grain size: រង្វាស់ទំហំនៃគ្រាប់ដីរាប់បញ្ចូលចាប់ពីថ្មធំៗ (Lager cobbles) ត្រួស (Gravels) គ្រាប់ដីឥដ្ឋតូចៗ (Finer Clays) និងគ្រាប់ដីល្បាប់ (Silts) ។ ទំហំនៃគ្រាប់ដី គឺជាប៉ារ៉ាម៉ែត្រដ៏សំខាន់មួយក្នុងការត្រួតពិនិត្យនៅពេលធ្វើការកំណត់វត្តមាន ឬបរិមាណនៃធាតុកខ្វក់មួយនៅក្នុងជីវិតដែលរស់ក្នុងទឹក (Aquatic life) ។ ជាទូទៅ ដីដែលមានគ្រាប់តូច ហើយសំបូរដោយសារធាតុសរីរាង្គមានសមត្ថភាពបឺតជ្រុកសារធាតុកខ្វក់ច្រើន ។ គ្រាប់ដីតូចមានផ្ទៃខាងក្រៅធំជាងដីគ្រាប់ធំ បើគិតជាភាគរយទៅនឹងមាឌរបស់វា ។ លើសរីរាង្គនេះទៀត ធាតុគីមីកខ្វក់ជាច្រើនមានទំនោរក្នុងការជ្រៀតចូល ឬតោងភ្ជាប់ទៅលើកំណកដីល្បាប់ដែលមានសារធាតុសរីរាង្គខ្ពស់ ។

កំណកំទេចក្នុងទឹក

Sediment/water interface:
ការជួបគ្នារវាងទឹក (water column) និងកំណកដីល្បាប់នៅបាតក្រោម ឬដែលនៅក្នុងទឹក ។

តំណគ្នា

Succession: ការប្រែប្រួលរូបសាស្ត្រ (Dynamic) មួយលំដាប់ ឬសេរីនៃមុខងារវចនាសម្ព័ន្ធ និងសមាសភាពនៃប្រភេទនៅក្នុងប្រព័ន្ធអេកូឡូស៊ីមួយក្នុងរយៈពេលមួយ ។ ជាលទ្ធផលក្រុមមួយនៃសាពាំង្គកាយធ្វើការប្រជែងរស់យ៉ាងជោគជ័យលើក្រុមមួយទៀត ឬផ្សេងៗទៀត តាមរយៈដំណាក់កាលមួយចំនួន ដែលធ្វើអោយក្រុមនេះមានសក្តានុពលជាសហគមន៍ ធម្មជាតិ (A potential natatal community) ឬហៅម៉្យាងទៀតថា climax stage ។

ការវាស់កិរិតពុល

Toxicity test: មធ្យោបាយ ឬ វិធី ដែលតាមរយៈនោះ កិរិតពុលនៃធាតុគីមី ឬសមាសធាតុផ្សេងៗទៀត ដែលបានធ្វើពិសោធន៍ ត្រូវបានគេកំណត់ ។ ការធ្វើពិសោធន៍សាកល្បងអំពីកិរិតពុល ត្រូវបានប្រើប្រាស់ ដើម្បីធ្វើការវាស់ស្ទង់កិរិតនៃការឆ្លើយតប (degree of response) ដែលបានបង្កើតឡើងតាមរយៈការដាក់ដោយផ្ទាល់ ទៅនឹងកិរិតនៃកត្តាជំរុញ (Stimuls) ឬ កិរិតនៃសារធាតុគីមីពិសេសណាមួយ ។

ការធ្វើពិសោធន៍សាកល្បងកិរិតពុលអាចត្រូវបានគេប្រើប្រាស់ ដើម្បីវាស់តទ្ធិពលនៃផលប៉ះពាល់របស់សារធាតុមួយទៅលើក្រុមសាពាំង្គកាយមួយប្រភេទដែលបានជ្រើសរើសនៅក្រោមលក្ខខណ្ឌកំណត់មួយ ។ ការធ្វើពិសោធន៍សាកល្បងកិរិតពុលនៅក្នុងទឹក ជាទូទៅអាចវាស់ a) សមាមាត្រនៃសាពាំង្គកាយដែលទទួលរងតទ្ធិពល ឬ b) កិរិតនៃតទ្ធិពលជះបន្ទាប់ពីការដាក់ដោយផ្ទាល់ទៅនឹងសារធាតុមួយជាកំណត់ ដែលគេធ្វើការសាកល្បង (ឧទាហរណ៍ សំណាកគំរូនៃកំណកដីល្បាប់ ឬកាកសំណល់រាវ) ។

គ្រោះថ្នាក់

Hazard

Hazard quotient: រូបមន្តដែលត្រូវបានគេប្រើប្រាស់សំរាប់គណនាការប៉ាន់ស្មាន ភាពគ្រោះថ្នាក់នៃសារធាតុកខ្វក់មួយជាកំណត់ ។ Hazard quotient (HQ) ត្រូវបានកំណត់ដោយផលចែករវាងកំហាប់បរិស្ថាន ដែលគេបានរំពឹងទុក (EEC) និងកំហាប់គោល (benchmark concentration "BC ") ។ កាលណា HQ មានតំលៃតូចជាង ១ (HQ<1) នោះ បញ្ជាក់ថា ភាពគ្រោះថ្នាក់មានលក្ខណៈអាចអោយគេទាត់ចោលបាន ។ ម៉្យាងទៀត កាលណា Hazard quotient មានតំលៃស្មើ ១ (HQ=1) នោះ បញ្ជាក់ថា មានវត្តមាននៃគ្រោះថ្នាក់ ។

ខ្សែអាហារ

Food chain: ការផ្ទេរថាមពលពីអ្នកផលិតដំបូងគេ (រុក្ខជាតិ) តាមរយៈសាពាំង្គកាយមួយសេរី ឬ លំដាប់ ដែលជាអ្នកស៊ី នឹងត្រូវបានគេស៊ីបន្ត ហើយដែលសន្មតថា សាពាំង្គកាយនីមួយៗចិញ្ចឹមជីវិតដោយស៊ីតែសាពាំង្គផ្សេងៗទៀតមួយប្រភេទប៉ុណ្ណោះ (ឧទាហរណ៍ វឌ្ឍនកម្មនៃជន្លេន គ្រលីងគ្រលោងចាប និងស្លាំង) ។ នៅក្នុងដំណាក់កាលនៃការប្រើ

ប្រាស់ថាមពល ត្រូវបានបំលែងជាកំដៅ ដែលកំណត់ចំនួនដំណាក់កាល ឬវគ្គ ឬកំរិតជីជាតិ (Trophic level) នៅក្នុងចង្វាក់អាហារជា ៤ ឬ ៥ ។ មូលដ្ឋាននៃការទទួលស្គាល់ចង្វាក់អាហារ គឺពពួកស៊ុីសរីរាង្គរស់ និងពពួកស៊ុីសរីរាង្គស្លាប់ (ពពួកចំពារ ឬបំបែកធាតុ) ។ អន្តរអំពើទាំងនេះ កើតឡើងនៅក្នុងបណ្តាញចំណីអាហារដ៏ស្មុគស្មាញមួយ ។

គ្មានអុកស៊ីសែន

Anaerobic: (1) លក្ខខណ្ឌបរិស្ថាន ដែលក្នុងនោះគ្មានវត្តមានអុកស៊ីសែន

(2) សាពាង្គកាយដែលអាចរស់នៅបាន ដោយគ្មានវត្តមានអុកស៊ីសែន

(3) ដំណើរការដែលអាចកើតមានឡើងបាននៅក្នុងលក្ខខណ្ឌដែលគ្មានអុកស៊ីសែន ។

គ្រោះថ្នាក់អាចនឹងកើតមាន ការប្រថុយ

Risk

Risk estimate: ការបង្ហាញ ឬបញ្ជាក់ថា បរិមាណតាមរយៈប្រូបាប៊ីលីតេ នៃឥទ្ធិពលមិនល្អ ដែលកើតឡើងពីការដាក់ដោយផ្ទាល់ទៅនឹងបរិស្ថាន ដែលមានកំហាប់នៃសារធាតុពុលមួយ ។

ចំរុះ នានាភាព

Diversity

Diversity indices: រង្វាស់ផ្សេងៗ ដែលត្រូវបានគេប្រើប្រាស់សំរាប់គណនា ចំរុះភាពនៃប្រភេទរបស់លំនៅដ្ឋានធម្មជាតិមួយជាកំណត់ ។ ជាទូទៅ កាលណា diversity indices កាន់តែធំគឺបញ្ជាក់ថាប្រព័ន្ធអេកូឡូស៊ីកាន់តែមានសុខភាពល្អ ។

ចែកជាភាគ

fragmentation: ដែលជាលទ្ធផលនៃការកែប្រែ ឬការបំលែងទេសភាព ដោយការរំខាន ឬប៉ះពាល់ ។

ចំណោត

Slope

Slope gradient:
គឺជាជ្រុងដែលផ្ទៃរាបនៃផ្ទៃខាងលើ ទ្រេត ឬចោត ប្រៀបធៀបទៅនឹងបណ្តែងដេក ។ ឧទាហរណ៍ ចំណោតស្មើរាបស្មើ (Mearly level slopes) មានកំរិតចោត (Stope gradient) ពី 0-3% ហើយចំណោតខ្លាំង មានកំរិតចោតពី ៣0-៦៥%

ជលធរណីវិទ្យា

Hydrogeology: ការសិក្សាអំពីចលនានៃទឹកក្រោមដីឆ្លងកាត់សារធាតុដីធម្មជាតិ ។

ជីវៈចំរុះ

Biodiversity: ជាពាក្យ ដែលត្រូវបានគេប្រើប្រាស់ដើម្បីពិពណ៌នានូវរាល់ទស្សនៈទាននៃភាពចំរុះប្រភេទនៃអេកូឡូស៊ី ជាពិសេស គឺរាប់បញ្ចូលនូវភាពសម្បូរនៃប្រភេទភាពស្មុគស្មាញនៃប្រព័ន្ធអេកូឡូស៊ី និងនានាភាពនៃសេនេទិច ។ រង្វាស់ដែលមានទំហំធំ ឬខ្ពស់នៃ biodiversity ។ ជាទូទៅគេចាត់ទុកថាជាសន្ទស្សន៍បញ្ជាក់អំពីសុខភាពដ៏ល្អប្រសើរនៅក្នុងប្រព័ន្ធអេកូឡូស៊ី

ជំរាបទឹក

Infiltration : ចលនានៃទឹកលើដី ទៅក្នុងដី ឬថ្ម តាមរយៈក្រហែងបែក ឬចន្លោះប្រហោងផ្សេងៗ ។

ផលិតភាព

Productivity: អត្រាផលិត ជីវម៉ាស (Biomass) ដោយរុក្ខជាតិរស់ជាទំរង់សារធាតុសរីរាង្គ ដែលភាគច្រើន ត្រូវបានប្រើប្រាស់ជាចំណីអាហារ ។

ការជ្រើសរើស ការកេណ្ឌ

Recruitment ចំនួនបន្ថែម ឬការបន្តពូជនីនៃឯកត្តៈនីមួយៗទៅក្នុងសារព័ន្ធ (Population) ។

ដែលគ្មានជីវិត

Abiotic: នៃផ្នែកដែលគ្មានជីវិត

ដងជ្រើមទឹក

Aquifer: តួអង្គ ឬបន្តុំ (Body) នៃថ្ម គ្រួស (gravel) ខ្សាច់ដែលជ្រាបទឹក ហើយដែលមានសមត្ថភាពអាចផ្ទុកបរិមាណទឹកដ៏ច្រើន ដែលក្រោលពីក្រោមដោយរូបធាតុមិនជ្រាបទឹក ហើយដែលតាមរយៈបន្តុំទឹកនេះ (Body) ទឹកក្រោមដីត្រូវបានគេទាញយក ។

ដីអិនអេ/អាដេអិន

DNA (Deixyribonucleic acid)" ម៉ូលេគុលអាស៊ីដនុយក្លេអិចដ៏ស្មុគស្មាញមួយ ។ វាគឺជារូបធាតុសេនេទិចនៃគ្រប់សាពាង្គកាយទាំងអស់ ។

ដែលមានខ្យល់/ដែលមានអុកស៊ីសែន

Aerobic: (1) លក្ខខ័ណ្ឌបរិស្ថានដែលក្នុងនោះមានអុកស៊ីសែន

(2) សាពាង្គកាយដែលចាំបាច់ត្រូវការអុកស៊ីសែនសំរាប់ជីវិតរស់នៅ

(3) ដំណើរដែលអាចកើតមានឡើងបាន តែក្នុងលក្ខខណ្ឌ ដែលមានវត្តមានអុកស៊ីសែន ។

ដែលមានកំណត់

Finite: ដែលមានកំរិត ឬកំណត់ ។

ដីវិទ្យា

Pedology: ការសិក្សាជាលក្ខណៈវិទ្យាសាស្ត្រអំពីលក្ខណៈទូទៅ ប្រភព និងចំណាត់ថ្នាក់នៃដី ។

ដៃទន្លេ

Tributary: ជាទូទៅគឺជាផ្លូវទឹកតូចៗ ដែលហូរចាក់ទៅផ្លូវទឹកមួយផ្សេងទៀត ដែលមានទំហំធំជាង ។

តំបន់

Endemi: គឺជាប្រភេទក្នុងស្រុក ជារឿយៗ គឺជាប្រភេទដែលមានកំណើតនៅក្នុងលំដាប់នៃស្ថានភាពភូមិសាស្ត្រកំណត់មួយ ។

ថលជលិក

Amphibian: សត្វឆ្អឹងកងដែលមានឈាមត្រជាក់ស្ថិតក្នុងថ្នាក់ Amphibia ដែលអាចរស់នៅក្នុងទឹកក៏បាន និងលើគោកក៏បាន ។
លក្ខណៈមួយចំនួនរបស់ វារួមមាន :

1) នៅពេលពេញវ័យរស់នៅលើដី ប៉ុន្តែត្រឡប់ទៅក្នុងទឹកវិញនៅពេលបង្កកំណើត

2) អាចប្រើប្រាស់ស្បែក និងមាត់សំរាប់បន្ធូរអុកស៊ីសែននៅក្នុងទឹក

3) ក្រពេញស្បែកគ្មានរោម ស្រកា ឬស្លាប់

4) ស៊ុតញាស់បង្កើនជាកូនញាស់ដែលរស់នៅក្នុងទឹក ។

ថ្នាំពុលកសិកម្ម (ដេដេតេ)

DDT; (Dichloro-Diphenyli-Trichloroethane, or 1, 1, 1-Trichloro-2,2-bislp-chlorophenyl)" គឺជាថ្នាំសំរាប់សត្វល្អិតមួយប្រភេទ ដែលមានសារធាតុសរីរាង្គ និងក្លរ (organochlorinated pestiside) . DDT អាចមានជាទំរង់ p,p'-DDT nigo,p'-DDT ។ ជាទូទៅ DDT បានដល់វត្តមាននៃ DDT ទាំងអស់ដែលមានទំរង់មេតាបូលីកបញ្ចូលគ្នា (លើកលែងតែមានករណីបញ្ជាក់ផ្សេងៗពីនេះ) ។ DDT គឺជាថ្នាំគីមី ដែលមានកំរិតពុលខ្លាំង និងជាអង្គធាតុសមាសដែលមានទំរង់ធន់យូរអង្វែង ពោលគឺមិនងាយបែកធាតុ (Persistem chemical compound) ។

ទំនាបលិចទឹក

Floodplain: គឺជាតំបន់ទំនាបជាប់ដងទន្លេ ស្ទឹង ឬផ្លូវទឹក ដែលនៅលើនោះទឹកជំនន់តែងតែគ្របដណ្តប់ ។ តំបន់នេះកើតឡើងពីកំណកដីល្បាប់ ដែលមានលក្ខណៈធូរ (Unconsolidated material) ដែលជាទូទៅ រងធ្លាក់ចុះពីទឹកជំនន់ក្នុងពេលមុន ។ ទំហំនៃទំនាបលិចទឹកនេះ ប្រែប្រួលទៅតាមមាឌ ឬទំហំទឹកជំនន់ ហើយហេតុនេះ ទើបវាត្រូវបានកំណត់ដោយទំហំនៃតំបន់ជំនន់នីមួយៗ ។ ឧទាហរណ៍ តំបន់ទំនាបលិចទឹកចំនួន ១០ដង ក្នុងរយៈពេល ១០ឆ្នាំ (10 years floodplain) នឹងត្រូវកំណត់ដោយទឹកជំនន់ ដែលធំជាងគេ ដែលបានកើតឡើងជាមធ្យមរាងរាល់ឆ្នាំម្តង ។

ទឹកក្រោមដី

Groundwater: ទឹកដែលកើតមាននៅក្នុងដី ដែលស្ថិតនៅក្នុងចន្លោះប្រហោងលំហរនៃសីលាស្រទាប់ក្រោម និងសារធាតុខនិជនៃដីស្ថិតនៅជាប់ពីលើសីលាស្រទាប់ក្រោម (Bedrock) នេះ ។

ទឹកប្រៃ

Saltwater

Saltwater intrusion (Salinisation): ការជ្រាប ឬហូរចូលនៃទឹកប្រៃទៅក្នុងប្រព័ន្ធអេកូឡូស៊ីតំបន់ទឹកសាប ដែលជាលទ្ធផលបង្កឡើងដោយការរំខាននៃមនុស្ស ឬធម្មជាតិ ឬកិច្ចអភិវឌ្ឍន៍ដោយសកម្មភាពមនុស្ស ។ ការប្រែប្រួល គឺកំហុក ឬរបៀបនៃសមាសភាពប្រភេទ អាចកើតមានឡើង ។

ទឹកក្រោមដី

Water column: ជំហរនៃទឹកតាមបែបទស្សនទាន (A conceptual column of water) ពីផ្ទៃលើនៃទឹកបឹងរហូតដល់បាតបឹង ដែលជាកំណកដី ។

ទឹកក្រោមដី

Water table: កំរិតខ្ពស់ជាងគេនៅក្នុងដីនៃទឹកក្រោមដី ។water tuble បង្កើតជាព្រំប្រទល់រវាងតំបន ដែលឆ្អែតដោយទឹក (Zone of saturation) (គ្មានអុកស៊ីសែន) និងតំបន់ដែលមានប្រហោយខ្យល់ (Zone of aerating) (មានវត្តមានអុកស៊ីសែន) ។

Watershed: សូមអានពាក្យ Catchment ។

ធរណីវិទ្យា/ភូគព្ភសាស្ត្រ

Geology: វិទ្យាសាស្ត្រដែលទាក់ទិនទៅនឹងប្រវត្តិនៃភពផែនដី និងជីវិតរបស់វា ពិសេសគឺព័ត៌មានដែលកត់ត្រានៅក្នុងសីលាផ្សេងៗ ។

ធារាសាស្ត្រ

Hydrology: វិទ្យាសាស្ត្រសិក្សាអំពីទឹកនៅលើនៅក្នុង និងនៅពីខាងលើតំបន់មួយនៃភពផែនដី រួមមាន របាយទឹក ការវិលចុះឡើង (Circulation) នៃទឹក លក្ខណៈរូបរូប និងគីមីនៃទឹក ព្រមទាំងប្រតិកម្មនៃបរិស្ថានជាមួយទឹកខ្លួនឯងផងដែរ ។

ធនធាន

Resource

Resource exploitation: ការប្រើប្រាស់ ឬការធ្វើអាជីវកម្មធនធានធម្មជាតិមួយ ដែលលើសពីសមត្ថភាពនៃធនធាននោះក្នុងការបន្តពូជ ឬមានវត្តមាននៅក្នុងប្រព័ន្ធអេកូឡូស៊ី។

នៃគុណភាព

Qualitative: ដែលជាការអធិប្បាយ ដែលមិនអាចរាប់បាន

នៃបរិមាណ

Quantitative: ដែលអាចរាប់បាន ផ្អែកលើការរាប់ការវាស់វែង ។

និរន្តរភាព

Sustainable

Sustainable yield: បរិមាណនៃធនធានមួយជាកំណត់ ដែលអាចផលិតជាអចិន្ត្រៃយ៍ដោយចីរភាព ក្រោមវិធីសាស្ត្រគ្រប់គ្រងមួយ (ដូចជា ការកំណត់អត្រាដកហូត ឬប្រមូលផលអោយស្មើគ្នាទៅនឹង អត្រាផលិតដោយធម្មជាតិ) ។ តួលេខនៃទិន្នផលដោយនិរន្តរភាពសំរាប់រយៈពេលវែងមួយ (ឧទាហរណ៍ បរិមាណឈើដែលបានកាប់រំលំ) ដែលគេអាចជ្រើសរើស ដើម្បីអោយស្របគ្នាទៅនឹងការគ្រប់គ្រង ដែលបានកំណត់ទុកជាមុន និងគោលដៅនៃសង្គម ។

បដិបក្ខភាព ភាពផ្ទុយគ្នា

(Antagonism) : ហេតុភូតដែលក្នុងនោះ កំរិតពុលនៃល្បាយធាតុគីមីមួយទាបជាងកំរិតពុល ដែលបានរំពឹងទុកចេញពីការបូកផ្សំនៃកំរិតពុលនៃធាតុគីមីនីមួយៗនៅក្នុងល្បាយនោះ ។

បង់តូស

Benthos : បណ្តុំនៃសាពាំង្គកាយមួយចំនួន (រួមមានរុក្ខជាតិ និងសត្វ) រស់នៅក្នុង ឬលើកំណកដីល្បាប់នៃលំនៅដ្ឋានធម្មជាតិទឹក ។

បណ្តុំជីវៈ

Bioaccumulation: ពាក្យទូទៅប្រើសំរាប់អធិប្បាយ អំពីដំណើរការ ដែលតាមរយៈនោះធាតុគីមីទាំងឡាយ ត្រូវបានទាញយកដោយផ្ទាល់ពីទឹកដោយសាពាំង្គកាយទឹក ។ របៀបនៃការទាញយកនេះ រួមមានការស៊ីចំណីអាហារ និងកំណកដីល្បាប់ដែលមានផ្ទុកធាតុគីមី ។

ប្រសព្វគ្នា (ទន្លេ)

Confluence: ចំណុចដែលនៅទីនោះ ចរន្តទឹកហូរនៃអាងទឹកលើដីពីរ (water bodies) (ដូចជា ទន្លេ ស្ទឹង ឬផ្លូវទឹក តូចៗ) ជួបគ្នា ហើយហូររួមគ្នា ។

ប្រភេទសត្វស៊ីសំណល់សរីរាង្គនៃសារពាង្គកាយនានា

Detrivore

Detrital feeders ប្រភេទដែលចិញ្ចឹមជីវិតដោយស៊ីសរីរាង្គស្លាប់នៅស្រស់ ឬរលួយនៃរុក្ខជាតិ ឬសត្វ ។

ប្រភេទត្រីនាំចូល

Exotic fish species: គឺជាប្រភេទត្រីទាំងឡាយដែលមិនមែនជាប្រភេទក្នុងស្រុក ហើយត្រូវបាននាំចូលពីខាងក្រៅ ឬពីក្រៅប្រទេស ។ ជួនកាលប្រភេទនាំចូលនេះ អាចប្រជែងរស់យ៉ាងជោគជ័យទៅលើប្រភេទក្នុងស្រុក ដោយសារវាធន់ទៅនឹងជំងឺផ្សេងៗ (ឬកត្តាកំណត់ប្រជាសាស្ត្រផ្សេងៗ ទៀត " Population-limiting " ជាងប្រភេទក្នុងស្រុក ។

បណ្តាញអាហារ

Food web: គឺជាឱ្យាក្រាមជាទស្សទាន ដែលតាងអោយទំនាក់ទំនងនៃការចិញ្ចឹមជីវិតរបស់សាពាំង្គទាំងឡាយនៅក្នុងប្រព័ន្ធអេកូឡូស៊ីមួយ ។ វាផ្សំឡើងដោយសេរី ឬលំដាប់មួយចំនួននៃចង្វាក់អាហារដែលតភ្ជាប់គ្នាទៅវិញទៅមក ។

បឹងវិទ្យា

Limnology: ការសិក្សាជាលក្ខណៈវិទ្យាសាស្ត្រនៃអាងស្តុកទឹកសាប ដូចជា បឹងជាដើម ។

ប្រភេទ សមាសភាព

Species

Species composition: របាយនៃចំនួនប្រភេទ និងចំនួនឯកត: (individuals) នៃប្រភេទនីមួយៗ នៅក្នុងសហគមន៍មួយ ។

ភាពសម្បូណ៌នៃប្រភេទ៍

Species richness : ចំនួននៃប្រភេទនៅក្នុងតំបន់មួយ ដោយមិនរាប់បញ្ចូលនូវរបាយរបស់វាឡើយ ។

បំលែងកំរិតពុល

Transformation rate: អត្រាដែលធាតុគីមីធ្វើការបំលែងទ្រង់ទ្រាយនៅក្នុងតំបន់ដីសើម ។ ការឡើងចុះកំរិតកំពស់ទឹក និងការស្រូបយកជីជាតិ អាចជះឥទ្ធិពលទៅលើកំរិតបំលែងជាតិពុលនេះ ។

ប្រព័ន្ធទឹកហូរ

Water budget

តុល្យភាពនៃទឹកដែលហូរចូល និងហូរចេញ នៅក្នុងប្រព័ន្ធអេកូឡូស៊ីតំបន់ដីសើមមួយ ។

ប៉ារ៉ាម៉ែត

Parameter : ការប្រែប្រួលផ្សេងៗ ការបញ្ជាក់ន័យ ឬលក្ខណៈរូបសាស្ត្រនៃការកំណត់ ការប្រែប្រួល ឬលក្ខណៈ ដែលត្រូវបានគេដាក់បញ្ចូលគ្នានូវលក្ខណៈ និងតួនាទីនៃប្រព័ន្ធអេកូឡូស៊ីមួយ ។ ជាទូទៅ Parameter មានលក្ខណៈអាចអោយគេវាស់បានដូចជា បរិមាណអុកស៊ីសែនរលាយក្នុងទឹកជាដើម ។

អាងរងទឹកភ្លៀង

Catchment: គឺជាតំបន់ដែលពីទីនោះ ផ្លូវទឹកលើដី ឬប្រព័ន្ធទឹកក្រោមដី ទទួលទឹកពីប្រព័ន្ធបង្ហូរទឹកនៅក្នុងអាងនៃបឹង ឬស្ទឹង ទន្លេ ។ Catchment ប្រមូល និងបង្ហូរទឹកចេញតាមរយៈច្រកចេញ ឬមាត់មួយ ។ ព្រំប្រទល់នៃ catchment ជាទូទៅកំណត់ដោយខ្សែរយៈកំពស់ ឬ ឋានលេខានៃតំបន់ខ្ពស់ ។

ពាម

Estuary: អាងស្តុកទឹកនៅតាមតំបន់ឆ្នេរសមុទ្រ ដែលអាចតភ្ជាប់ដោយផ្លូវទឹកមួយ ឬច្រើន ទៅនឹងសមុទ្រ ហើយដែលទីនោះទឹកសាប គឺបានមកពីប្រព័ន្ធបង្ហូរទឹកនៅលើដី (Land drainage) លាយឡំជាមួយនឹងទឹកប្រៃ ។ Estuaries ជាទូទៅតែងតែទទួលរងសកម្មភាពទឹកជោរ-នាច ហើយមានតំលៃខ្ពស់ ដែលជាថ្នាលប្រព័ន្ធអេកូឡូស៊ីមួយសំរាប់ជីវិតជាច្រើនប្រភេទ ដែលរស់នៅក្នុងទឹកសមុទ្រ ។

ពពួកសត្វ

Fauna : សហគមន៍សត្វនៅក្នុងលំនៅដ្ឋានធម្មជាតិ ឬតំបន់ណាមួយ ។

ពពួករុក្ខជាតិ

Flora: សហគមន៍រុក្ខជាតិនៅក្នុងតំបន់ ឬលំនៅដ្ឋានធម្មជាតិណាមួយ ។

ភាវៈរស់

Biota: គ្រប់សាពាំង្គកាយមានជីវិតទាំងអស់ (រុក្ខជាតិ សត្វ ផ្សិត និងមីក្រូសាពាំង្គកាយទាំងឡាយ) ដែលមាននៅក្នុងតំបន់នីមួយៗ ។

ភក់ ល្បាប់ម៉ដ្ដ

Siltation (Sedimentation): ការធ្លាក់រងចុះនិងកករគរលើគ្នានៃកំទេចកំទីដី ដែលបានទទួលការហូរច្រោះ ឬរេចរឹល នៅក្នុងទឹកព្រែកតូចៗ បឹង ទន្លេ ឬអាងស្តុកទឹកផ្សេងៗទៀត ។ បាតុភូត Siltation នៅក្នុងបរិស្ថាន ទឹក អាចមានផលប៉ះពាល់បរិស្ថានដ៏អាក្រក់ ដូចជា ការកាប់ដីបាតទឹកដែលជាកន្លែងត្រីពង ឬបង្កើនភាពល្អក់កករ (Turbidity) ដែលអាចប៉ះពាល់ដល់ការដកដង្ហើមនៃសាពាំង្គកាយរស់នៅក្នុងទឹកទាំងឡាយ ។

ភក់ សំណល់

Sludge: សមាសភាពនៃអង្គធាតុរឹង និងអង្គធាតុរាវ ដែលជាលទ្ធផលនៃដំណើរការប្រព្រឹត្តកម្មទឹកសំអុយ ដោយមិនបានទទួលរងនូវការធ្វើអោយខាប់ដោយប្រព្រឹត្តកម្មរូប ឬគីមី មុនពេលធ្វើប្រព្រឹត្តកម្មទឹកសំអុយ ។

ភាពពុល

Toxicity: សក្តានុពលដែលមាននៅក្នុងសារធាតុជីវៈ ឬគីមីមួយ ក្នុងការបង្កឥទ្ធិពលអាក្រក់ទៅលើសាពាំង្គកាយមានជីវិតនៅពេលដែលសាពាំង្គកាយនោះ ត្រូវបានគេដាក់ដោយផ្ទាល់ទៅលើសារធាតុនោះ ។

ការធ្វើពិសោធន៍សាកល្បងកំរិតពុលអាចត្រូវបានគេប្រើប្រាស់ ដើម្បីវាស់ឥទ្ធិពល ប៉ះពាល់នៃសារធាតុមួយទៅលើក្រុមសាពាំង្គកាយមួយប្រភេទ ដែលបានជ្រើសរើសនៅក្រោមលក្ខខណ្ឌកំណត់មួយ ។ ការធ្វើពិសោធន៍សាកល្បងកំរិតពុលនៅក្នុងទឹក ជាទូទៅអាចវាស់ a) សមាមាត្រនៃសាពាំង្គកាយដែលទទួលរងឥទ្ធិពល ឬ b) កំរិតនៃឥទ្ធិពលជះ បន្ទាប់ពីការដាក់ដោយផ្ទាល់ទៅនឹងសារធាតុមួយដាក់ណាត់ ដែលគេធ្វើការសាកល្បង (ឧទាហរណ៍ សំណាកគំរូនៃកំណាកដីល្បាប់ ឬកាកសំណល់រាវ) ។

ភាពជ្រាបទឹក

Permeability គឺជារង្វាស់មួយនៃភាពងាយស្រួលដែលជាមួយនោះឧស្ម័ន ឬវត្ថុរាវ អាចជ្រាប ឬឆ្លងកាត់ប្រហោងខ្យល់មួយចំនួននៃសារធាតុមួយ ។ នៅក្នុងដី Permeability នេះ ត្រូវបានគេកំណត់ដោយទំហំ រប្បេបតភ្ជាប់ (arrangement) និងសមាសភាពនៃគ្រាប់ដី (Soil particles) និងដោយកំរិតនៃភាពហាប់នៃដី ។

ភ្លៀងអាស៊ីដ

Acid rain: ទឹកភ្លៀងដែលមាន pH ទាបជាង ៥.៦ ។ កំរិតកើនឡើងនៃជាតិអាស៊ីដអាចបង្កឡើងដោយធម្មជាតិ (ដូចជា ដោយសារការបញ្ចេញឧស្ម័ននៅក្នុងពេលមានបន្ទុះភ្នំភ្លើង) ឬដោយ ការរំខានដោយមនុស្ស (ដូចជា ចំហេះឥណ្ធនៈ ឬធាតុរេះផ្សេងៗ....) ។

មំសាសី

Carnivore: សត្វទាំងឡាយ ដែលស៊ីតែសាច់សត្វផ្សេងៗទៀត (មាំង្សាសត្វ) ។

មហន្តរាយ

Catatrophe

Catastrophic: ការប៉ះពាល់ ឬការរំខានធ្ងន់ធ្ងរដែលកើតមានភ្លាមៗ និងវិសាមញ្ញ (មានកំរិតខ្ពស់កើតឡើងមិនញឹកញាប់ ឬឃ្លាតៗម្តង "Low frequency " ។

មេតាបូលីស

Metabolism: រាល់ដំណើរការគីមីទាំងអស់ ដែលកើតឡើងនៅក្នុងសាពាំង្គកាយទាំងដំណើរការធ្វើសំយោគ និងបំបែកសារធាតុសរីរាង្គ រួមមាន ការរំលាយអាហារជាដើម ។

រំហួតចំហាយទឹក

Evapotranspiration: គឺជាចលនានៃទឹកពីដី ឬរុក្ខជាតិនីមួយៗ និងសហគមន៏រុក្ខជាតិ (Plent commumities) ទៅក្នុងបរិយាកាសតាមរយៈ ការបំភាយជាចំហាយ (Evaporation) នៃទឹកពីដី និងការបំភាយនៃទឹកតាមរយៈដំណើររស្មីសំយោគ (Transpiration) ដោយរុក្ខជាតិ ។

រ៉ាមសារ

Ramsar : អនុសញ្ញាស្តីអំពី តំបន់ដីសើម ដែលបានចុះហត្ថលេខានៅ Ramsar ប្រទេសអៀរ៉ង់ ក្នុងឆ្នាំ ១៩៧១ គឺជាសន្ធិសញ្ញាអន្តរជាតិ ដែលផ្តល់ក្របខណ្ឌ សំរាប់សកម្មភាពថ្នាក់ជាតិ និង កិច្ចសហប្រតិបត្តិការណ៏អន្តរជាតិ ក្នុងការអនុវត្តអនុសញ្ញា និងការប្រើប្រាស់ដ៏សមស្របចំពោះតំបន់ដីសើម និងធនធានរបស់វា ។ រហូតមកទល់បច្ចុប្បន្ននេះ ឈ្មោះនៃអនុសញ្ញានេះ ត្រូវបានគេសរសេរថា អនុសញ្ញា ស្តីពីតំបន់ដីសើម “(Convention on wetlands (Ramsar, Iran, 1971) “ ដែលត្រូវបានគេស្គាល់ និងនិយមប្រើប្រាស់ជាអនុសញ្ញា Ramsar “Ramsar Convention” ។ បច្ចុប្បន្ននេះ អនុសញ្ញានេះ មានភាគីចុះកិច្ចសន្យាចំនួន ១២៨ ដែលមានតំបន់ដីសើមចំនួន ១០៩០កន្លែង មានផ្ទៃដីសរុប ៨២,៤ លាន ហិកតា ដែលត្រូវបានគេកំណត់នៅក្នុងតារាងតំបន់ដីសើម ដែលមានសារៈសំខាន់ថ្នាក់អន្តរជាតិ Ramsar (Ramsar List of Wetland of International Importance) ។

រស្មីសំយោគ

Photosynthesis: គឺជាដំណើរការដែលតាមរយៈនោះ រុក្ខជាតិធ្វើការបំលែង CO_2 និង H_2O ទៅជាកាបូអ៊ីដ្រាត (Carbohydrates) និងសមាធាតុផ្សេងៗទៀត ដោយប្រើប្រាស់ជាថាមពលពីព្រះអាទិត្យ

រំភាយចំហាយទឹក

Plant transpiration: ការបាត់បង់ចំហាយទឹកពីរុក្ខជាតិទៅក្នុងបរិយាកាស ។

ល្បាប់

Alluvium

Alluvial deposits:

កំទេចកំទីដែលហូរនាំមកដោយ ស្ទឹង ទន្លេ ឬផ្លូវទឹកផ្សេងៗ ហើយរងធ្លាក់ចុះបង្កើតបានជា ទំនាបលិចទឹកនៅជាប់នឹងទន្លេ ឬផ្លូវទឹកទាំងនោះ ។

លំនឹង តុល្យភាព

Equilibrium : គឺជាប្រព័ន្ធមួយដែលស្ថិតក្នុងភាពលំនឹង ឬស្ថេរភាពជាមួយនឹងធនធាន និងលទ្ធផល (inputs and outputs matching) ។ លក្ខខ័ណ្ឌនៃភាពនឹងថ្កល់ ឬប្រែប្រួលតិច (Conditions of stasis) ។

លំនៅឋាន ជំរក

Habitat : ការប្រែប្រួល ឬការបែកបាក់ខូចខាតនៃលំនៅដ្ឋានធម្មជាតិ ទៅលើជាកោះដាច់ៗពីគ្នា ។

លំហោស ភាពស្ពោត

Porosity : ភាពដែលអាចជ្រាបអង្គធាតុរាវ ឬឧស្ម័ននៃសារធាតុមួយ ហើយដែលបានឆ្លុះបញ្ចាំង ឬគិតជាមាឌនៃលំហ ដែលបំពេញប្រហោងចន្លោះរវាងគ្រាប់ដី (Soil particles)

លីពីត

Lipid : ម៉ូលេគុលខ្លាញ់ ឬប្រេង

វិភាគ

Analyse : ផ្នែកណាមួយជាកំណត់ដែលត្រូវបានវាស់វែងនៅក្នុងការវិភាគគីមី ។ គឺអ្វីដែលត្រូវបានគេកត់សំគាល់ និងកំណត់បរិមាណនៅក្នុងដំណើរការវិភាគសំណាកគំរូ (sample) ។

វិនីទ្រីកម្ម

Denitrification: ការបាត់បង់អាសូតតាមរយៈការបំលែងរបស់វាផលិតផលឧស្ម័ន (ដែលសំខាន់ជាងគេនោះ គឺម៉ូលេគុល អាសូត “ N “ និងអាសូតអុកស៊ីត “ N_2O “) ។ ដំណើរការនេះ គឺធ្វើឡើងដោយពពួកមីក្រូសាពាង្គកាយ (បាក់តេរី) នៅក្នុងលក្ខខណ្ឌបរិស្ថានមួយ ដែលគ្មានអុកស៊ីសែន ។

PHOTO: L&L

សហគមន៏

Community: ក្នុងន័យអេកូឡូស៊ី គឺជាសាពាង្គកាយមានជីវិតទាំងឡាយនៃប្រព័ន្ធអេកូឡូស៊ីពិសេសមួយ ពោលគឺ ជាពិភពរុក្ខជាតិ សត្វ ផ្សិត និងមីក្រូសាពាង្គកាយ ។

សារធាតុបំពុល

Contaminant

Contaminant sink : គឺជាប្រព័ន្ធមួយ (ឧទាហរណ៏ តំបន់ដីសើមមួយ) ដែលត្រូវបានគេប្រើប្រាស់ជាអាងស្តុកទុកទាំងស្រុងនូវសារធាតុកខ្វក់ 9ជ្សនតាមិនានតសច ណាមួយជាកំណត់ ។ ឬដោយប្រើពាក្យម៉្យាងទៀត ធាតុគីមីដែលបង្ហូរចូលប្រព័ន្ធនេះមានបរិមាណដ៏ច្រើនលើសលប់ បើប្រៀបទៅនឹងបរិមាណធាតុគីមីដែលបង្ហូរចេញ ។

ស៊ីតូប្លាស

Cytoplasm : ផ្នែកផ្សំ ដែលមានជីវិតនៃកោសិកាក្រៅពីនុយក្លេអ៊ែរ ។

ស្ថានប្រពន្ធ័

Ecosystem : គឺជាក្រុមមួយប្រព័ន្ធមានជីវិត និងគ្មានជីវិត ដែលមានអន្តរអំពើទៅលើគ្នាទៅវិញទៅមក បង្កើតបានជាប្រព័ន្ធមួយមានស្ថេរភាព ។ តាមទស្សនៈទានជាមូលដ្ឋាននោះគឺ រាប់បញ្ចូលនូវទឹក និងវដ្តនៃជីជាតិ ចរន្តនៃថាមពលតាមរយៈចង្វាក់អាហារ និងបណ្តាញអាហារ (Food webs) ។ ជាទូទៅប្រព័ន្ធអេកូឡូស៊ី (Ecosystem) មួយគឺជាប្រព័ន្ធនៃដំណើរការថាមពល និងការបង្កើនជីជាតិ ដែលផ្នែកនីមួយៗរបស់វាពាក់ព័ន្ធទៅនឹងរយៈពេលមួយដ៏វែង ។ គោលការណ៏នៃប្រព័ន្ធអេកូឡូស៊ីអាចត្រូវបានគេយកទៅអនុវត្តនៅគ្រប់កំរិតទាំងអស់ ពីត្រពាំងនីមួយៗរហូតដល់បឹង សមុទ្រ និងផែនដីទាំងមូល ។

សេនេទិច
Genetic

Gene pool : គឺជា សែនសរុបទាំងអស់នៃសត្វ ឬរុក្ខជាតិបង្កាត់នីមួយៗនៅក្នុងប្រជាសាស្ត្រ (Population) នៅក្នុងពេលតែមួយ ។

សំរាម
Litter

Litter production: ការប្រមូលផ្តុំដោយធម្មជាតិ នៃស្រទាប់លើដីក្នុងតំបន់ព្រៃឈើ ។ សំរាមផ្សំឡើងពីសារធាតុសរីរាង្គដែលមិនទាន់បែកធាតុក្នុងទំរង់ជាចំណែកនៃដីស្រទាប់លើ (ស្លឹក មែកតូច ដែលបានធ្លាក់ចុះពីគំរបស្លឹកនៃដើមឈើ) ។ សំរាមគឺជាប្រភពដំបូងបង្អស់នៃសារធាតុសរីរាង្គចំពោះដីព្រៃឈើ ។

សារធាតុចិញ្ចឹម
Nutrient

សារធាតុចិញ្ចឹមសរីរាង្គ
Nutrient budget: ការពិពណ៌នាមួយ អំពីបរិមាណដែលបានដាក់ បាត់បង់ និងបរិមាណជីរ ដូចជា ផូស្វ័រ កាបូន អាសូត ដែលវិលវល់ ឬចូលទៅក្នុងប្រព័ន្ធអេកូឡូស៊ីមួយ ។

សារធាតុចិញ្ចឹមបន្ត
Nutrient cycling: គន្លងផ្លូវធរណី ជីវៈ គីមី នៃជីជាតិជីវៈសំខាន់ ដូចជា កាបូន អាសូត និងអុកស៊ីសែននៅក្នុងមណ្ឌលជីវៈ។ គន្លងផ្លូវ ឬផ្លូវឆ្លងកាត់នេះ រួមមាន ការស្រូបយកជីជាតិ ការបំលែងជីជាតិ

ការប្រើប្រាស់ជីជាតិ និងការបញ្ចេញចោល ដោយសាពាំង្គកាយ “A “ ហើយបន្ទាប់មក បញ្ជូនទៅ និងស្រូបយកដោយសាពាំង្គកាយ “B “ ។

សត្វរំពា
Predator

Predatory: សត្វដែលតោង សំលាប់ និងស៊ីសត្វផ្សេងៗទៀត

សំយោគ
Synthesis

Synthesize : ការផ្សំគ្នានូវធាតុផ្សំនីមួយៗ អោយទៅជាសមាសធាតុមួយ (A unified whole) ។ ជាពិសេស គឺដំណើរការនៃការចងសម្ព័ន្ធសមាសធាតុគីមីពីសារធាតុ ដែលផ្សំឡើងដោយប្រតិកម្មគីមីមួយឬច្រើន ។

សំណល់រាវបង្ហូរចេញ
Effluent : គឺជាកាកសំណល់ដ៏ស្មុគស្មាញមួយ (ដូចជា កាកសំណល់រាវចេញពីរោងចក្រឧស្សាហកម្ម ឬទឹកសំអុយ) ដែលអាចត្រូវបានគេទាត់ចោលទៅក្នុងបរិស្ថាន ។

សមត្ថភាពការងារ
Energy : សមត្ថភាពក្នុងការបំពេញការងារ ។

អាងស្តុកទឹក (បាសាំង)
Basin : តំបន់ទំនាបដែលគ្មាន ឬមានច្រកបង្ហូរចេញតិចតួចបំផុត សំរាប់ទឹកលើដី ឧទាហរណ៍ រួមមាន អាង បឹង ឬទន្លេណាមួយ ។

អឺត្រូភីកាស្យុង
Eutrophication: គឺជាជីជាតិធម្មជាតិ ឬជារឿយៗជាការបង្កដោយមនុស្ស ទៅក្នុងអាងស្តុកទឹក ដែលបណ្តាលអោយមានអត្រាផលិតកម្មសារធាតុសរីរាង្គខ្ពស់ ។ Eutrophication បង្កើតអោយមានឥទ្ធិពលប៉ះពាល់ផ្សេងៗទៀត (side effects) ជាច្រើនដែលគេមិនបានរំពឹងទុកជាមុន រួមមាន

បន្តុំនៃពពួកស្លែ ដែលមានការលូតលាស់ខ្លាំង (Alqal blooms) ការិតអុកស៊ីសែន ទាបទៅតាមរដូវ និងបន្ថយការរស់នៅនៃត្រី និងពពួកសត្វឥតឆ្អឹងកងរស់នៅក្នុងទឹកផ្សេងៗទៀត ។

អ្នកកាត់បន្ថយ
Reductionist : ទ្រឹស្តីមួយដែលគ្រប់ប្រព័ន្ធស្មុគ្រស្មាញទាំងអស់ អាចត្រូវបានគេយល់យ៉ាងច្បាស់នូវផ្នែកទាំងឡាយរបស់វា ។ ឬម៉្យាងទៀត ការរុករក ឬស្វែងរក ដើម្បីធ្វើការកាត់បន្ថយទិន្នន័យ ឬបាតុភូតដែលមានលក្ខណៈស្មុគស្មាញអោយក្លាយទៅជាលក្ខខណ្ឌមួយ ដែលមានភាពងាយយល់ (Simple terms) ។

អាចកើតឡើងវិញ
Renewable : ធនធានជីវៈទាំងឡាយ ដែលមានសមត្ថភាពអាចកើតឡើងជាថ្មីវិញ ដោយគ្មានកំណត់ (នៅក្នុងកំឡុងពេលមួយនៃមនុស្សមួយជំនាន់ៗ) ដោយសន្មតថា មានការអនុញ្ញាត ឬ ទទួលយកលើបញ្ហានេះ ពីសំណាក់កំលាំងទូទៅនៃបរិស្ថានសង្គម និងនយោបាយ ។

Dichlorodiphenel :ផលិតផលមួយដែលបានមកពីការបែកធាតុដោយធម្មជាតិនៃ DDT ។

di-chloroethylene (DDE)

ឌីអុកស៊ីន
Dioxin : ក្រុមមួយនៃធាតុគីមី ដែលមានចំនួនប្រហែល ៧៥ ប្រភេទនៃគ្រួសារ ក្លរីលោភីតឌីបង់សូឌីអុកស៊ីន (Chlorinated debenzodioxin famity) ។ សារធាតុ ២, ៣, ៧, ៨-TCDD គឺត្រូវបានគេចាត់ទុកថាជាទំរង់ដែលមានការិតពុលខ្លាំងជាងគេបំផុត ។ គឺជា ផ្នែកទូទៅមួយនៃកាកសំណល់រាវចេញពីរោងចក្រផលិតម្សៅប្រដាស ។

ឧស្ម័នផ្ទះកញ្ចក់
Greenhouse gases: ឧស្ម័នសំគាល់ (Trace gases) មួយចំនួននៅក្នុងបរិយាកាស ដែលរក្សាសីតុណ្ហភាពភពផែនដីអោយនៅការិតមធ្យមដែលយើងមានសព្វថ្ងៃនេះ ។ ឧស្ម័នទាំងនេះត្រូវបានគេហៅថា “greenhouse gases “ ហើយប្រភេទសំខាន់ជាងគេដែលទទួលរងតទ្ធិពលដោយផ្ទាល់ពីសកម្មភាពរបស់មនុស្ស គឺឧស្ម័នកាបូនិច មេតាន អាសូតអុកស៊ីត និង CFCs-Chlorinated fluorocarbons ដូចជា Freon ។ បរិមាណនៃឧស្ម័នផ្ទះកញ្ចក់ គឺជាលំនឹង ឬតុល្យភាពមួយរវាងអ្វីដែលបញ្ចាក់ថា តើក្នុងល្បឿនល្បឿនប៉ុណ្ណា ដែលឧស្ម័ននេះ ត្រូវបានបញ្ចេញទៅក្នុងបរិយាកាស (ប្រភព) និងអ្វីដែលបញ្ចាក់ថា តើវាបាត់បង់ទៅវិញនៅក្នុងល្បឿនល្បឿនការិតណាដែរ ។ យើងទាំងអស់គ្នា កំពុងចាប់អារម្មណ៍អំពី អ្វីដែលថាតើសកម្មភាពរបស់មនុស្សអ្វីខ្លះដែលកំពុងធ្វើអោយប្រែប្រួលការិតកើតឡើងដោយធម្មជាតិនៃឧស្ម័នកាបូនិច និងមេតាន ។

Phreactic zone : ស្រទាប់ក្រោមផ្ទៃលើ ដែលក្នុងនោះរាល់សត្វឥតឆ្អឹងកងទាំងអស់ ត្រូវបានបំពេញដោយទឹក ដែលមានសំពាធធំជាងសំពាធបរិយាកាស ។ ក្នុងសិលាផ្សេងៗ ការិតនៃភាពស្មោតជះឥទ្ធិពលលើលទ្ធភាពនៃឧស្ម័ន ឬអង្គធាតុរាវ ធ្វើចលនាឆ្លងកាត់សិលា ឬដី ។

Taxa richness :ចំនួននៃថ្នាក់នីមួយៗ (Individual taxa) ដែលបានប្រមូលនៅស្ថានីយ៍ស្រង់សំណាកគំរូ (Sampling station) ។ តួលេខនេះ អាចជាតំណាងនៃសម្បូរណ្ណភាពមធ្យមមួយ (Amean richness) ឬសម្បូរណ្ណភាពនៃក្រុម ឬសហគមន៍មួយ (A pooled rechness) ។

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ABBREVIATIONS AND ACRONYMS

អក្សរកាត់

ACAPE អង្គការ ACAPE (Association Cambodgienne d'Approvisionnement en Eau)

ACCB មជ្ឈមណ្ឌលអង្គរ សំរាប់ការអភិរក្សជីវៈចំរុះ (Angkor Center for the Conservation of Biodiversity)

ADB ធនាគារអភិវឌ្ឍន៍អាស៊ី (Asian Development Bank)

AEAM ការគ្រប់គ្រង និង វាយតំលៃការប្រែប្រួលបរិស្ថាន (Adaptive Environmental Assessment and Management)

AJA សមាគម AJL (Association de la Jeunesse pour l'Animation)

ATT អាងត្រពាំងធំ (Ang Trapeang Thom)

AOX អាឡូសែនសរីរាង្គដែលស្រូបយកបាន (Adsorbable Organic Halogens)

APDO អង្គការចូលរួមអភិវឌ្ឍន៍អង្គរ (Angkor Participatory Development Organization)

AWC អង្គការជំរឿនបក្សីទឹកអាស៊ី (Asian Waterfowl Census)

BC ការប្រមូលផ្តុំតំរុយ (Benchmark Concentration)

BDP ផែនការអភិវឌ្ឍន៍អាងស្តុក (Basin Development Plan)

BFD អង្គការព្រះពុទ្ធសាសនា សំរាប់អភិវឌ្ឍន៍ (Buddhism for Development)

BFDKT អង្គការព្រះពុទ្ធសាសនា សំរាប់អភិវឌ្ឍន៍ខេត្តកំពង់ធំ (Buddhism for Development Kompong Thom)

BOD តំរូវការ អុកស៊ីសែនជីវៈ (Biological Oxygen Demand)

CEA ការវាយតំលៃឥទ្ធិពលកើនឡើង (Cumulative Effects Assessment)

CEARC ក្រុមប្រឹក្សាស្រាវជ្រាវវាយតំលៃបរិស្ថាននៃប្រទេសកាណាដា (Canadian Environmental Assessment Research Council)

CED សហគមន៍អភិវឌ្ឍន៍សេដ្ឋកិច្ច (Community Economic Development)

CEIA ការវាយតំលៃហេតុប៉ះពាល់បរិស្ថានកើនឡើង (Cumulative Environmental Impact Assessment)

CEQ ក្រុមប្រឹក្សា គុណភាពបរិស្ថាន (សហរដ្ឋអាមេរិក) (Council on Environmental Quality "United States of America")

CEPA សមាគមអភិរក្សបរិស្ថាន និងវប្បធម៌ (Culture and Environment Preservation Association)

CFDS សេវាកម្មអភិវឌ្ឍន៍គ្រួសារកម្ពុជា (Cambodian Family Development Services)

CITES អនុសញ្ញាស្តីពី ការធ្វើពាណិជ្ជកម្មអន្តរជាតិចំពោះប្រភេទសត្វ និង រុក្ខជាតិ ជិតផុតពូជ (Convention on International Trade in Endangered Species of Wild Fauna and Flora)

CLEC មជ្ឈមណ្ឌលអប់រំច្បាប់សហគមន៍ (Community Legal Education Centre)

CNMC គណៈកម្មាធិការជាតិទន្លេមេគង្គ កម្ពុជា (Cambodian National Mekong Committee)

CSARO អង្គការសហគមន៍កែច្នៃ និងអនាម័យសហគមន៍ " ស្គារ៉ូ " (Community Sanitation and Recycling Organization)

DAC សមាគមអភិវឌ្ឍន៍កម្ពុជា (Development Association of Cambodia)

DOF រដ្ឋបាលជលផល (Department of Fisheries)

DPKS កម្មវិធីអភិវឌ្ឍនសិស្ស និស្សិតខ្មែរ (Development Program for Khmer Students)

EA ការវាយតំលៃបរិស្ថាន (Environmental Assessment)

EC/SPEC អង្គការ SPEC/EC (European Commission Support for the Environment Sector in Cambodia)

EE ការអប់រំបរិស្ថាន (Environmental Education)

EP កម្មវិធីបរិស្ថាន (Environment Program)

C50 ការប្រមូលផ្តុំតទ្ធិពល (សំរាប់ ៥0% សារពាង្គកាយដែលធ្វើពិសោធន៏) (Effect Concentration "for 50% of the test organisms")

EEC ការប្រមូលផ្តុំបរិស្ថានដែលរំពឹងទុក (Expected Environmental Concentration)

EEM ការតាមដានប្រសិទ្ធភាពបរិស្ថាន (Environmental Effects Monitoring)

EES សេចក្តីថ្លែងការណ៏ពីតទ្ធិពលបរិស្ថាន (Environmental Effects Statement)

EIA ការវាយតំលៃហេតុប៉ះពាល់បរិស្ថាន (Environmental Impact Assessment)

EIED សេចក្តីសំរេចនៃការវាយតំលៃហេតុប៉ះពាល់បរិស្ថាន (តាមរយៈ OEPP ប្រទេសថៃ) Environmental Impact Evaluation Decision (through OEPP , Thailand)

EIS សេចក្តីថ្លែងការផលប៉ះពាល់បរិស្ថាន (Environmental Impact Statement)

EMS ប្រព័ន្ធគ្រប់គ្រងបរិស្ថាន (Environmental Management System)

EPDO អង្គការអភិវឌ្ឍន៏ និងការពារបរិស្ថាន (Environment Protection and Development Organization)

ETP កម្មវិធីបណ្តុះបណ្តាលបរិស្ថាន (Environment Training Program)

EPT សន្ទស្សន៏ អេម៉ុបផ្ទៃរ៉ា.ផ្លេកុបផ្ទៃរ៉ា.ទ្រីកុបផ្ទៃរ៉ា (Ephemoptera, Plecoptera, Tricoptera Index)

ERA ការវាយតំលៃគ្រោះថ្នាក់បរិស្ថាន (Ecological Risk Assessment)

FACT សម័ន្ធភាពដើម្បីអភិរក្សធនធានជលផល (Fisheries Action Coalition Team)

FAO អង្គការស្បៀងអាហារ និងកសិកម្មសហប្រជាជាតិ (Food and Agriculture Organization)

FCC អង្គការអនាគតកុមារកម្ពុជា (Future for Cambodian Children)

FIMC គណៈកម្មាធិការគ្រប់គ្រងវិនិយោគទុនបរទេស (រដ្ឋាភិបាលឡាវ)

(Foreign Investment Management Committee "Government of Lao PDR")

FP កម្មវិធីជលផល (Fisheries Program)

GECKO ការិយាល័យបរិស្ថាន ចុងឃ្នៀស (Great Environment Chhong Kneas Office)

GEF ស្ថានភាពបរិស្ថានទាំងមូល GEF (Global Environment Facility)

GIS ប្រព័ន្ធព័តិមានភូមិសាស្ត្រ (geogrpahic information system)

GNP ផលទុនជាតិ (Gross National Product)

GPS ស្ថានភាពប្រព័ន្ធទាំងមូល GPS (global positioning system)

HQ ផលចែកសារធាតុពុល (Hazard Quotient)

IAA ភ្នាក់ងារជំនួយអន្តរជាតិ (International Assisting Agency)

ICF អង្គការមូលនិធិអភិរក្សសត្វក្រៀលអន្តរជាតិ ICF (international Crane Foundation)

IEE ការត្រួតពិនិត្យបរិស្ថានដំបូង (Initial Environmental Examination)

IFReDI វិទ្យាស្ថានអភិវឌ្ឍន៏ និងស្រាវជ្រាវជលផលទឹកសាប (Inland Fisheries Research and Development Institute)

IJF មូលនិធិសារព័តិមានឯករាជ្យ (Independent Journalism Foundation)

IMWG ក្រុមការងារអន្តរៈក្រសួង (រដ្ឋាភិបាលឡាវ) (Inter-Ministerial Working Group "Government of Lao PDR")

IUCN សហភាពអន្តរជាតិសំរាប់ការអភិរក្សធនធានធម្មជាតិ (International Union For Conservation of Nature And Natural Resources)

Koc មេគុណអុកតាណុល-ទឹក (Water-Octanol Coefficient)

ISO អង្គការអន្តរជាតិសំរាប់រៀបចំស្តង់ដា (International Organization for Standardization Designation)

JICA ទីភ្នាក់ងារសហប្រតិបត្តិការអន្តរជាតិជប៉ុន (Japan International Cooperation Agency)

PNKA សមាគមភ្នំនាងកង្រី (Phnom Neang Kangrei Association)

Lao PDR សាធារណៈរដ្ឋប្រជាមានិត ប្រជាធិបតេយ្យឡាវ (Lao People's Democratic Republic)

LC50 ការប្រមូលផ្តុំសារពាង្គកាយស្លាប់(គិតយក ៥0%នៃសារពាង្គកាយដែលធ្វើពិសោធន៏) (Lethal Concentration (for 50% of the test organisms))

LEP ច្បាប់ស្តីពីការការពារបរិស្ថាន (វៀតណាម) (Law on Environmental Protection "Vietnam") '

LMB អាងទន្លេមេគង្គខាងក្រោម (Lower Mekong Basin)

LLEE អង្គការ ការអប់រំស្តីពី ការរស់នៅជាមួយបរិស្ថាន (Live and Learn Environmental Education)

LNMC គណៈកម្មាធិការជាតិមេគង្គ ឡាវ (Lao National Mekong Committee)

LOEC ការប្រមូលផ្តុំប្រសិទ្ធភាពតាមការអង្កេតទាបបំផុត (Lowest Observable Effects Concentration)

MAFF ក្រសួងកសិកម្ម រុក្ខាប្រម៉ាញ់ និងនេសាទ (Ministry of Agriculture Forestry and Fisheries)

Tree planting

PHOTO: L&L

MDGs គោលដៅអភិវឌ្ឍន៍សហសវត្ស (Millennium Development Goals)

MOEYS ក្រសួងអប់រំ យុវជន និងកីឡា (Ministry of Education,Youth and Sport)

MOE ក្រសួងបរិស្ថាន (Ministry of Environment)

MOP ក្រសួងផែនការ (Ministry of Planning)

MOSTE ក្រសួងវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងបរិស្ថាន (វៀតណាម និង ថៃ) Ministry of Science, Technology and Environment (Thailand and Vietnam)

MOU អនុស្សរណៈនៃការយោគយល់ (Memorandum of Understanding)

MOWRAM ក្រសួងធនធានទឹក និងឧតុនិយម (Ministry of Water Resources and Meteorology)

MRB អាងទន្លេមេគង្គ (Mekong River Basin)

MRC គណៈកម្មការទន្លេមេគង្គ (Mekong River Commission)

MRCS លេខាធិការដ្ឋាននៃគណៈកម្មាធិការទន្លេមេគង្គ (Mekong River Commission Secretariat)

NEAP ផែនការសកម្មភាពបរិស្ថានជាតិកម្ពុជា (National Environment Action Plan "Cambodia")

NEEAC យុទ្ធនាការផ្សព្វផ្សាយ និងអប់រំបរិស្ថានថ្នាក់ជាតិ (National Environmental Education and Awareness Campaign)

NEPA នយោបាយបរិស្ថានជាតិ (សហរដ្ឋអាមេរិក) (National Environment Policy "United States of America")

NEQA ការអភិរក្សនិងកែលំអសេចក្តីសំរេចពីគុណភាពបរិស្ថានជាតិ (ប្រទេសថៃ) (Enhancement and Conservation of the National Environmental Quality Act "Thailand")

NGO អង្គការមិនមែនរដ្ឋាភិបាល (Non Government Organization)

NRM គ្រប់គ្រងធនធានធម្មជាតិ (Natural Resource Management)

NOEC ការប្រមូលផ្តុំប្រសិទ្ធភាពមិនបានអង្កេត (No Observable Effects Concentration)

OEPP ការិយាល័យនយោបាយ និងផែនការបរិស្ថាន (ប្រទេសថៃ)

(Office of Environmental Policy and Planning "Thailand")

PDA សកម្មភាពសាកល្បងរយៈខ្លី (Pilot and Demonstration Activity)

PDE មន្ទីរបរិស្ថានខេត្ត (Provincial Department of Environment)

PIO ការិយាល័យអនុវត្តន៍គំរោង (project implementation office)

PIU អង្គភាពរឹ ផ្នែកអនុវត្តន៍គំរោង (project implementation unit)

PPPs នយោបាយ ផែនការ និងកម្មវិធី (Policies, Plans and Programs)

Coconut beehive

PRC សាធារណៈរដ្ឋប្រជាមានិតចិន (People's Republic of China)

RAP ការវាយតំលៃនៃការយល់ដឹង (Rapid Assessment of Perceptions)

RCEDO អង្គការ អភិវឌ្ឍន៍បរិស្ថានសហគមន៍ជនបទ (Rural Community Environment Development Organization)

RRFAs សកម្មភាពអនាគតដែលប្រមើលទុកជាមុនតាមហេតុផល (Reasonably Foreseeable Future Actions)

RUPP សាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ (Royal University of Phnom Penh)

SEA ការវាយតំលៃយុទ្ធសាស្ត្របរិស្ថាន (Strategic Environmental Assessment)

SEA សមាគមសេវាកម្មសមណៈគ្មានព្រំដែន (Samanak Service Endlessness Association)

SEIs ផលប៉ះពាល់បរិស្ថានសំខាន់ (Significant Environmental Impacts)

SIPAR អង្គការ ស៊ីប៉ា (Soutien a l'Iniative Pour l'Aide a la Reconstruction)

SoE សកម្មភាពបរិស្ថាន (State of the Environment)

SPEC អង្គការគាំទ្រផ្នែកបរិស្ថាននៅកម្ពុជា សហគមន៍អឺរ៉ុប (European Commission Support for the Environment Sector in Cambodia)

SSP ស្ត្រីសន្តិភាព ដើម្បីបរិស្ថាន (Strey Santepheap Deiombeiy Parethan)

STEA ទីភ្នាក់ងារវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងបរិស្ថាន (ឡាវ) (Science, Technology and

Environment Agency “Lao PDR”)

TCH អង្គភាពសំរបសំរួលបច្ចេកទេស (Technical Coordination Unit)

TNMC គណៈកម្មាធិការជាតិទន្លេមេគង្គថៃ (Thai National Mekong Committee)

TOC កាបោនសរីរាង្គសរុប (Total Organic Carbon)

TOR ឯកសារយោង (Terms of Reference)

TSBR បំបនីយជីវមណ្ឌលបឹងទន្លេសាប (Tonle Sap Biosphere Reserve)

TSBR លេខាធិការដ្ឋានបំបនីយជីវមណ្ឌលបឹងទន្លេសាប (Tonle Sap Biosphere Reserve Secretariat)

TSBS យុទ្ធសាស្ត្រអាងបឹងទន្លេសាប (Tonle Sap Basin Strategy)

TSCP គំរោងអភិរក្សបឹងទន្លេសាប (Tonle Sap Conservation Project)

TSEMP គំរោងគ្រប់គ្រងបរិស្ថានបឹងទន្លេសាប (Tonle Sap Environmental Management Project)

TSI កំរងគំរោងបឹងទន្លេសាប (Tonle Sap Initiative)

TSS សារធាតុកករអណ្តែតសរុប /សារធាតុកករិលរិលវល់ (Total Suspended Solids)

UNDP អង្គការ កម្មវិធីអភិវឌ្ឍន៍សហប្រជាជាតិ (United Nations Development Program)

UNEP អង្គការ កម្មវិធីបរិស្ថានសហប្រជាជាតិ (United Nations Environment Program)

UNESCO អង្គការ សហប្រជាតិសំរាប់អប់រំ វិទ្យាសស្ត្រ និងវប្បធម៌ ” យូណេស្កូ ” (United Nations Educational, Scientific and Cultural Organisation)

UNICEF អង្គការ មូនិធិកុមាររបស់អង្គការសហប្រជាជាតិ (United Nations Children’s Fund)

USEPA ទីភ្នាក់ងារការពារបរិស្ថានសហរដ្ឋអាមេរិក (United States Environmental Protection Agency)

VECs សមាសភាគប្រព័ន្ធបរិស្ថាន និងបរិស្ថានដែលបានវាយតំលៃ (Valued Environmental / Ecosystem Components)

VNMC គណៈកម្មាធិការជាតិទន្លេមេគង្គវៀតណាម (Vietnam National Mekong Committee)

VSG ក្រុមគាំទ្រភូមិ (Village Support Group)

WAP កម្មវិធីយល់ដឹងពីបញ្ហាទឹក (Water Awareness Programme)

WCS អង្គការអភិរក្សសត្វព្រៃ (Wildlife Conservation Society)

WEC អង្គការអប់រំពិភពលោក កម្ពុជា (World Education Cambodia)

WFC មជ្ឈមណ្ឌលជលផលពិភពលោក (World Fish Center)

WHO អង្គការសុខភាពពិភពលោក (World Health Organization)

WPO ការិយាល័យការពារសត្វព្រៃ (Wildlife Protection Office)

WUP កម្មវិធីប្រើប្រាស់ទឹក (Water Utilisation Program)

WWF អង្គការ មូលនិធិពិភពលោកសំរាប់អភិរក្សធម្មជាតិ (World Wide Fund for Nature)

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DIRECTORY

DIRECTORY

The following is a list of government institutions, multilateral agencies, bilateral donors and non-governmental organisations involved in environmental education in Cambodia. It includes information from the Cooperation Committee for Cambodia and is based on the directory contained in a status report on Cambodia's environmental education published in 2006 as part of the Tonle Sap Management Project.

Angkor Center for the Conservation of Biodiversity (ACCB)

Siem Reap

Education centre with a library and classroom at the foot of Phnom Kbal Spean. Affiliated with the Ministry of Agriculture, Forestry and Fisheries, Germany's Stiftung Artenschutz and Allwetterzoo in Munster, the center especially aims to help preserve small, inconspicuous or "ugly" species. Runs a beekeeping program in villages between Kbal Spean and Siem Reap and is considering a breed and release program for endangered species. Plans public displays of confiscated wildlife and workshops for adults and children to increase environmental awareness.

accb@stiftung-artenshutz.de

Angkor Participatory Development Organization (APDO)

Siem Reap

Established by former United Nations Volunteers in 2000, APDO is involved in community activities around Angkor. Its project for sustainable human resource development aims to "enhance rural capacity" to alleviate poverty and support village self-reliance for socio-economic, cultural, and environmental development.

Tek Sakan Savuth, Director
Email: apdo@camintel.com
Website: www.apdoangkor.org
0630, Group 12, Wat Bo village, Salar Kamroek Commune, Siem Reap

Association Cambodgienne d'Approvisionnement en Eau (ACAPE)

Phnom Penh

ACAPE has been implementing water projects in Cambodia since 1988 and developed a professional training team in 1991. Established as a local NGO in 1995, it has experience in the fields of community water supply and sanitation. It operates in Banteay Meanchey, Kompong Thom, Kompong Speu, Pursat, Kampot and Kandal provinces.

Ros Saroeun, Director
Tel: (023) 802 131
E-mail: acape@forum.org.kh #282, Northbridge St, Sleng Roleung, Teuk Thla, Phnom Penh

Association de la Jeunesse pour l'Animation (AJA)

Phnom Penh

Authorised by the Ministry of Interior in 1988, AJA coordinate plans for academic education as part of Accueil Cambodgien. Its Maison des Jeunes Cambodgiens in Kampot provides foreign-language education and extra classes for school subjects as well as computing, sports and other programs. The association also provides education on health and the environment.

Mao Kolbtr, Director
Tel: 881 363/016 880 593 E-mail: aja@forum.org.khaja, mjc@forum.com.kh
#99, St. 608, Boeung Kork II, Tuol Kork, Phnom Penh

Bondos Komar

Phnom Penh

Set up by French NGO Partage, Bondos Komar has been operating since 1999. It supports government primary and pre-schools through projects ranging from school construction and rehabilitation to sanitation, hygiene, health education and vegetable gardens. Bondos Komar works in Pursat, Kandal, Kompong Speu, and Takeo provinces.

Kong Sarom, Director Tel: 216 023
Fax: 215 591 E-mail: bondoskomar@camnet.com.kh #6, St. 388, Tuol Svay Prey I, Chamkar Morn, Phnom Penh

Buddhism for Development (BFD)

Battambang

BFD was founded by Indapanno Bhikhu, Heng Mony Chenda and a group of monks at the Site 2 refugee camp in Thailand in 1990. Now based at a wat in Battambang, its goal is to achieve sustainable socio-economic development of the population of northwest Cambodia. In addition to Battambang, it operates in Banteay Meanchey, Pailin, Siem Reap, Kompong Thom, Preah Vihear and Phnom Penh.

Heng Monychenda, Director
Tel: (053) 370 041
E-mail: bfdkhmer@camintel.com
Web: www.bfdkhmer.org
Wat Anlongville, Srok Sangke, Battambang

Buddhism for Development Kompong Thom (BFDK)

Kompong Thom

Registered as an NGO since 2000, Buddhism for Development Kompong Thom is involved in community-forestry and organic-farming projects. Venerable Ly Khom started its activities at Vor Yeav in 1997 with the establishment of savings groups in three villages, two rice banks and a pagoda-based tree nursery.

Ly Khom, Director Tel: 012 734 467
E-mail: 012 734467@mobitel.com.kh
National Road 6, Kompong Thom

Community Economic Development (CED)

Kratie

Registered with the Ministry of Interior in 2003, CED works in an area targeting 67 villages, 16 communes and four districts in Kratie. It has three main programs involved in non-formal

education, health education and integrated agriculture and animal husbandry. Other activities include natural resource preservation.

Yos Pheary, Team Coordinator
E-mail: cedcam@camintel.com
St. 3, Tropang Pring, Kratie

Community Legal Education Centre (CLEC)

Phnom Penh

CLEC provides education, advocacy and other legal services. It was created in 1996 as legal resource centre promoting the rule of law, justice and democracy. From 1996 to 2001, it operated under the University of San Francisco Law School and was funded by the United States Agency for International Development (USAID). In 2002, it registered as a local NGO. CLEC has a public-interest legal advocacy project focussing on land and natural resources. Work is mainly in Ratanakiri and Mondulkiri provinces.

Yeng Virak, Executive Director
Tel: 211 723
E-mail: clec@online.com.kh
Web: http://www.bigpond.com.kh/users/usfpp/CLEC_home.htm
#56, St. 306, Boeung Kang Kang 1, Phnom Penh

Community Sanitation and Recycling Organization (CSARO)

Phnom Penh

Founded in 1997, CSARO aims to raise sanitary, health and environmental standards and generate new opportunities for those engaged in solid waste management. Work is focussed on Phnom Penh.

Heng You Kora, Programme Director
Tel/Fax: 023 211 116 E-mail: csaro@online.com.kh Web: http://www.bigpond.com.kh/users/csaro/organization_info.htm
#71, St. 368/163, Tuol Svay Prey 1, Chamkar Morn, Phnom Penh

Culture and Environment Preservation Association (CEVA)

Phnom Penh

Established in 1995 and registered as an NGO the following year, CEVAS provides training on environmental and natural resource management to university students, NGO staff and government officers. Target areas are Phnom Penh and Stung Treng. Activities included community forestry and fisheries, the Sesan Protection Network and river-based management.

Tep Bunnarith, Acting Director
Tel/Fax: (023) 369 179/720 062
E-mail: cepa@online.com.kh
Web: www.cepa-cambodia.org
#40, St. 352, Boeung Kang Korng, Chamkar Morn, Phnom Penh

Development Association of Cambodia (DAC)

Phnom Penh

Started in 1994 and registered with the Ministry of Interior in 1999, the association has a cooperation agreement on non-formal education with the Ministry of Education Youth and Sport. It focuses on Pursat province and aims to provide vocational training on environment, democracy and human rights.

Po Tieng, Director
Tel: 016 555 144 / 012 923 642
E-mail: potiengdac@yahoo.com Kilo 6, St. 214/143, Boeung Prolit, 7 Makara, Phnom Penh

Development Program for Khmer Students (DPKS)

Pursat

Established by people with backgrounds in education, communications and child rights, DPKS supports children and young people with limited access to their rights. It registered with provincial authorities and the Ministry of Interior in 2000 and is involved in community forestry and environmental protection.

Lov Bunlieng, Director
Tel/Fax: 092 932 654
E-mail: dpkspur@yahoo.com
444, Phsar Chas, Peal Neak1, Sampao Meas, Pursat Province

Environment Protection and Development Organization (EPDO)

Pursat

Founded in 1998 with the support of national and international organizations in Pursat, EPDO works in the areas of good governance and poverty reduction. It is involved in community forestry and livelihoods activities and efforts to promote public participation in democracy.

Uth Samrith, Executive Director
Tel: 012 962 635 Fax: 052 951 665
E-mail: epdopur@yahoo.com
4, Peal Nhek, Phtas Prey Commune, Sam Poa Meas District, Pursat Province

Fisheries Action Coalition Team (FACT)

Phnom Penh

FACT was set up in 2003 by NGO members working on fisheries and environmental issues around the Tonle Sap. Established as part of an NGO Forum sub-working group on fisheries, it gained support from different international NGOs such as Oxfam and the Environmental Justice Foundation. In 2004, it separated from the NGO Forum. Working around the Tonle Sap and in coastal provinces, FACT conducts advocacy in the area of fisheries issues and monitors policy reform.

Mak Sithirith, Executive Director
Tel: (023) 992 044
E-mail: factpp@camnet.com.kh
Web: www.fact.org.kh 71, St. 592, Boeung Kak II, Khan Toul Kork, Phnom Penh

Food and Agriculture Organization (FAO)

Phnom Penh

The UN agency's mandate is to raise levels of nutrition, improve agricultural productivity, better the lives of rural populations and contribute to economic growth. In Cambodia, its activities included integrated pest management and resource management. The agency is particularly active in Siem Reap.

Tel: (855 23) 216 566
E-mail: fao@un.org.kh
Web:http://www.fao.org/countryprofiles/

House 5, Street 370, Boeung Keng Kang 1.
Phnom Penh

Future for Cambodian Children (FCC)

Siem Reap

Registered by the Ministry of Interior in 2000, FCC aims to educate children about art and culture. Its activities include shadow puppet theatre.

Ky Moeng, Executive Director
Tel: 012 920 506
E-mail: anakotkomar@hotmail.com
Web: www.h6.dion.ne.jp/fcc
Brasat Bakong, Siem Reap

Greater Environment Chong Khneas Office (Gecko Centre)

Siem Reap

Fixed floating structure established by the Food and Agricultural Organisation in 1999 to display fishing techniques and local livelihoods. Also has some small exhibits on biodiversity. About 5,000 students had visited the centre as of late 2005. By this time, groups of 16 primary students were visiting the centre once a week. The centre has also developed a video on protecting flooded forests as well as posters and signs.

Japan International Cooperation Agency (JICA)

Phnom Penh

Operating in Cambodia since 1993, the Japanese government agency has environmental resource management as one of its key objectives. JICA operates nationwide.

Mr. Juro Chikararaishi, Representative
Tel: 023 212 142 / 023 211 673 / 217129
Fax: 023 211 675 / 015 913 639
E-mail:jica@online.com.kh
Web: www.jica.org.kh
#440A/448Eo, Preah Monivong Boulevard,
Chamkar Morn, Phnom Penh

Live and Learn Environmental Education

Phnom Penh

Registered as a local NGO in 2005, Live and Learn Environmental Education promotes greater understanding and action toward human and environmental sustainability through education and dialogue building. The Ministry of Environment contracted Live and Learn to carry out a National Environmental Education and Awareness Campaign as part of the Tonle Sap Environmental Management Project in 2005 and 2006. Activities are focussed on Kompong Chhnang, Pursat, Battambang, Siem Reap and Kompong Thom.

Keat Bunthan, Environmental Education Officer; Chum Somonn, Media Officer
Tel: 023 224 053 E:livelearn@online.com.kh
Website: www.idea.org.au/liveandlearn/
364, Preah Monivong Blvd, Khan Chamkarmon, Phnom Penh

Ministry of Agriculture, Forestry and Fisheries

Phnom Penh

The ministry has a Department of Agricultural Extension and also extension staff in the forestry and fisheries departments.

Tel: (855) 23 211 351 Fax: 23 217 320
E-mail: maff@everyday.com.kh
Web: http://www.maff.gov.kh/
#200 Norodom Blvd, Sangkat Tonle Basak,
Khan Chamkarmorn, Phnom Penh

Ministry of Education, Youth and Sport

Phnom Penh

The ministry oversees the Faculty of Pedagogy which trains teaching methodology to graduates before they start teaching. A one-year curriculum includes basic environmental knowledge that can be integrated into professional teaching subjects.

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Ministry of Environment

Phnom Penh

The ministry has a Department of Environmental Education, Information and Communication. Its role is to improve environmental knowledge and awareness through formal and non-formal education to ensure that natural resources carefully managed and conserved in sustainable way. Under the department is an Environmental Education and Training Office set up in 1994,

Sou Savuth, Director, Department of Environmental Education, Information and Communication
Roath Sith, Chief Officer, Environmental Education and Training Office
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Fax: 23 212540
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48 Samdech Preah Sihanouk,
Tonle Bassac, Chamcar Mon, Phnom Penh

Ministry of Water Resources and Meteorology

Phnom Penh

The ministry conducts extension activities around the country.

Tel: (855 23) 724 327/882 160
E-mail: mowram@cambodia.gov.kh
Web: www.mowram.gov.kh
#47 Norodom Boulevard, Phnom Penh

Mlup Baitong

Phnom Penh

Mlup Baitong is one of the few NGOs in Cambodia with a specific focus on environmental education. Established by a British NGO in 1998, it was locally registered in 2001. It aims to increase environmental awareness and conservation through education, training, advocacy and other services to support the sustainable and equitable use of natural resources. It mainly works in Kompong Speu and Kompong Thom.

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NGO Forum

Phnom Penh

Started as an international campaign to end the aid embargo of Cambodia

in 1986, NGO Forum now focuses on national issues such as development policies and sustainable management of natural resources. It is involved in environmental awareness, forest livelihoods and the Sesan network.

Russell Peterson, Representative
Siv Senith, Deputy Representative
Tel: 023 986 269
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#9-11, St. 476, Toul Tompoung 1,
Phnom Penh

Osmose

Siem Reap

Osmose, is a not-for-profit association running an ecotourism project in Prek Toal, Tonle Sap Lake, Cambodia, which focuses on preserving and sustaining the waterbird colonies of the lake, while assisting in the development of the local communities. They also run ecotours to the site and villages, and carry out environmental education classes.

Address: PO Box 93045,
Siem Reap
Cambodia
Tel: 855 (0)12 832 812

Phnom Neang Kangrei Association (PNKA)

Kompong Chhnang

PNKA has been involved with community fishery and forestry projects in Kompong Chhnang province.

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Lor Teuk Trey Village,
Kompong Chhnang Commune,
Kompong Chhnang

Promvihearthor

Pursat

Set up in in Kandieng district in Pursat province in 2000, Promvihearthor is involved in sculpture, raising animals, and cultivating plants and vegetables. In addition to community forestry and agricultural activities, it works in the areas of human rights and HIV/AIDS.

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Peal Nhek 2, Phtas Prey Commune,
Sam Poa Meas District, Pursat province

Room to Read

Phnom Penh

Room to Read provides education to underprivileged children. In 2002, it began to set up libraries and computer labs in schools and community centres. It publishes books in the Khmer language, buys Khmer-language content and ships donated children's books from US publishers. Libraries are concentrated in Phnom Penh, Battambang and Siem Reap.

E-mail: donate@roomtoread.org
Web: http://www.roomtoread.org/cambodia

Royal University of Phnom Penh (RUPP)

Phnom Penh

The university's Department of Environmental Sciences offers a four-year degree program which emphasises environmental management. Streams are planned for Natural Resource Management and Urban Environmental Studies. With support from Danida and Roskilde University in Denmark as well as the Asian Institute of Technology in Thailand, the department has developed a curriculum of 33 courses. It has also conducted training courses in areas such as solid waste management and environmental management planning. The department has undertaken several research projects including fisheries management in Boeung Chhmar.

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Russian Confederation Blvd., Phnom Penh

Rural Community Environment Development Organization (RCEDO)

Banteay Meanchey

Registered with the Ministry of Interior in 1998 and the Ministry of Rural Development and Cambodian Development Council in 2003, RCEDO builds wells in Siem Reap and Oddor Meanchey. It is also involved in health education.

Sam Serey Wathana, Director
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E-mail: rcedobmc@forum.org.kh Road 59, Sophy, Kampong Svay, Sereisophon
Banteay Meanchey

Samanak Service Endlessness Association (SEA)

Battambang

Established at the Sangker pagoda in Battambang in 2003, SEA was registered by the Ministry of Interior in 2004. It aims to reduce and prevent pollution and the destruction of the environment and to improve knowledge of environmental protection.

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Save Cambodia's Wildlife (SCW)

Phnom Penh

Save Cambodia's Wildlife has a specific focus on environmental education. Registered as a local NGO in 2000, it aims to protect and conserve wildlife and habitats through education. Projects cover awareness, land mines, resource and livelihood rights and natural resource management. Work is focussed on Kampot, Koh Kong, Pursat, Stung Treng, Ratanakiri, Mondulkiri and Oddar Meanchey.

Lim Solinn - Director
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Phnom Penh

Soutien a l'Iniative Pour l'Aide a la Reconstruction (SIPAR)

Phnom Penh

SIPAR operates three mobile libraries around Phnom Penh and has been training librarians since 2000. A Khmer-language publishing program aims to

provide quality educational books at low prices. Titles in the "I want to know" series include a book on life around the Tonle Sap Lake.

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#9, St. 21, Tonle Basac, Chamkarmon, Phnom Penh

Srer Khmer

Phnom Penh

Srer Khmer helps farmers gain knowledge and strengthen their capacity to lead and manage their lives through approaches which build on understanding the relationship between agriculture, environment and rural societies. It works closely with farmers groups, government institutions and other NGOs.

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Phnom Penh

Strey Santepheap Deiombeiy Parethan (SSP)

Kratie

Formed in 2000 and registered with the Ministry of Interior in 2002, SSP educates people living in forest concessions about forestry law, especially communities rights and the obligations of concessionaires. Its work is focussed on Kratie, Mondulkiri, and Stung Treng provinces.

Uch Kimnary, Coordinator
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E-mail: sp_org@yahoo.com O'Russey 1, Kratie Province

United Nations Children's Fund (UNICEF)

Phnom Penh

The priorities of UNICEF's programme for Cambodia include ensuring the right of every child to a quality education by increasing access to learning opportunities and reducing disparities and gender gaps. The agency is actively involved in formal education and its approach to health education approach is relevant to environmental education.

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United Nations Educational, Scientific and Cultural Organization (UNESCO)

Phnom Penh

Cambodia joined UNESCO in 1951, six years after it was set up.The UN agency's approach to environmental education embraces all disciplines and covers all levels and types of education including life-long learning. Regional science activities including the Southeast Asia Biosphere Network are coordinated though its Jakarta office.

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Fax: (855-23) 42 61 63/ 21 70 22
Web Address: www.unesco.org
No. 38, Samdech Preah Sothearos Blvd, Phnom Penh

Village Support Group (VSG)

Battambang

Registered in 1995, the group ran a food security and relief program in Battambang before expanding into community development in 1997. Its activities include initiatives that focus on community environmental protection. The group focuses on Battambang and Banteay Meanchey provinces.

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Wetlands International

Phnom Penh

The Wetlands International program has been operating in Phnom Penh since 1996. Activities began with assistance to the government to accede to the Ramsar Convention. It has been working on a demonstration project to develop management zones, a legal framework and operational guidelines for Ream National Park. The program has also produced an Asian Wetland Inventory Manual.

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Wildlife Conservation Society (WCS)

Phnom Penh

The international organization began working in Cambodia in 1999 and became a local NGO in 2000. WCS wants to bring conservation to the forefront of science education, affirming that a solid understanding of how nature works is the right of each high school graduate and an obligation of every citizen in a democracy. Its work in Cambodia focuses on the northern plains and the eastern forests around the Tonle Sap.

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World Conservation Union (IUCN)

Phnom Penh

IUCN began working in Cambodia in 1992. It aims to develop a sustainable wetlands program for Stung Treng province, conserve mangrove forests,

promote the findings of the World Commission on Dams, and review protected areas and socio-economic development.

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World Education Cambodia (WEC)

Phnom Penh

WEC has provided training and human resource development in Cambodia since 1992, initially focussing on adults. Since 1998, its focus has been on basic education and teacher training. Work in the primary education sector includes teacher training and curriculum development in the field of life skills. Work is focussed on Kompong Cham and Prey Veng provinces

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Morn, Phnom Penh

World Wide Fund for Nature (WWF)

Phnom Penh

The World Wide Fund for Nature has been working in Cambodia since 1993 and opened an office in 1998. Conservation activities focus on the four areas of forest landscapes, freshwater ecosystems, coastal and marine ecosystems and species of special concern. Work is focussed on Ratanakiri, Mondulkiri, Kompong Speu, Stung Treng and Kratie.

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Source: Live and Learn Environmental Education

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ANNEX

THE TONLE SAP ENVIRONMENTAL MANAGEMENT PROJECT NEEAC PROGRAM BACKGROUND

TONLE SAP ENVIRONMENTAL MANAGEMENT PROJECT
NEEAC PROGRAM BACKGROUND

I. INTRODUCTION

A. THE PROJECT AND THE CAMPAIGN

The Tonle Sap Environment Management Project is a $20 million project jointly financed by the Asian Development Bank (ADB), United Nations agencies and the Royal Government of Cambodia. In June, 2005, the Ministry of Environment appointed Live and Learn Environmental Education Inc. to carry out a National Environment Education and Awareness Campaign on behalf of the project. Live & Learn is a non-profit organisation and incorporated in Melbourne, Australia. Based in Fiji, it also operates in Papua New Guinea, the Solomon Islands and Vanuatu as well as Cambodia and the Maldives.

Approved in 2002, the overall project has three parts – strengthening the management of natural resources, organising communities and conserving biodiversity in the Tonle Sap Biosphere Reserve. The 18-month education and awareness campaign led by Live and Learn supports the first part of the project and also ties in with the third part. This includes setting up coordination and information mechanisms for the reserve which was designated by United Nations Educational, Scientific and Cultural Organisation (UNESCO) in 1997.

Most of the Tonle Sap project is being financed by an ADB loan for $10.9 million, with the Cambodian government providing the equivalent of $3.9 million in local currency (about 1.6 billion riel). The Global Environment Facility of the United Nations has offered a separate $3.9 million grant and the United Nations Development Program (UNDP) is providing a grant of $623,000. To improve the regulation and management of inland fisheries, the ADB is offering a further $540,000 in the form of a technical assistance grant.

The campaign focuses on the environmental, economic and social aspects of the Tonle Sap as a source of food in an area with special hydrological features and specific threats. It targets the general public, decision makers, media, teachers and government agencies. The campaign uses existing networks, activities and materials with priority given to teachers, communities, journalists and decision makers.

B. CHALLENGES FACING THE TONLE SAP

With a dry season area of as little as 2,500 square kilometres, the Tonle Sap is the biggest lake in Southeast Asia. At the peak of the wet season, the lake expands to as much as 16,000 square kilometres with water levels rising by up to 10 metres. The vast areas of seasonally-flooded forests and shrub lands create a very high diversity of fish, reptiles, birds and mammals. Abundant fisheries directly support more than a million people.

With record numbers of people consuming more resources, the ADB is concerned that the Tonle Sap is under pressure. Problems include over-exploitation of fisheries and wildlife, dry-season encroachment and clearing of flooded forest areas. Damage to natural vegetation is destroying habitats, reducing water and soil quality and increasing siltation rates.

Between 40 percent and 60 percent of households in provinces around the lake are below the official poverty line, although the ratio is as high as 80 percent in some areas. The ADB has noted that many households are entirely dependent on fishing and foraging. Property disputes are common. Other challenges include a disproportionate number of households headed by women and significant numbers of ethnic minorities (Vietnamese and Muslims). The destruction of natural resources also has serious environmental implications for neighbouring countries.

"The Tonle Sap is most likely being exploited beyond sustainable limits," the ADB has warned. "In the last 20 years, transactions involving the Tonle Sap's natural resources – especially its

ANNEX–TONLE SAP ENVIRONMENTAL MANAGEMENT PROJECT–NEEAC PROGRAM BACKGROUND

fisheries – have been characterized by inequity, fraud, widespread corruption, environmental degradation from unsustainable patterns of exploitation and escalating conflict." The bank says further deterioration could have unpredictable consequences as irreversible damage to parts of the ecosystem by overfishing can cause fish catches to collapse suddenly. "Such a collapse would have serious social and welfare consequence," the ADB says, noting that fish provide most of the protein in Cambodian diets as well as supplementary income to buy rice.

C. STRATEGIES

In February, 2005, the ADB board in Manila approved a new country strategy and program for Cambodia. Under the package, Cambodia is scheduled to receive $104 million in loans and about $3.5 million in technical assistance grants in 2005 and 2006. The package has three pillars including "inclusive social development" – improving education, empowering vulnerable groups, controlling diseases, providing water and sanitation in rural areas and managing natural resources around he Tonle Sap.

In April 2005, the ADB said its Tonle Sap Basin Strategy formulated two years earlier would support its country strategy and program from 2005 to 2007. The bank said the strategy – which has "informing and listening" among its key operating principles – would be the basis for setting priorities and planning assistance to Cambodia over the next five to 10 years.

PHOTO: L&L

D. ENVIRONMENTAL EDUCATION INITIATIVES SO FAR

Environmental education in the Tonle Sap Biosphere Reserve is typically small, targeting local communities, teachers and primary students. Providers include the Food and Agriculture Organisation (FAO) and non-government agencies like Osmose, Mlup Baitong and Sangkrous Satprey. Other agencies, international organisations and government departments have less active roles. The UNDP has noted that environmental education in the area is still in its infancy. Moreover, the meaning of environmental education differs between organisations.

Working with Osmose and Mlup Baitong, the FAO in Siem Reap developed and published 1,000 copies of a training manual with 14 themes. To promote the manual, Osmose trained 40 teachers in two-day workshops. Mlup Baitong trained another 25 teachers to use parts of the manual in extra-curricular environmental clubs for primary students around Phnom Penh. Both organisations pay the teachers to include environmental education alongside school lessons. Mlup Baitong also broadcasts two 15-minute programs and a one-hour show from the Women's Media Centre twice a week. The impact of these programs has not been measured.

The FAO established a fixed floating exhibition center known as the Greater Environment Chhong Kneas Office (Gecko) Centre in Siem Reap in 1999. In 2005, groups of 16 primary students were visiting the centre for an hour each week. About 5,000 had attended a session of some sort. The FAO has also conducted non-formal education in fishing communities.

Among other initiatives, non-government agencies have held workshops for monks and developed training manuals with Buddhist themes. Cambodian Family Development Services, Support for the Reconstruction Aid Initiative (SIPAR) and Forum NGO have developed some materials, as have the environment departments of Pursat province and Battambang province which includes Prek Toal, one of the three core areas of the biosphere reserve. Community Sanitation and Recycling Organisation (CSARO) works on recycling in Phnom Penh and the Japan International Cooperation Agency (JICA) carries out environmental training for government officials.

E. PERCEPTIONS OF TONLE SAP ENVIRONMENTAL ISSUES

The assessment of Tonle Sap environmental issues in 2004 identified curricula, theatre, radio and visual materials as key education tools. These are all incorporated into NEEAC.

Most people living in the Tonle Sap region have a comprehensive knowledge of the environment but lack the power or money to do anything about it. The campaign therefore promotes greater understanding of the biosphere reserve among decision makers, religious leaders and government officials.

Even though water pollution poses public health hazards, people have different ideas about the importance of having a clean environment. Theatrical performances will seek to inform, educate and build a common understanding of the environment.

The traditional linear approach to environmental educational needs to be reassessed. Educational tools need to be action-oriented and, if possible, streamlined into school curricula.

Sustainable development of the Tonle Sap is poorly understood. The benefits

of taking action and the dangers of not doing anything should be highlighted among decision makers, religious leaders and government officials.

Educating people about the environment can backfire. If people feel more responsible towards the environment, they need to have more power.

Bureaucracy and inertia restrict change. Corruption complicates efforts to achieve long-term improvements supported by political will.

Responsibility for environmental education is split between the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment and the Ministry of Education,Youth and Sports. Efforts will be made to strengthen ties between the ministries to achieve a more harmonious approach.

Environmental education means different things to different people. New terms are proliferating and need to be explained. Education tools should highlight the importance of developing the economy, education and civil society.

The Ministry of Education, Youth and Sports is reluctant to support environmental education unless it is seen as a cost-effective way of meeting priority objectives. The campaign could integrate educational tools into the ministry's "child friendly school initiative" policy and cluster schools.

Environmental education is a tool for long-term educational reform. Themes related to sustainable development should be integrated into subjects dealing with social, cultural and historical issues in the environmental schools and teacher training centres.

If formal education improves job opportunities, parents may be more likely to send their children to school. The campaign should use "eco schools" to increase skills by integrating schoolwork with non-formal education.

Without short-term tangible results, knowing how to manage natural resources is worthless. Getting the print and broadcast media to cover the importance of the Tonle Sap as a biosphere reserve is crucial.

Collective environmental knowledge is low to non-existent in the Tonle Sap Biosphere Reserve. Schools should collaborate with environmental organisations so communes can act and share traditional knowledge.

II. APPROACH AND IMPLEMENTATION

F. BASIN-WIDE APPROACH

Environmental education must clarify what sustainable development means. The Tonle Sap is not just a biosphere but an engine of the Cambodian economy that is closely tied to national identity, history, culture and society.

The campaign will have seven outputs divided into 48 activities. It will recognise the roles of various institutions and the links between the environment, livelihoods and health as well as the limits to economic growth.

Cambodian culture must always be taken into account. The campaign has to convey clear, tangible and direct messages that are also subtle, holistic and multi-dimensional. It must address the Tonle Sap as a whole.

The campaign will highlight the national and international importance of the Tonle Sap. Government officials, local decision makers and religious leaders will be made aware of Cambodia's obligations and responsibilities.

Creative thinking is crucial. If education is to bring about change, people must investigate local issues be willing and able to act. Such skills are needed to identify and address environmental problems.

G. PARTICIPATION

The campaign was targeted at groups representing a limited number of reputable local and national organisations. Three "targeted stakeholder groups" for community awareness, education and media will be set up to develop resources, conduct training and monitor the impact of the campaign. The groups will meet regularly and be shown new techniques in environmental education.

H. CAMPAIGN FOCUS

The campaign addresses five specific challenges faced by people living in the Tonle Sap biosphere reserve. These include Cambodia's *international obligations* to preserve the ecosystem as well as water quality, sanitation and health. The campaign will also address *lobbying and decision making* as well as the *importance of the flooded forest* and the *benefits of protected areas*. The target groups will develop the campaign content with the aim of promoting change and sustainable development.

I. INFORMATION REVIEW

The information review will be channelled into the work of the targeted groups. It will focus on past initiatives and how they can be used in the campaign.

J. TARGET GROUPS

Target groups will comprise relevant government ministries, non-government organisations, community groups and training schools. In developing campaign and training resources, the groups will be guided by data from the Information Review and Live and Learn's earlier reports on the Tonle Sap.

K. COMMUNITY AWARENESS

Improving education and raising environmental awareness will focus on theatre, radio and training for local and provincial decision makers. Theatrical performances should be integrated with Buddhist teachings and Cambodian stories. **One-minute** radio spots could highlight successful case

studies and be hosted by famous local people or women.

Education toolkits for communes should include various practical examples of how environmental education can reduce poverty. They should also highlight how traditional knowledge – in areas such as flora and fauna, land and water use, and sustainable fishing practices – can be used to improve the environment. The toolkits should address issues of immediate importance and show actions can lead to economic gains.

L. EDUCATION

The formal education toolkit will be targeted at teachers, teacher training centres and education officials. It will highlight how the biology of the Tonle Sap area is linked to poverty, livelihoods, health and well being. Sustainable development will be integrated into the curriculum and several pilot schools will be developed. Educational tools will be designed to promote creative thinking, problem solving and student participation and to train teachers. Relevant practical solutions will be promoted. Toolkits will contain a teachers guide, five curriculum modules on the main environmental challenges in the Tonle Sap region and a guide to possible school activities.

M. MEDIA COVERAGE

The campaign will promote broad public awareness of the Tonle Sap's importance through media organisations and various journalism training programs at the Royal University of Phnom Penh. A media target group will be set up with close links to the Tonle Sap quarterly newsletter. The campaign will provide journalists and trainers with information about challenges to the Tonle Sap

and opportunities for those living and working in the area. The campaign will distribute news releases, hold news conferences, briefings and round-table discussions and promote accurate reporting of Tonle Sap issues by both provincial reporters and those based in Phnom Penh.

A media toolkit will be developed with training material that can be used as a comprehensive guide to reporting Tonle Sap issues. The toolkit will include a video/VCD and be launched at a Tonle Sap Fair which will be used to promote the work of various target groups among people in Phnom Penh.

N. MONITORING AND EVALUATION

Processes to monitor and evaluate the campaign must be in place from the start. The quantitative approach needs to include how many people benefit from the campaign and how many resources are produced, although it cannot be expected to adequately measure impacts like the adoption of values and changes in behaviour.

The qualitative approach will focus on personal accounts of the most significant changes that have taken place. Under this approach, the target groups will establish four "domains of change" spanning quality of life, community participation, target group capacity and other changes. Campaign staff and target groups will be trained to ask questions, listen and take notes. The target groups and selected commune representatives will select the most significant stories in each domain which can then be publicised more widely.

O. OUTPUT 7: NATIONAL FORUM

The campaign will arrange a national forum. The forum will bring together all target groups and other organisations with the aim of sharing experiences and discussing future directions and plans for environmental education in Cambodia.

P. ENGAGING PARTNERS

The effectiveness of the campaign depends on the partnerships, networks and alliances developed, hence the strong focus on target groups. The campaign is too broad for a single local, national or international institution. Target groups and other partners must be outward looking to promote the campaign through links to other initiatives, programs and networks. National government agencies and non-government organisations require particular attention.

Partners have to picked from more than 400 local environmental and development organisations registered in Cambodia. They will be mobilized through the three target groups set up for community awareness, education and media coverage. Given the importance of knowing what others are doing on the lake, the campaign staff will play a coordinating role by channelling the experiences of partners into toolkits and other activities.

Q. IMPORTANT LINKS

The campaign was linked to other parts of the Tonle Sap Environmental Management Project, notably the Environmental Awareness and Education Outreach Program. Funded by the UNDP and the Global Environment Facility, this falls under the third part of the project which includes promoting an awareness of biodiversity conservation. Models, tools and resources developed by the campaign will be shared with the overall management project. To ensure maximum synergy, monitoring these links with other initiatives needs to be constant.

The campaign also linked to related international initiatives, notably Cambodia's efforts to achieve the UNDP's Millennium Development Goals. Other initiatives include UNESCO's Education for All Campaign launched in Thailand in 1990, the UN's Decade of Education for Sustainable Development agreed to in South Africa in 2002 and the UN's Water for Life Decade which started in 2003.

Managing expectations, clarifying what the campaign can do best and spending resources effectively on community awareness, education and media coverage are crucial. One effective approach was to equip local and national organisations with tools and skills. Another was to raise the awareness of decision makers regarding the challenges facing the Tonle Sap and the consequences of doing nothing about them.

III.CONCLUSIONS AND RECOMMENDATIONS

The values needed to sustain the Tonle Sap's natural resources will not come from environmental education alone. But education is the central pillar to promote such values. It must strive to encourage every person to believe that he or she can bring about global change and aim to increase people's ability to transform visions into reality. Education has to foster values, behavior and lifestyles to sustain development and develop future-oriented thinking.

Education needs to address challenges by promoting change. The public has a crucial role to play in managing the Tonle Sap's resources. To be sustained, economic development must be friendly to the environment and responsible to society. But there is no quick fix. The long-term vision requires commitment and approaches at all levels of Cambodian society.

IV. RECOMMENDATIONS

The campaign is not only about information and messages but also about changing people's attitudes and behaviour. The timing of consultancy work needs to be flexible to take into account the scope of work and the participation of target groups. The director of the Tonle Sap Environmental Management project will kept informed of any changes.

ANNEX–TONLE SAP ENVIRONMENTAL MANAGEMENT PROJECT–NEEAC PROGRAM BACKGROUND

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ស៊ីឌីនេះមានឯកសារ មគ្គុទេសក៍សារព័ត៌មានបឹងទន្លេសាបជាភាសាខ្មែរ និងអង់គ្លេស ។ ឯកសារនេះអាចបើកបានដោយប្រើកម្មវិធីអាក្រូបាត ។ អត្ថបទនេះអាចចំលងយកទៅប្រើបានក្នុងគោលបំណងអប់រំ ។ ប្រសិនបើអ្នកប្រើ សូមបញ្ជាក់ពីប្រភពដើម ។

ដើម្បីចំលងអត្ថបទ : សូមបើកឯកសារនៅក្នុងកម្មវិធីអាក្រូបាត និងប្រើ TEXT TOOL ដើម្បីជ្រើសយកអត្ថបទដែលចង់បាន ។ បន្ទាប់មកជ្រើសរើសយក : Edit > Copy, Edit > Paste ចូលទៅក្នុងឯកសារថ្មី ។