



**Ministry of Water Resources and Meteorology**

**Climate Change Strategic Plan  
For  
Water Resources and  
Meteorology**

**Phnom Penh, 2012**

## Executive Summary

The Kingdom of Cambodia is highly considered as one of the water-abundant countries in the region. Rivers and streams, lakes, aquifers and marine water of Cambodia are important sources for national economic development in many sectors such as agriculture, manufacturing and small-scale industries, hydropower, navigation, tourism, environmental protection, and daily life. Cambodia's economy is highly dependent on water. The importance of water for food production, rural livelihoods and economic development is recognized in the government Rectangular Strategy (RS) on Growth, Employment, Equity and Efficiency (phase 2, 2008), the National Strategic Development Plan (NSDP) Update (2009 – 2013), and the Strategy for Agriculture and Water Resources (SAW 2009 – 2013).

There are two types of water available in Cambodia: annually around 75,000 million cubic meter of surface water runoff and 17,600 million cubic meter of aquifer ground water. Cambodia precipitation varies from 1,400 mm to 3,500 mm annually depending on areas and numbers of rains.

The Mekong and Tonle Sap Rivers and its systems play vital roles in maintaining aquatic ecosystems, and provide natural resource-bases for national economic and social development. Agriculture and fisheries, to give the few, are main sources of national and family incomes. Agriculture alone generates more or less 31.4% (2005) of the country Gross Domestic Products (GDP) annually.

However, it has been agreed that Climate Change (CC) will increase water management challenges; less rainfall is anticipated during the dry season and more during the wet season, with more extreme weather events and potentially worse seasonal water storages and floods. Challenges are even more threatened at developing country like Cambodia where meteorological systems have not yet up-to-date to forecast extreme weather like flash floods and unpredicted drought, which have often happened in Cambodia.

It is estimated that the approximate cost for the implementation of the CCSP for Water Resources and Meteorology could be US\$1,250,024,000 for duration of four years. Financial sources is, also, vary from national, bilateral or multilateral, and non-governmental organizational supports. Private sector sources for the CCSP implementation could be little contribution.

To the success of CCSP for Water Resources and Meteorology implementation, besides from financial supports, capacity building needs and climate change awareness raising are among the most vital priorities to be the first ever done at the beginning of the strategic implementation for climate change adaptation in water resources and meteorology sector. Most importantly, coordination and collaboration among all key relevant stakeholders have to be strongly committed from each sectoral agency.

## **Introduction**

Climate change poses immense threats, and new opportunities for development of water resources in Cambodia. In this regards, government of Cambodia has recently increasingly considered that climate change impacts as an urgent and critical issues. The climate change could potentially affect negative impacts on Cambodia's society and natural resources including natural ecosystems.

The Ministry of Water Resources Management and Meteorology has committed itself to overcome the impacts of climate change introducing law on water resource management, national water resources management policy and strategy and many more guidelines and regulations for better climate change adapted management and development. The Ministry has considered that Farmer Water User Committee development as the most among the many immediate tasks because the farmers are the very direct vulnerable groups to climate change impacts. Countrywide master plan development for water resources management has been under the process of development with the support of Republic of Korea and the government of Cambodia under the leadership of Samdech Akka Moha Sena Padei Decho Hun Sen – the Prime Minister of the Royal Government of Cambodia.

The Climate Change Strategic Plan for Water Resources and Meteorology is another outcome that the Ministry of Water Resources and Meteorology has developed. It is believed that the Climate Change Strategic Plan for Water Resources and Meteorology would contribute to further development of national climate change strategic plan, which would be addressed climate change impacts on the country socio-economic development while adapting as much as possible.

## Acronyms and Abbreviation

ASEAN	South-East Asia Nations
CC	Climate Change
CMDG	Cambodia Millennium Development Goal
CNMC	Cambodia National Mekong Committee
FWUC	Farmer Water User Committee
GDP	Gross Domestic Products
IWRM	Integrated Water Resources Management
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIME	Ministry of Industry, Mines and Energy
MoE	Ministry of Environment
MOWRAM	Ministry of Water Resources Management and Meteorology
MRC	Mekong River Commission
NAPA	National Adaptation of Action for Climate Change
NCCC	National Committee for Climate Change
NCDM	National Committee for Disaster Management
NSDP	National Strategic Development Plan
RS	Rectangular Strategy
SAW	Strategy for Agriculture ad Water
UNDP	United Nations for Development Program
UNFCCC	United Nations Framework Convention for Climate Change
WHO	World Health Organization

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## 1 National Endeavor and Sustainable Use of water resources

Mekong River is the largest river in Cambodia and dominates the hydrology of the country followed by Tonle Sap River and Tonle Sap Lake. The annual average flow of the Mekong River is 374.2 billion m<sup>3</sup> (Kratie station during 1996 - 2005) and the average monthly flows varies from 1,060 m<sup>3</sup>/s to 40,060 m<sup>3</sup>/s.

During monsoon wet season, the Mekong River swells with water reaching a flood discharge of 45,000m<sup>3</sup>/s at Phnom Penh. By about mid-June, the flow of the Mekong River and the Bassac River fed by monsoon rains, increases to a point where its outlets through the delta cannot handle the enormous volume of water, flooding extensively to adjacent floodplains for about 4 to 7 months. During this period, floods damage large area of the region.

Apart from two main river basins – the Mekong and Tonle Sap, Cambodia consists of 42 sub-river basins that provide the country of plenty of water for family and national economic development, especially agriculture. The 42 sub-basins are located along those tributary rivers of the Mekong and Tonle Sap rivers.

### 1.1 Water Resources, Agriculture, and National Economy

The Kingdom of Cambodia is highly considered as one of the water-abundant countries in the region. Rivers and streams, lakes, aquifers and marine water of Cambodia are important sources for national economic development in many sectors such as agriculture, manufacturing and small-scale industries, hydropower, navigation, tourism, environmental protection, and daily life.

There are two types of water available in Cambodia: annually around 75,000 million cubic meter of surface water runoff and 17,600 million cubic meter of aquifer ground water. Cambodia precipitation varies from 1,400mm to 3,500mm annually depending on areas and numbers of rains.

The Mekong and Tonle Sap Rivers and their systems play vital roles in maintaining aquatic ecosystems, and provide natural resource-bases for national economic and social development. Agriculture and fisheries, to give the few, are main sources of national and family incomes. Agriculture alone generates more or less 31.4% (2005) of the country Gross Domestic Products (GDP) annually.

Water has been used for dozen, if not hundreds, of purposes including for household, agriculture, industry, hydropower, navigation and tourism. Maximum quantity of water used each year is estimated 750 million cubic meter (10% of the total country available water quantity), of which 95% (710 million cubic meters) is used for irrigated agriculture. Very unfortunately, there is not reliable data on water quantity used for other purposes.

Cambodia's economy is highly dependent on water. The importance of water for food production, rural livelihoods and economic development is recognized in the government Rectangular Strategy (RS) on Growth, Employment, Equity and Efficiency (phase 2, 2008), the

National Strategic Development Plan (NSDP) Update (2009 – 2013), and the Strategy for Agriculture and Water Resources (SAW 2009 – 2013). However, it has been agreed that Climate Change (CC) will increase water management challenges; less rainfall is anticipated during the dry season and more during the wet season, with more extreme weather events and potentially worse seasonal water storages and floods. Challenges are even more threatened at developing country like Cambodia where meteorological systems have not yet up-to-date to forecast extreme weather like flash floods and unpredicted drought, which have often happened in Cambodia.

Water quality is determined by natural processes, particularly by the dilution effects of water runoff from heavy rainfall, which is normally, occur during wet season. At this time bacteriological and chemical water quality is generally high, although physical water quality may be reduced because of heavy sediment loads. However, when river flows decline water quality may deteriorate remarkably because contaminations are diluted to a much smaller extent. In addition, due to the human population growth and socio-economic development, water quality has been increasingly threatened especially during the dry season, particularly at the less-rainfall years.

## **1.2 National Policy and Strategy**

The government's ultimate objectives are poverty reduction and economic development. The government places a high priority on social expenditure and reform, particularly in the area of agriculture, water resources management and rural development. It also has taken particular strong action in the area of forest policy and management, including watershed management, and aims to achieve and maintain food security.

The royal government of Cambodia (RGC) commits itself to the United Nations Conventions and various regional economic development programs and initiatives of Association of South-East Asia Nations (ASEAN) and in the Greater Mekong Sub-Region. Significantly, for the water sector, the RGC policy has resumed membership of the Mekong River Commission since 1995. The RGC commits to achieve its Millennium Development Goal 7 – “Ensure Environmental Sustainability” by 2015.

The Law on Water Resources Management was approved in 2007 building on the National Policy on Water Resources Management and the Strategic Plan on Water Resources Management and Development (2005 – 2008). The Law is set within the framework of Integrated Water Resource Management (IWRM) that recognizes different sector interests in water uses. The Law includes several articles that deal with rights, organization and participation of water users. The law emphasizes Farmer Water User Committee (FWUC) integration into water resources sustainable management as the most important and decentralized scheme of the RGC for poverty alleviation. The law does make reference to the need to integrate environmental considerations into water management, but does not address climate change issues specifically. It does however recognize the cross sectoral nature of water management, and the need for inter-agency and ministerial cooperation, although realizing such cooperation is challenging in practice.

Other challenges include legal framework, rules and regulations and institutional mechanisms for water integrated management are not in place for maintaining environmental flows at both upstream and downstream levels (MoE and UNDP, 2011). Climate change related-responses in water resources manage also have yet been taken into main consideration due to the country capability and ability.

## 2 Water Resources related to Variability and Climate Change situation

### 2.1 Climatic Information

The dominant features of Cambodia landscape are defined by the large, almost centrally located Tonle Sap (Great Lake), the Bassac River, and the Mekong river systems across the country from north to south. Surrounding the Central Plains, which cover three quarter of the country area, there are Elephant Mountains and Cardamom Mountains of southwest and western regions; Dangrek Mountain of the north adjoining the Korat Plateau of Thailand; and the northeast Plateau of Ratanakiri and Chhlong Highlands on the east merging with the Central Highlands of Vietnam.

Like in many countries in the Southeast Asia region, Cambodia climate is dominated by monsoon, which is known as tropical wet and dry climates. The monsoon brings rain to Cambodia during May to September or early October – called wet season; and northeast monsoon blows during November- March bringing dry-cool air; and hotter localized air during late March - late April.

Temperatures are fairly uniform throughout the Mekong River Basin with only small variations from the average annual mean of a round 28°C and the average maximum and minimum temperatures of 34°C and 21° C, respectively (2004).The coldest temperature can be as low as 10° C during the month of January. The warmest month is in April during which the temperature can be as high as 38°C before the rainy season arrives. Normally, typhoons and tropical storms hit hard the Vietnam bays leave less damage on Cambodia areas.

The average of precipitation rate in Cambodia for the recent 11 years (1994 – 2004) is estimated to 1,598.4 mm. The average annual rainfall on the Tonle Sap Basin and the lowlands near Mekong River is estimated of 1,300 to 1,900 mm.

Table 2.1: Variability temperature (Unit in Degree Celsius, ° C) throughout the year

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average temperature
Maximum	34.5	35.4	37.2	38.0	37.1	35.7	34.9	34.5	34.2	33.8	34.8	33.4	34.0
Minimum	18	18.1	21.9	21.9	23.1	22.5	22.9	22.7	22.8	21.9	20.1	18.0	21.2

Source: Statistical Year Book, 2005, cited in MOWRAM, 2008

### 2.2 Water Resources

**Surface water or runoff water** is defined as the amount of water that flows into rivers remaining from the processes of evaporation, transpiration, infiltration, and percolation.

Surface water sourcing from rain water flows down to Tonle Sap Lake and Mekong River before further down to Mekong Delta and South China Sea. Surface water plays vital role in Cambodia agriculture and economic development.

**Ground water:** The applications of groundwater as irrigation water are limited to small-scale vegetable gardens, fruit farms or such in the dry season. While groundwater has been developed and used as irrigation water in the southern and eastern areas of Cambodia, the groundwater has been scarcely used in the northwestern areas of the country. MOWRAM (2008) reported that irrigated farmlands accounted for about 20% of the entire cultivated lands, and the farmlands irrigated by surface water and by groundwater accounted for 31.2% and 68.8%, respectively of the entire irrigated farmlands.

**Uses of water and development:** Total amount of water resources in Cambodia is 289.4 billion m<sup>3</sup> and average runoff is 45%, considering the average annual rainfall of 1,598.4 mm, and the land area of 181,086mk<sup>2</sup>. Total uses of water of all purposes were amounted to 7.9 billion m<sup>3</sup> (table 2.2). The consumed water for agriculture is estimated about 7.59 billion m<sup>3</sup> (96% of total use), for domestic use is 0.24 billion m<sup>3</sup> (3% of total use) and for the industrial use is 0.07 billion m<sup>3</sup> (1% of total use).

**Table 2.2:** Annual water use (2005)

Use of water	Domestic purpose	Industrial purpose	Agriculture purpose	Total
Amount, million m <sup>3</sup> per year	235.9	71.4	7,586.7	7,894.0

Source: MOWRAM, 2008 p 4-31

**Coastal and marine water:** Cambodia lies on 440km coastline from northwest to southwest areas within the provinces of Koh Kong, Sihanouk, Kampot and Kep. These provinces are increasingly populated due to economic and tourism development. The areas, especially in the offshore areas, can have much more development activities in the short future because of the exploitation of oil and gas productions.

**Concerns:** There is growing concern at the likely impact of agrochemicals, particularly of pesticides on fisheries, although data are lacking on the actual quantities of chemical use or of the consequences for water quality. There is less concern about the effects of industrial effluent, because of limited industrial activity until recently. However, future development, principally around Phnom Penh and particularly in the garment industry, could be expected to present growing problems and the environmental impact and monitoring provisions of environmental legislation will become increasingly important. Bacteriological contamination is of greater concern from a public health point of view, with Cambodia “high levels of morbidity and mortality from diseases that often are water-related. Bacteriological quality of Mekong/Bassac waters deteriorates from Phnom Penh, although particularly so downstream from Vietnamese border, across the densely populated delta.

Most Cambodian people face a shortage of freshwater during the dry season, and also during the “small dry season” in the wet season, but in the rainy season face too much water: flood.

Irrigation infrastructure is insufficient, old and run-down, which has a severe impact on water storage, distribution and supply, sanitation, and food production. The waters of the Gulf of Thailand are enclosed by land, and there is a growing risk that contaminants and sediment from coastal towns, agricultural areas, and forest logging may pollute the sea. Furthermore, shipping and off-shore exploration for oil and gas reserves present additional risks to the water resources. The Kingdom's marine waters require careful management, particularly along the coastline and in estuaries, to ensure that they continue to support healthy ecosystems and fisheries, and provide the basis for sustainable economic activities, particularly fishing and tourism.

River transport, particularly of petroleum products, to the port of Phnom Penh presents a threat to water quality in the Mekong and its distributaries through the delta. Apart from the unpredictable risk of a major accidental oil spill, there is likely to be more or less continuous leakage and spillage of fuel and cargo, and contamination from ballast tanks etc. The growing use of outboard motors by other river users also presents a pervasive threat to surface water quality, through spillage, leakage etc. No data are available on contamination by hydrocarbons.

Surface water quality in rivers draining from catchments underlain by metalliferous rocks is in some cases degraded naturally. There are locally high concentrations of toxic metals in stream flow from areas in which mining is undertaken. The degree of contamination of surface water by human activity is difficult to quantify. Non-point source contamination by domestic animals and people presumably is widespread in settled areas, because of uncontrolled waste disposal and, to a lesser extent, fertilizer applications. However, loadings per person or stock unit are rather low, and data for nutrient concentrations in the Mekong mainstream indicate low average and maximum values ( $\text{PO}_4\text{-P}$  0.03mg/l, total-P 0.08 mg/l,  $\text{NH}_4\text{-N}$  0.1 mg/l, total-N 0.5 mg/l,  $\text{NO}_3\text{-N}$  in the range 0.1-0.4 mg/l) (MOWRAM, 2000).

The most concerned issue of groundwater quality is arsenic content. There are many wells exceeding the WHO (World Health Organization) guideline in arsenic content, and it is known that this is caused by natural reason, not by human induced activities. Increase of arsenic contents in groundwater affects surface water quality as well.

### **2.3 Floods**

Floods normally occur in Cambodia 42 river basins especially in the Mekong and Tonle Sap basins. Two types of floods occur in these are: flash and long-month (3-4month) floods. Flash flood occurs during rainy season, especially within the slop areas of the Cambodia plateau whereas long-month flood normally occurs along the river basins of the Mekong, Tonle Sap and their tributaries. According to historical records, a serious flood happens in the Mekong Delta in more or less of every 4 to 6 years. The serious floods result in really damage agricultural productions, human, and properties. Since the 1960s there have been more than seven serious floods in Cambodia. Flood is one of the most serious problems in Cambodia, while it affects on the country in both positive and negative manners.

On the bright side, seasonal floods play important role in the increase of fishery production, maintenance of ecological environment in marsh, improvement of land productivity by supplying silt sediment, and agriculture water supply. Floodplains are essential to fish hatching areas and fish habitats. Large fishes lay eggs on the bushes inundated by floods. Floodplains are closely related to farming providing a field for seeding, floating rice and flooded rice crop. Mostly rice crop rotation is conducted by farming rice floating in deep water depth of the floodplains.

On the dark side, severe floods make damages on infrastructures, interruption of economic activities, losses of human lives as well as livestock and farm products. When a huge flood came in 2000, about 370,000 ha of farmland were inundated, and 6,081 houses were destroyed affecting people lives of 3.44 million in 132 districts. The estimated amount of flood damage during 1900 and 2012 are shown in [table 2.3](#).

It has been noted that flood status has changed for the last few decades, and 3 types of floods identified: i) the increase of flood numbers in the Mekong River more than expected, ii) Heavy rain on the Mekong tributaries, and iii) the increase in flood level.

## 2.4 Droughts

The most recent droughts occurred in 1992, 1993, 1998, and 1999. The drought of the 1999 was the most severe that occurred across the country. The impact of drought have similarly been addressed by a number of programs with aiming to improving the irrigation system, rehabilitation of pumping stations and water pump, water supply and sanitation and establishment of Farmer Water User Community (FWUC). For example, MOWRAM’s objective for 2001-2005 have been achieved a total of 290 irrigation rehabilitation projects, covering 532,673 ha of wet season rice and 154,368 ha of dry season rice, at a total cost of about US\$ 607 million (see also [table 2.3](#)). Up to 2003, 315 irrigation projects had been implemented, covering 153,149 ha of paddy rice, of which 89,383 ha for wet season and 63,766 ha for dry season (MOWRAM, 2003).

Sorted by Number of Killed				Sorted by Number of total affected people			Sorted by economic damage cost		
No	Disaster	Date	No.Killed	Disaster	Date	No.Total Affected	Disaster	Date	Damage (US\$)
1	Flood	1994	506	Drought	1994	5,000,000	Flood	2000	160,000,000
2	Epidemic	1998	475	Flood	2000	3,448,053	Flood	1991	150,000,000
3	Flood	2000	347	Flood	2001	1,669,182	Drought	1994	100,000,000
4	Flood	2011	207	Flood	2002	1,470,000	Flood	2011	95,000,000
5	Epidemic	2007	182	Flood	2011	1,350,000	Flood	2010	70,000,000
6	Flood	1991	100	Flood	1996	1,300,000	Drought	2002	38,000,000
7	Flood	1996	59	Flood	1991	900,000	Flood	2001	15,000,000
8	Epidemic	1999	56	Drought	2002	650,000	Flood	1996	1,500,000
9	Flood	2001	56	Drought	2005	600,000	Flood	2007	1,000,000
10	Epidemic	1992	50	Flood	1999	535,904	Flood	1999	500,000

**Table 2.3:** Top 10 Natural Disaster in Cambodia for the period of 1900 to 2012 (source: www.emdat.net)

## 2.5 Storm

Extreme weather events such as storms or typhoons are not usually considered a major problem in Cambodia because the country is protected by surrounding mountain ranges. However, storms do occasionally affect the country with most of the storm-related damage caused by localized floods associated with heavy rain. Tropical storms can also affect the level

of Mekong River flooding experienced on a given year. The storm incursions into the Mekong basin spread from the South China Sea towards the east and Southeast across Vietnam and the Southern China. Greatest damage occurs when these arrive during September and October when the seasonal discharge of the Mekong River is already high and a second significant peak to the annual flood is generated (MRC 2007, cited in RGC, 2008). Wind on the other hand, casually damages human property such as houses, agriculture and ecological systems. Ketsana damaged hundreds of houses in Kamong Thom and Siem Reap in 2009.

### 3 General Legal Framework

#### 3.1 National Legal Framework

The Ministry of Water Resources and Meteorology (MOWRAM) was established in 1999. Since then, national managerial capacity has grown through technical assistance and experience and additional financial and technical support has been mobilized. At institutional, i.e. policy level, Cambodia has adopted:

- Law on Water Resources Management (2007)
- Strategic Plan on Agriculture and Water (SAW) for 2006-2010 (2007) and 2009-13 (2010)
- National Policy on Water Resources Management (2004)
- Participatory Irrigation Management and Development (PIMD)
- Prakas (proclamation) No. 306 for establishing community-based water management
- Circular No. 1 on the implementation of sustainable irrigation policy (2000).
- Other pending policies and regulations include: (i) sub-decrees on the procedure for establishing a farmer water-user community, (ii) river basin management, and (iii) water allocation and water use permits.

A number of agencies and sub-agencies have roles related to the management of natural resources and environment, of importance to the Tonle Sap Basin, and a number perform or have the mandate to perform a coordinating role. These are:

- Ministry of Water Resources and Meteorology (MOWRAM)
- Ministry of Environment (MOE)
- Ministry of Agriculture, Forests and Fisheries (MAFF)
- Tonle Sap Authority (report its activities to the Council of Ministers)
- Cambodia National Mekong Committee (CNMC),
- Tonle Sap Biosphere Reserve Secretariat, which is an agency of the CNMC, and
- National Committee for Disaster Management (NCDM) (report its activities to the Council of Ministers).

All of these agencies have developed or may develop plans or strategies related to the natural resources of the Tonle Sap Basin.

**Law on Water resources management:** The general purpose of the Law is to foster the effective and sustainable management of the water resources of the Kingdom of Cambodia to attain socio-economic development and the welfare of the people. The Law determines:

- The rights and obligations of water users,
- The fundamental principles of water resources management, and
- The participation of users and their associations in the sustainable development of water resources.

The MOWRAM is mandated to manage, lead and supervise the implementation of the present law on water resources management. The MOWRAM shall conduct consultation with other concerned ministries. In case of need, the Royal Government of Cambodia shall set up a joint commission for addressing and coordinating works and activities among the Ministries concerned (Article 5).

Flood Control (Article 24 of the Water Law): In the purpose of the flood protection, the MOWRAM, in collaboration with the other agencies concerned, may designate any floodplain area as Flood Retention Area. Within a Flood Control Area, the MOWRAM, together with other agencies and local authorities concerned, shall develop plan(s) on measures for flood prevention and mitigation to ensure the safety to the human life, animals and property. The MOWRAM may suspend temporary activities that damage flood protection works or obstruct the natural flow of water.

International rivers (Article 34): The Kingdom of Cambodia has the right and duty to participate in the utilization, development and management of an equitable and reasonable share of the international river basins in its territory, consistent with the obligations arising from the international agreements to which Cambodia is a Party. The MOWRAM shall pay particular attention to the optimum and effective use of the Mekong River Basin in all fields including the navigation and transport, consistent with the governing principles of the CNMC.

The law is very much focusing efforts on sustainable uses of water resources, equitable water sharing and poverty alleviation but has yet taken CC into detail consideration. However, the CC hazard and CC related-response measures have shown in the National Water Resources Policy (page 14).

### 3.2 National Water Policy

**The National Water Resources Policy (2004):** The National Water Resources Policy is aiming on:

- Protect, manage and use water resources with effective, equitable and sustainable manner,
- Foresee and take measures to assist related institutions to settle the facing problems which might be occurred in water sector,
- Develop and implement the national strategy and formulate the national policy and sector policies on water resources management,
- Direct the water resources development, management and utilization in the Kingdom of Cambodia to all activities of institutions, private sector and public sector,

- Improve and uplift the people living to achieve the national policy on poverty reduction and sustainable national economy development.

The policy raises issues and shows guiding measures to cope with these issues in couple sectoral economic developments. These related sectoral economic developments include agriculture, energy, industry and services, domestic uses, navigation and tourism. Water resources use effectiveness and partnership utilization are among the main concerns that the policy is taken into most consideration.

The policy also is planned to conduct research and development and institutional capacity building and strengthening. The policy furthermore states its commitment to coordinate with line ministries and neighboring countries especially the Mekong River Commission members.

### 3.3 Strategy

Since its establishment the MOWRAM has implemented two national water resources management and meteorology strategies: the 2006 – 2010 and the 2009 – 2013. Both strategies aim at sustainable water resources management and development for all related sectors consuming water such as agriculture, livestock, domestic uses, industry, and other. Both strategies, moreover, align with the country policy and development goal such as National Sustainable Development Plan (NSDP) (both 2006 – 2010 and 2009 – 2013) and Cambodia Millennium Development Goal. The main strategies efforts are to rehabilitate and improve irrigation systems, build new canal, establish pumping stations, establish FWUCs, conduct research and development studies and development of human resource capacity building in water resources sustainable management.

Flood and drought management, for pre-, during- and post disaster stages, are main focuses of the strategy of the MOWRAM. Despite NCDM efforts in disaster risk reduction management, MOWRAM have played important roles in coordination among key government and non-government players for disaster prevention and rehabilitation.

#### **The Water Resources Management and Meteorology Strategic Development Plan (2009 - 2013):**

In responding to emerging issues of CC in water resources management and meteorology, updated MOWRAM Strategic Development (2009 - 2013) aims at specific plans including:

- Water resources management and development
- Flood and drought management
- Strengthen law, regulations and water resources sustainability
- Management of water resources and meteorology data and information
- Improve administrative management and human resources development.

### 3.4 Institutional Framework

The Ministry of Water Resources Management and Meteorology (MOWRAM) is mandated to be responsible for water resources management in the areas of the river basin, sub-basins, watershed run-off, groundwater and aquifers in collaboration with all concerned Ministries (article 10, Law on water 2007). MOWRAM was established in 1999 by Kram (Royal Legislation)

No. NS/RKM/0699/08 dated on 23 June 1999 (see annex 1 for detail MOWRAM Organization Chart). Two departments, water resources management and meteorology, play important roles in improving water management for development. MOWRAM is coordinating programs on Climate Risk Management and Rehabilitation of Small- and Medium-scale Irrigation Schemes in the Tonle Sap Basin, and on the Enhancement of Flood and Drought Management, with the support of the PPCR. These programs will be implemented in collaboration with MAFF, MOE, and the NCDM. These projects will be implemented in a few select provinces, and are intended to involve provincial, district, and commune level stakeholders – including NGOs, water user associations, and local community representatives.

- MOWRAM is mandated to play main coordination roles for the RGC in project/program related water resources management and development.
- MOWRAM, on behalf of the RGC, is structured as Ministry that consists of dozens of [Central] Departments, and Provincial Departments, each in every province and capital. At the national level, there are two main technical departments: the department of water resources management and conservation and the department of meteorology.

The MOWRAM plays two folds roles at the same time: coordination at the government ministry levels and managing line departments that represent the MOWRAM at sub-national levels (each province consists of one DOWRAM).

## **4 Climate Change Strategic Plan for Water Resources and Meteorology**

### **4.1 Vision**

The Vision of the Climate Change Strategic Plan for Water Resources and Meteorology is sustainable water resources uses in adapting to climate change; and timely trusted weather, climatic information; for better livelihoods of the Cambodian people.

### **4.2 Mission**

Our MISSION is to ensure water resources and meteorology are effectively and sustainably managed and timely serviced warning systems and climatic information, equitably accessed, shared and adapted to the changing of climate.

## **5 Climate Change Strategic Plan for Water Resources**

### **5.1 Goal and Objective for Water Resources**

The goal of the Water-related CCSP is: to fulfill all climate change adaptation activities in water resources management and development for sustainable water resource uses.

With the global changing climate and climate change mitigation and adaptation, the objectives of the CCSP for water resources are as followings:

1. Protect , manage and use water resources with effective, equitable and sustainable manners from CC negative impacts;

2. Along with the climate change adaptation and/mitigation schemes, regulate, modify and intervene water resources service fees of all water resources development activities;
3. Maximize sustainable water resources contribution to poverty reduction, enhanced livelihoods and equitable economic growth;
4. Adapt to climate change and mitigate its effects on water resources based livelihoods;
5. Apply Integrated Water Resources Management (IWRM) that allows for holistic planning across sectors, jurisdictions and local government border for climate change adaptation and mitigation;
6. Take stronger community participation such as Farmer Water User Committee in water resources management and development to address impacts or obtain benefits from climate change induced opportunities;
7. Raise awareness, capacity of institutions and quality of officials in climate change adaptation and mitigation to enable sustainable development and management of water resources;
8. Ensure environmental protection and conservation of water resources;
9. Apply modern sustainable management models adaptive to climate change context; and
10. Develop sustainable financial systems partnering with private sectors.

### 5.1.1 The Strategy Framework for water resources

*Responding to the urgent need for climate change issues and impact, Cambodia ratified the UNFCCC in 1995 and launched the first climate change project to help prepare the Cambodia's Initial National Communication (UNDP/GEF) in 1999. In 2002, Cambodia has acceded to the Kyoto Protocol. The National Climate Change Committee (NCCC), which was established by sub-decree in April 2006 with the representative of 19 Government ministries and agencies, serves as a policy-making body and coordinates the development and implementation of policies, plans and measures to address climate change issues within the country. Recently, the Ministry of Women Affairs has been included into this Committee. Being as one of the Vice-chair Ministry (figure 4.4), MOWRAM has played crucial roles in the NCCC coordination and policy development such as National Adaptation of Action for Climate Change (NAPA) and especially in development of Cambodia climate change position for the annual UNFCCC conference. The NAPA also identified water resources management and development is one of the 20 priority items, which determines MOWRAM in important position for Cambodia to develop policies to address climate change issues.*

The framework CC for water resources management and meteorology is laid out as: sustainable uses of natural water resources, equitable sharing, decentralized water resources management, good governance, and sufficient irrigation systems. The framework is detailed in the points of: Priority Water Resources and Irrigation climate change related issues; Water-Climate Change Impacts and Opportunities; Water-Climate Change Strategy; Water-Climate Change Roadmap and Implementation Plan; Water-Climate Change Adaptation Strategy; Water-Climate Change Mitigation Strategy; Water-Climate Change Cross-Sectoral Issues at

national and sub-national levels; Key Water-Climate Change Response Activities and Risks; Financial Resource Planning; and List of Climate Change Response Activities.

### **5.1.2 Priority Water Resources and Irrigation climate change-related issues**

In water resources management and development in Cambodia, there are barriers related to capacity for climate change adaptation that highlighted to be addressed as followings:

- a) Limited financial resources or funding for water resources-climate change related activities, especially in the irrigation systems for agriculture sectors;
- b) Few water resources-climate change studies and little experience within the country;
- c) Lack of sustainable water resources management and development research in response to climate change and/or training institutions in the country;
- d) Lack of data availability and reliability and, in particular, absence of a formal mechanism for water resources-climate change information sharing;
- e) Limited cooperation and coordination among institutional agencies related to research or studies on water resources-climate change and climate variability;
- f) Relatively low technical capacity of officials at both national and sub-national levels;
- g) Relatively low government salary and limited incentives from the climate change project;
- h) Incomprehensive national climate change policies and/or strategy;
- i) Lack of qualified national experts in the country;
- j) Limited public awareness and education on water resources-climate change; and
- k) Limited technical, financial and institutional resources for water resources management and development in climate change adaptation and mitigation.

### **5.1.3 Climate Change Impacts and Opportunities on water resources**

#### **5.1.3.1 Climate Change Impact**

The impact of climate change will be an unprecedented and increasing global threat to life, livelihoods and life-supporting systems. Cambodia's contribution to greenhouse gas emissions is negligible and the country is ranked number 109 by the World Resources Institute, with emissions of only 0.29 ton of carbon dioxide per head of population each year. However, Cambodia will suffer from the effects of global warming due to excessive emissions in other parts of the world. Like other countries in Southeast Asia, Cambodia is expected to experience higher and more intense rainfall. The effects are likely to include more severe water scarcity and more frequent floods, resulting in crop failures and food shortages. Accelerated loss of biodiversity will cause a decline in ecosystem services. Coastal communities and eco-systems are likely to be affected by rises in sea levels. Higher temperatures and humidity will create conditions for increased incidence of malaria and dengue fever. The poor and marginalized, particularly women and children, will be worst affected.

Recently, Cambodia facing various problems since there are increasing natural resources degradation due to forest, water, land and mineral resources have been overusing for economic development and pro-poor development activities in country-wide up to date. These problems are major for environment which appeared such as higher temperature,

precipitation and sea level rise. It is to start a knowledge related to climate change in Cambodia. The simple understanding on climate change, showed by Website chinaview.com, the word "climate change" is a change in the "average weather" that a given region experiences. Average weather includes all the features we associate with the weather such as temperature, wind patterns and precipitation. What Cambodia is more worried about now is the impact of human activities on climate change and the human responses to the changes of climate. The world agreed that CC comes from human activities, releasing greenhouse gases (GHG) into the atmosphere. Carbon dioxide (CO<sub>2</sub>) is produced when fossil fuels are used to generate energy or when forests are cut down and burned. Methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) are emitted in many ways for example agricultural activities, change in land use, and other sources.

The impacts of CC on water works include:

- a) Water resources sector: problems of increased frequencies of flood & drought, changes in water supply, water quality, and increased competition for water. The irregular seasonal time of raining and dry months caused by CC especially during the last few decades imposes on water resources management and development efforts. At the same time, the increasing demand of water for emerging sectors including industry, livestock, domestic uses, and especially for agriculture, while season is changing due to CC, creates many more social problems. With the global warming, the Cambodia temperature has increased makes it difficult to prevent water from evaporation and lost. The groundwater, on the other hand, requires recharge annually from rain water. Due to the CC impacts on the amount of rainwater that needed to be recharged to the groundwater, it is seriously reduced the recharge rate; and as the result, Cambodian farmers have insufficient groundwater for their farming activities. It is worth noticed that the groundwater shares 3.1% of the total 4.5% of the current irrigation water while surface water shares the rest (MOWRAM, 2008).
- b) Reservoir: Many reservoir have gradually been shallower caused by sedimentation, which leads to reduce capacity of water storage.
- c) Irrigation systems and hydraulic infrastructure: It is noted that the irrigation systems and hydraulic infrastructure have not yet been modernized and taken CC into consideration in almost all areas of the country. Floods and droughts impact on irrigation systems and hydraulic infrastructure. Most importantly floods cause tremendous negative impacts on irrigation systems located in the low land areas.
- d) Dam/weir: Frequent floods destroy many dams; most of them are old and unrealistically considered on the impacts of CC.
- e) Flood Protection Dike (FPD): Most dikes have been destroyed by floods because during each floodwater overflows on these Flood Protection Dikes due to their height are not high enough compared to flood levels. The problem is that CC impacts were not taken into account during the FPD construction. Moreover, these FPDs are made from almost soils.
- f) River Bank and Coastal Areas: erosion of beaches/banks caused by floods and/or high speed waves induced by the impacts of unpredictable CC leads to negative impact on rural livelihoods, especially farmers who are completely dependent on limited land areas.

### **5.1.3.2 Climate Change Opportunities**

Being as Vice-Chair of the National Committee for Climate Change, the MOWRAM has played an important role in water-Climate Change related coordination and facilitation. With the Chair-Ministry, the Ministry of Environment, the MOWRAM has committed itself to address climate change issues in particularly sustainable water development and water good governance. This should be significant opportunity for the mandates of the MOWRAM to implement water-related laws and regulations to achieve the Vision, missions, and objectives of the water resources management and sustainable development in Cambodia. Also, this should be an excellent opportunity for the MOWRAM to fulfill its tasks in sustainable water management and development mainstreaming gender balance in climate change responses.

Due to the global and regional CC, Cambodia has faced with increasing floods and droughts. In this regards, climate change funds should be crucially important additional fund for flood and drought disaster management and prevention. In Cambodia, climate change funds should be used for planned adaptation while at the same time encourage autonomous adaptation that has been implemented for thousands of years in Cambodia and in the Mekong River Basin.

Because climate change is one of the emerging global issues, most of the laws and regulations related to water resources management and meteorology have yet detailed addressing climate change issues. Therefore, it is the right time for Cambodia to include national CC strategic plan in water resources and meteorological management and development.

### **5.1.4 Climate Change Strategy for water resources**

Resulting from the importance and barriers of adaptive capacity for climate change in Cambodia, several challenges for adaptive capacity to respond to climate change can be summarized as follows:

- i. Awareness and knowledge on climate change related to water resources management and development must be mainstreamed to all water-related sectors development aspect at local, provincial and national levels through media system, TV spots, radio and campaign; (A&M)
- ii. Staff capacity building on water resources-climate change through long term-studies, short course trainings and exchange study tours in and out of the country and the region.
- iii. Establishment of data management system for collecting and sharing data and information on water resources related climate change issue and adaptation/mitigation capacity to related stakeholders; (A&M)
- iv. Establishment and or improvement of networks for meteorology and hydrology to manage and control for example temperature, rainfall, flood, drought and weather impacted by climate change; (A)
- v. Mobilization of secured financial resources for programs/projects, research and development on water resources-climate change adaptation or mitigation from both the government agencies and development partners; (A&M)

- vi. The appropriate capacity of local farmers, especially FWUC members, on the selection of less-water-crop varieties, and the planning of less-water-crop system for climate change adaptation. (A&M)
- vii. Development of long-term water resources integrated planning of providing best chance of minimizing the sea-level rise's negative effects; (M)
- viii. Strengthening the cooperation and coordination mechanism among different sectors agencies at local, national, regional and international level applying IWRM aspects to response the climate change adaptation and/or mitigation; (A&M)
- ix. Improve and introduce high technologies in water work development in order to respond to the negative impacts of CC. (A)

### 5.1.5 Climate Change Roadmap and Implementation Plan for water resources

Aligning with the government National Strategic Development Plan (2009 – 2013), the MOWRAM set its strategic roadmap for water resources climate change-related management and development plan as followings:

1. Capacity building for staff and farmer/publics on CC adaptation/mitigation in regards to water resource development and management.
2. Mobilize high technology and financial resources for water resources and meteorology development in highly responding to CC impacts.
3. Data management in regards to water resources and meteorology for timely CC responses.
4. Develop integrated long-term water resources and meteorology countrywide plans for CC adaptation and mitigation.
5. Establish national policy and legislations in an emerging needed CC responded for water resources and meteorology management.
6. Strengthen inter-ministerial coordination in the framework of CC adaptation and mitigation.

Gender mainstreaming in water resources management and development is one of the most important targets of the MOWRAM. A gender balance in water resources and meteorological management is firmly implemented as followings:

- Improve gender balance in water resources management through capacity building;
- Create opportunities for women in socio-economic and political participation;
- Mainstream gender balance and supports for both national and sub-national levels;
- Engage women in capacity building through on-the-job training in office and in abroad;
- Ensure that water resources related-services benefit to women especially in the FWUC.

### 5.1.6 Water Resources-Climate Change Adaptation Strategy

Based on previous excellent achievement such as improvement of the irrigation system, rehabilitation of pumping stations and water pump, water supply and sanitation and establishment of Farmer Water User Community, the water-climate change adaptation strategy should be included for future plans. As the Master Plan of Water Resources Development in Cambodia has been developed with very detail and specific management

plans for many chapters of water schemes (MOWRAM, 2008), our water-climate change adaptation strategy should be focusing on main adaptive strategies and activities as followings:

- i. Awareness and knowledge on climate change related to water resources management and development must be mainstreamed to all water-related sectors development aspect at local, provincial and national levels through media system, TV spots, radio and campaign. The detail activities are as followings:
  - To strengthen and extend the hydrological and meteorological systems including data collection and dissemination;
  - To provide short, medium and long-term forecasts and warnings of droughts, floods and storms to the public and related institutions;
  - To improve the existing and install new hydrological and meteorological stations and staff/rain gauges in the selected rivers and locations including data collection and dissemination;
  - To establish hydrological observing system that provides real-time water level and flow data for forecasting purposes, and hydrological data for design of water resources projects, water resources management, and other purposes;
  - To install a meteorological observing system that provides real-time weather data for forecasting purposes, and climatological data for agro-meteorology, design and other purposes;
  - To provide public weather forecasts and warnings, and inform and educate the public about climate, climate variability, and climate change;
- ii. Staff capacity building on water resources-climate change through long term-studies, short course trainings and exchange study tours in and out of the country and the region.
  - To expand the surface water storage (reservoirs, ponds), channel capacities and drainage systems to ensure water supply and environmental sustainability way;
  - To extend the land area served by sustainable irrigation and/or drainage systems, particularly in areas with a high incidence of poverty;
  - To strengthen the technical and institutional capacity of MOWRAM to implement the I&D strategy;
  - To focus management effort on priority river basins and to conserve the ability of groundwater aquifers;
  - development and management plans;
  - To establish the capacity of FWUC's in participatory irrigation management and development (PIMD);
  - To facilitate increasing income in the irrigated agriculture sector, to ensure continued investment in water for crop production.
- iii. Establishment of data management system for collecting and sharing data and information on water resources related climate change issue and adaptation/mitigation capacity to related stakeholders. The detail activities are as followings:
  - Timely collect data on water resources-related climate change disaster and possible overcome strategies;
  - Provide open access to data of water resources development and management and meteorology;

- Based on historical records of water resources and meteorology data, provide and analyze possible CC vulnerability.
  - To study, rehabilitate and construct the system of flood protection embankment and drainage in the purpose of the natural disaster reduction related to water;
  - To improve and strengthen on weather and flood forecasting in real-term related natural hazards;
  - To respond immediately paying an action on pump and heavy equipment intervention, where are suffering and affected by drought, flood, and other water-related hazards;
  - To encourage and promote to the people and institutions at all levels participatively in flood mitigation measures and drought intervention;
  - To develop and enhance the national groundwater data and information base.
- iv. Establishment and or improvement of networks for meteorology and hydrology to manage and control for example temperature, rainfall, flood, drought and weather impacted by climate change. The detail activities are as followings:
- Provide timely prior warning information and trusted data;
  - Use all means of the meteorology systems to inform all possible risks caused by weather.
  - To strengthen the implementation and enforcement of law on water resources management, sub- decree on water management, irrigation management and transfer and others water related regulations to control and prohibit all construction projects that are impact to the water resources as well as eco-systems;
  - To develop and apply procedures for social and environmental impact assessment and mitigation;
  - To preserve the river flows and minimum water level of rivers, streams, lake for ensuring the ecosystems, social and cultural values, and navigation;
  - To prohibit and take necessary measures to the infilling or excavation of or encroachment on watercourses, seasonally inundated depressions, permanent water bodies, and the sea, where there would not be permitted and would be an impact on water resources, aquatic ecosystems or the environment;
  - To conserve and strengthen the ability of natural lakes to provide flood retention and support aquatic ecosystems;
- v. Mobilization of secured financial resources for programs/projects, research and development on water resources-climate change adaptation or mitigation from both the government agencies and development partners. . The detail activities are as followings:
- Develop financial plan for short, medium and long-term water resources management and development;
  - Mobilize all sources of funding for water resources management and development in response to CC.

- vi. The appropriate capacity of local farmers, especially FWUC members, on the selection of less-water-crop varieties, and the planning of less-water-crop system for climate change adaptation. The detail activities are as followings:
- Conduct research and development (R&D) paying more attentions of CC adapted crop species;
  - Closely engage members of FWUCs in CC adaptive crop species;
  - Conduct study tours for selective members of FWUCs in CC adaptation agriculture development.
  - To mobilize participation of farmers, stakeholders and the private sector in all stages of design, development and improvement of I&D systems
  - To enable FWUC, beneficiary and private sector participation in all stages of the development and management of I&D (PIMD);
  - To strengthen and expand Farmer Water User Communities, to enable them to participate in water management and allocation and to maintain irrigation infrastructure with effectiveness and sustainability,
  - To promote investment by international funding agencies and the private sector in supporting PIMD;

#### **5.1.7 Water Resources-Climate Change Mitigation Strategy**

Water ecosystems, such as wetland and marine water, are considered as areas for carbon sequestration and carbon stock. When the water areas such as wetlands changed for other development purposes such as agriculture activities, the carbon stock areas will be lost. In this regards, the climate change mitigation strategy in the water resources management should be to reduce the change of land use as much as possible. As law on water resources management states, the MOWRAM strategy in climate change mitigation should be to strengthen the enforcement of the law as much as possible. At the same time all water resources management regulations have to be strongly implemented. Water resources management and meteorology in regard to CC mitigation can mostly related main mitigation strategies and activities are as followings:

- vii. Development of long-term water resources integrated planning of providing best chance of minimizing the sea-level rise's negative effects. The detail activities are as followings:
- Prepare strategic plan for prevention methods/means to cope with sea-level rise that could negatively affect on agricultural development;
  - Provide R&D in biofuel and biogas development and utilization to members of FWUCs;
  - Mobilize all means to assist rural publics in biofuel and biogas utilization in order to minimize GHG emission.
  - To prepare a river basin inventory and database.
  - To develop the Nationwide Flood Hazard Map.
  - To study and the preparation of short-, medium-, and long-term development plans for river basins by taking comprehensive account of modifications to the

- hydrological system, particularly river flows and aquifer levels, to ensure that utilization of water resources at present and in the future is sustainable;
- To establish the Nationwide Irrigation and water sources Inventory including monitoring system;
  - stakeholders and beneficiaries in, the preparation and implementation of river basin
- viii. Strengthening the cooperation and coordination mechanism among different sectors agencies at local, national, regional and international level applying IWRM aspects to response the climate change adaptation and/or mitigation. The detail activities are as followings:
- Coordinate among ministerial agencies in law enforcement on water resources pollution prevention;
  - Strengthen coordination of all Water Resources and Meteorology line ministry from national to sub-national levels to mitigate impacts from CC.
  - To strengthen in cooperation with MRC on Flood Mitigation and international programmes to mitigate related to water hazards.
  - To strengthen an integrated approach to water resources and agriculture development and management, that at the same time considers all sources of water, linkages between the water resource and agriculture and other aspects such as land management, natural environment, the varying human and ecological demands on the water resource, and the need for many different disciplines to carry out effective management;
  - To promote and facilitate knowledge about, and participation by line agencies,
- ix. Introduce high technologies in water work development and rehabilitation in order to respond to the negative impacts of CC. The detail activities are as followings:
- To rehabilitate and reconstruct the existing irrigation system, in order to response the urgent need the use of water for agricultural production;
  - To develop and extent an appropriate water management technologies that are particularly suited to rain-fed agricultural areas,

## **6 Climate Change Strategic Plan for Meteorology**

### **A- Status of National Meteorological Services**

Department of Meteorology (DoM) is under the Ministry of Water Resources and Meteorology responsible for national meteorology services in Cambodia.

The key activities of DoM are (i) recording meteorological observation round the clock and (ii) providing weather information necessary for preventing and mitigating natural disasters, which can cause negative impacts on human societies, communities and its socio-economic development activities. DoM generates many types of meteorological information, which can serve several purposes in different sector such as agriculture, mining and manufacturing industries, aviation, and daily weather forecasting. DoM also provides warning and advisory

services to many administrative divisions of MOWRAM (?), concerned agencies, and mass media. DoM must improve its capabilities in order to provide better information on natural disasters warning in local, national and regional level. This situation urgently requires DoM to improve its meteorological services including weather information forecasting and dissemination to the public's demand and to meet the function and responsibility as a national meteorological organization.

## **B- Current Situation**

### **B1- Background of Staff:**

- Department of Meteorology there is 47 Staffs :  
Master degree holder: 4  
Engineer: 5  
Technician: 38

### **B2: Technical abilities:**

- The officer, engineer and technicians are educated and trained to handle all facilities and equipment. However, further specific trainings for better application and utilization of modern technologies remains a high requirement.

### **B3- Existing facilities and instruments for weather observation and forecasting:**

- 8 Automatic Weather Station
- 24 Manual Weather Station
- 124 rainfall gauging
- Global Telecommunication System: Playing the role of member of World Meteorology Organization (WMO), data collection platform system can be possible to transmit observed meteorological (synoptic) data from Cambodia to Japan Meteorological Agency (JMA) as a GTS hub of WMO disseminate these data with the cord number of Cambodia onto GTS network to all the world.
- Satellite Imagery Receiving System: Receive and displaying GMS (MTSAT) satellite and imagery
- Weather Doppler radar System: Support Short-Term now casting and logging of meteorological phenomena. They provide civil protection managers with timely and accurate data to support decisions on the issue of alerts and the implementation of preventative action in cases of severe weather approaches or imminent flooding. And Support atmospheric research on regional climates and climate change.

### **B-4 Problem to be solved in the sector:**

Frequently being victim of natural calamities like heavy rain, flooding, strong wind, drought, etc. in Cambodia is one of the major natural disaster prone areas of the world. Consequently, the Department of Meteorology faces extreme difficulty in providing forecast and warning accuracy and reliability.

For reduction of natural disasters, safety and surveillance of hazardous weather in Cambodia, improvement of meteorological services and activities for hazardous weather is indispensable

to know what is the exact Cambodia's weather condition and what and where natural disaster occur.

## **6.1 Goals and Objectives for Meteorology**

- Goal:
  - To be a trust organization in providing excellent weather forecasting and climate information service for Cambodia.
- Objectives:
  - To improve and upgrade weather forecasting management system with best available technologies
  - To improve human resource in national and provincial level to meet the requirement of high quality in meteorological information service.
  - To set up and improve a national early climate warning system and information relate to air pollution.
  - To establish and improve networking inside and outside the country.
  - Build a reliable and predictable meteorology service with appropriate technologies for the country to ensure the safety, security and wellbeing of the communities with sustainable development manner.
  - To contribute the improvement of the living standard of the people of Cambodia and to the development of socio-economic activities including activities of any sector not only in Cambodia but also in the region (ASEAN) through the provision of the improve hazardous information, and also to contribute to effective development of any sectors in Cambodia through international cooperation and staff-training activities.

### **6.1.1 The Strategy Framework for Meteorology**

Meteorological strategy plan (MSP) under climate change context shall help improving quality and quantity of meteorological development service, building capacity of meteorological institution including human resources, modeling for climate risk assessment and management, which all of these is an important element, contributing to the development of a sensitive climate change sectoral planning. MSP shall commits with the governmental sustainable development plan, as such National Sustainable Development Plan (NSDP), the governmental rectangular strategy, the Cambodia Millennium Development Goal, and align with the global efforts in combating global climate change.

### **6.1.2 Priority Meteorology climate change-related issues**

There are many issues, which always hamper the implementation activities. The following issues are typically identified as insufficient financial resources, lack of equipment, spares and consumables; inadequate human resource and skill personnel, data base management system; lack of coordination and networking mechanisms for exchanging and sharing information among stakeholders; and the final issue is related to lack of policy/regulation, guidelines to integrate and harmonize climate change into sectoral activity development.

### 6.1.3 Climate Change Impacts and Opportunities on Meteorology

Climate Change has severe impact on human development activities and its society. DOM's overall responsibility is to administer and operate the meteorological service in the country and sharing meteorological information to the enamoring countries as per WMO charter. In order to fulfill its obligation, DoM must take this opportunity to review and update and integrate new concepts, knowledge and information related to climate change into its sectoral strategic plan. The strategic plan shall be built base on the potential issues identified and the national policies and plans. SWORT together with holistic approach are basically used to prepare this strategic plan.

### 6.1.4 Climate Change Strategy for Meteorology

Programs	Goals	Objectives	Activities
a. Policy and regulation	Enhance meteorology service, monitoring and evaluation.	To Develop and implementation of outreach programmes to promote meteorology and related sciences.	<ul style="list-style-type: none"> <li>- Review policy and regulation and identify policy gaps and recommendation</li> <li>- Policy/regulation development &amp; mainstreaming</li> </ul>
b. Institutional arrangement and implementation procedure	Play role in hazards and risk management, and the mechanisms for coordination among organizations and institutions.	To ensure the institutional and operational structure are continually optimized for carrying out the Department of Meteorology mission in accordance with contemporary corporate strategy and priority.	<ul style="list-style-type: none"> <li>- Review institutional structure, its ToR, implementation procedure, human resource allocation, management schemes.</li> <li>- Improving institutional structure base on a,b,c, d,e.</li> <li>- Improving networking with mass media for weather forecasting dissemination</li> </ul>
c. Human resource development	Staff motivation and development	To encourage, support and recognize staff performance an ensure the availabilities of skilled and motivated staff for the future development and operation of the Department.	<ul style="list-style-type: none"> <li>- Conducting human resource and capacity need assessment at national and provincial levels.</li> <li>- Prepare specific capacity building programs and work plan for all levels. It should include knowledge on IT, climate modeling, data base management, data recording and processing, climate-hydro map development, agro-climatology, etc.</li> <li>- Prepare internal staff management procedure</li> </ul>
d. Database management and networking	To have a reliable data	To meet the present and future needs of	<ul style="list-style-type: none"> <li>- Establishing/improving climate data base management system,</li> </ul>

		general public and specialized user for reliable, responsive, climate data, information, monitoring, prediction and advisory services.	daily weather forecasting and early warning system. - Develop regional and international knowledge/information exchange network
e. Research and development	Develop of the scientific infrastructure to manipulate and analyses meteorological and related data.	To meet the present and future needs of the general public and specialized users for reliable, responsive, climate data, information, monitoring, prediction and advisory service	- Coordinate/facilitate/ with other research institutes/government agencies to identify potential climate relate activities, - Conduct scientific researches and studies to improve weather forecasting service, early warning information, - Sharing research and study information to public, particularly to the most sensitive climate-threat areas within the country.

### 6.1.5 Climate Change Roadmap and Implementation Plan for Meteorology

Strategic roadmap of meteorology for change-related management and development plan as followings:

Four strategic roadmap of meteorology for climate change-related management and development plan

Strategic plan	Action Plan
1) Meteorology management and development with the changes of climate	- Manage and develop effectively, equitably and sustainably.
2) Flood and drought management	- Reduce Impacts from floods and droughts on people lives, property and livelihoods through the accuracy weather forecast and climate information dissemination.
3) Data management and methodology analysis development in regards to meteorology	- Develop and manage based on sufficient data and information and capacity analysis.
4) Improve administrative management and human resources development	- Strengthen and improve administrative and management systems, human resource for better in meteorology management.

### 6.1.6 Meteorology -Climate Change Adaptation Strategy

Throughout history, the adjustment of natural and human systems to climate change and climate variability has been the rule rather than the exception. Humans have always adapted to changes. It is a matter of survival. However the unprecedented pace of the current changes and the increasing complexity of our societies and economies suggest that isolated,

spontaneous and self-regulated adaptation mechanisms are not sufficient anymore. Climate change adaptation is a dynamic social process determined partly by our ability to act collectively.

Adaptation to climate change refers to the capacity of natural and human systems to reduce vulnerability against actual or expected climatic stimuli and their effects on society, the economy and the environment (UNFCCC).

The Strategy along with this part is included many goals of Department of Meteorology for Achieving as following:

Goal	Objective	Activity
Enhance Climate service to help communities understand and adapt to climate-related risks.	<ul style="list-style-type: none"> <li>- To Enhance National Weather Service to support development climate services.</li> </ul>	<ul style="list-style-type: none"> <li>- Create a suite of forecast to address local needs.</li> <li>- Engage National and local users to understand climate issue</li> </ul>
Improve Weather decision services for events that threaten safety, health, water resources, the environment, and economic productivity.	<ul style="list-style-type: none"> <li>- Provide demand-driven, impact-based weather service.</li> <li>- Utilize emerging science and technology to improve weather prediction</li> </ul>	<ul style="list-style-type: none"> <li>- Define warnings to focus on impact events targeting.</li> <li>- Generation integrated observing systems to address the needs for real-time weather and climate data.</li> </ul>

## 7 Water-Climate Change Cross-Sectoral Issues

On the domestic front the sources for water law in Cambodia are many and varied. They include:

- The New Constitution of the Kingdom of Cambodia 1993, Articles 58 and 59 (January, 1995);
- The Law on Environmental Protection and Natural Resource Management 1996, Article 8;
- The Land Law 2001, Articles 144–146, Article 155–159, Article 49 (East-West Management Institute, 2003);
- The Law on Fisheries Management and Administration 2006
- Circular No.01 (11 January 1999) on the “Implementation Policy of Sustainable Irrigation Systems”, and
- The law on Water Resources Management 2007.

With these laws and regulations, and with the mandates of MOWRAM, there are a couple of key agencies, government and non-government, that need to closely coordinate works for water resources management and development (table 4.3.8a).

table 4.3.8a: Institutional Involvement in water resources management and development

No.	Key Agency	Mandate
1	Ministry of Water Resources and Meteorology	Water resources management, development and conservation, irrigation, meteorology systems
2	Ministry of Industry, Mine and Energy	Use of water and hydropower management includes:

		<ul style="list-style-type: none"> <li>- Planning industrial water uses and hydropower,</li> <li>- Water supply provision to provincial towns</li> </ul>
3	Ministry of Rural Development	Provision of wells and water sanitation such as portable water systems and drainage in rural areas
4	Ministry of Public Work and Transport	<ul style="list-style-type: none"> <li>- Land drainage and sewerage in Phnom Penh and provincial towns</li> <li>- Study, survey, construction and maintenance of river works for navigation and water transport.</li> </ul>
5	Ministry of Environment	Water pollution control, Environmental Impact Assessment and licensing, Ramsar sites and Tonle Sap biosphere Reserve development and management
6	Ministry of Agriculture, Forestry and Fisheries	water for agriculture, livestock, and join Strategy on Agriculture and Water (SAW) implementation
7	Cambodia National Mekong Committee	Coordination for Mekong River Basin management and development, and international agreement implementation among signatory countries. Liaise between MRC and Cambodia government agencies.
8	Cambodia National Disaster Management Committee	Coordination for pre-, during-, and post disaster management and rehabilitation especially during and after flood and drought events
9	Tonle Sap Authority	Coordination for Tonle Sap Lake management and development
10	Various NGO agencies, e.g. Disaster Preparedness Program European Commission Humanitarian Aid Department(DIPECHO)	Various mandates related to water resources management and development, especially in regards to livelihoods improvement and development

As shown in the table below, water is widely used for various sectors including agriculture, domestic uses, livestock, industry and others (Table 4.3.8a). Due to the fact that several government ministries are responsible for those sectors, MOWRAM has to play crucial roles in both coordination and technical development to align with the development of other sectors. In many cases few other Authorities such as Tonle Sap Authority and National Committee for Disaster Management, have their own (sometimes overlapping duties) specific roles in water resources management and development.

**Table 4.3.8b: Uses of Water in Cambodia and governmental ministries' responsibilities**

Water Use for	Million m <sup>3</sup> /year and Percentage (number shown in the parenthesis)	Responsibility of Government Ministry
Agriculture	455 (56)	MAFF
Domestic Use	136 (17)	All (Main ministries should be MoE, MIME, and city administrations)
Livestock	100 (13)	MAFF
Industry	30 (4)	MIME
Other	79 (10)	All

## 7.1 At National Level

Related to the issue of water governance is the rule of law, and the legal frameworks put in place to regulate water. The starting point for the analysis of a regulatory framework as it pertains to water resources management is firstly to identify and secondly to evaluate the existing domestic and international legal frameworks. Research initially needs to determine what the rules are, and when and how these rules apply. To achieve the key objectives of sustainable development and equitable outcomes any regulatory framework for water

management should address the triple concerns of appropriate implementation, enforcement and conflict resolution mechanisms. Customary legal systems are also important in water management. Customary legal systems are those based on existing norms and practices, whereas formal legal systems are those backed up by law and state apparatus. Both are important in the context of water resources management internationally.

There are many commentaries on the impediments to the enforcement of laws in Cambodia. Some of those hurdles are related to the provisions of law and enforcement which may be the result of jurisdictional overlap, the absence of transparency mechanisms and a lack of political will. It is also important to clarify the regulatory framework as it applies to the legal agreements for water use ownership rights, especially at the local level with the Farmer Water User Community (FWUC) (see [annex 2 for](#) an example case of institutional coordination).

## 7.2 At Sub-national Level

In the fact that government officials of the provincial department, particularly the provincial department of water resources management and meteorology (DOWRAM), normally are limited in knowledge of climate change makes difficult for coordination matters among themselves at the provincial levels and between them and the national offices. It is worth noticed that due to the fact that the MOWRAM, as same as DOWRAM, is one of the young ministries that was established in 1999.

- Capacity and human resources
- Staff movement and relocation
- Financial supports
- General people knowledge in water-climate change related issues and sustainable development or water uses

## 8 Key Water Resources-Climate Change Response Activities and Risks

MOWRAM has been identified one of the most key ministries to address CC (table 4.3.9). The World Bank program PPCR (RGC-c, 2011) proposed \$33 million investment in the water resources sector: the proposed budget will be implemented as two components (Climate Risk Management and Rehabilitation of Small- and Medium-scale Irrigation Schemes in the Tonle Sap Basin, and Enhancement of Flood and Drought Management in Pursat and Kratie Provinces) to support both soft and hard interventions. Support to MOWRAM, especially the Departments of Water Resources Management and Conservation; and the Department of Meteorology, also seeks to build its capacity. At the same time the ministry has implemented skill enhancement and livelihood improvement of farmers and women increasing capacity of preparedness to climate extreme events like floods and droughts, community-based disaster risk reduction and climate change adaptation.

Together with MAFF, the MOWRAM implements the Strategy for Agriculture and Water (SAW, 2010 - 2013). The climate change related focus of the SAW has been on post-disaster emergency relief (SAW, 2010). The SAW takes into account the climate change impacts such as floods and droughts through interventions in Food Security and Water Resources

Management, and recognises climate change as one of the threats to agriculture and water long-term management.

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<b>Table 4.3.9: Key Water Resources-Climate Change Response Activities and Risks</b>			
<b>Main Items</b>	<b>Activity</b>	<b>Risk</b>	<b>Assumption</b>
Farmer Water User Committee (FWUC ) improvement and establishment	<ul style="list-style-type: none"> <li>- Mobilize all efforts and resources in order to improve existing FWUCs</li> <li>- Identify and establish new potential sites/areas for FWUC establishment.</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of financial support</li> <li>- Capacity of farmers in participation.</li> </ul>	Government policy supported
Integrated Water Resources Management (IWRM)	<ul style="list-style-type: none"> <li>- Enhance IWRM mechanism to manage water resources in the due course of CC.</li> <li>- Continue to coordinate among related key ministries for the process of IWRM</li> </ul>	<ul style="list-style-type: none"> <li>- Matter of coordination and willingness of key stakeholders</li> <li>- Unpredictable CC vulnerability</li> </ul>	Government policy supported
Private Sector involvement and responsibility	<ul style="list-style-type: none"> <li>- Engage private sectors in Payment for Environmental Services (PES),</li> <li>- Specific awareness raising for private companies in adapted climate change development,</li> <li>- Encourage private companies in low carbon development and sustainable development.</li> </ul>	<ul style="list-style-type: none"> <li>- Comprehensive national policy would be implemented,</li> <li>- Financial support to continuous law enforcement.</li> </ul>	Government policy supported
Decentralization and good governance in Water Resources Management	<ul style="list-style-type: none"> <li>- Deliver more mandates on water resources management to sub-national levels,</li> <li>- Capacity building in water resources management and uses of modern weather technologies to sub-national levels.</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of national financial support.</li> </ul>	Government policy supported
<b>“Master Plan” for Water resources management and development developed</b>			
Comprehensive water control schemes	<ul style="list-style-type: none"> <li>- Develop a long-term plan of national water control to prepare for possible heavy rain casualties caused by abnormal climate change</li> <li>- Establish flood prevention measures in the riskier regions such as in populated areas and agriculture potential sites</li> <li>- Build flood warning system</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of financial support</li> <li>- Lack of human resource</li> </ul>	Government will is committed
Preparation for the urbanization problem	Take measures against negative impacts on water resources from urbanization development such as stream flow reduction, worsened water quality, and draining water.	<ul style="list-style-type: none"> <li>- Coordination among relevant agencies</li> <li>- Knowledge of CC of the relevant agencies.</li> </ul>	Government will is committed
Securing stability of water use	<ul style="list-style-type: none"> <li>- Prepare water use considering drought</li> <li>- Build stabilized irrigation systems addressing reduced precipitation caused by CC</li> </ul>		
Safe water supply	Preserve water quality of the water supply sources (river, lake, etc) coping with the CC vulnerabilities.		
Groundwater utilization	<ul style="list-style-type: none"> <li>- Development of groundwater preservation plans</li> <li>- Develop groundwater restriction regulation</li> </ul>		
Comprehensive plan on river environment	<ul style="list-style-type: none"> <li>- Build foundation for river water utilization and control.</li> <li>- Ensure functions of river environment including ecological system</li> </ul>		

	preservation and water-familiar function.		
Water Research and Development	<ul style="list-style-type: none"> <li>- Conduct research on what matter most on water resources as impacts of CC.</li> <li>- Prioritize CC coping activities on sustainable water resources development and management.</li> </ul>		

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## 9 Financial Resource Planning

Financial sustainability is a crucial issue in many areas of the economy, including those in the water sector. Water resources management and development requires large investment. At the present the annual investment in water resources management and development is limited. Funds available for rehabilitation, operation and maintenance of hydraulic infrastructure, meteorological forecasting systems, and hydrological monitoring systems also are limited.

There are two sources of funds: the government and donor-support. The current and proposed project budget for the 2009 – 2013, is estimated of US\$1,250,024,000. Of which national budget is US\$99,500,000 and donor-support budget is US\$1,150,524,000. Up to date, the donor budget is only pledged (with agreements with the donor partners) US\$206,200,000. The budget figure is planned annually as shown in the table (3.4.9) below:

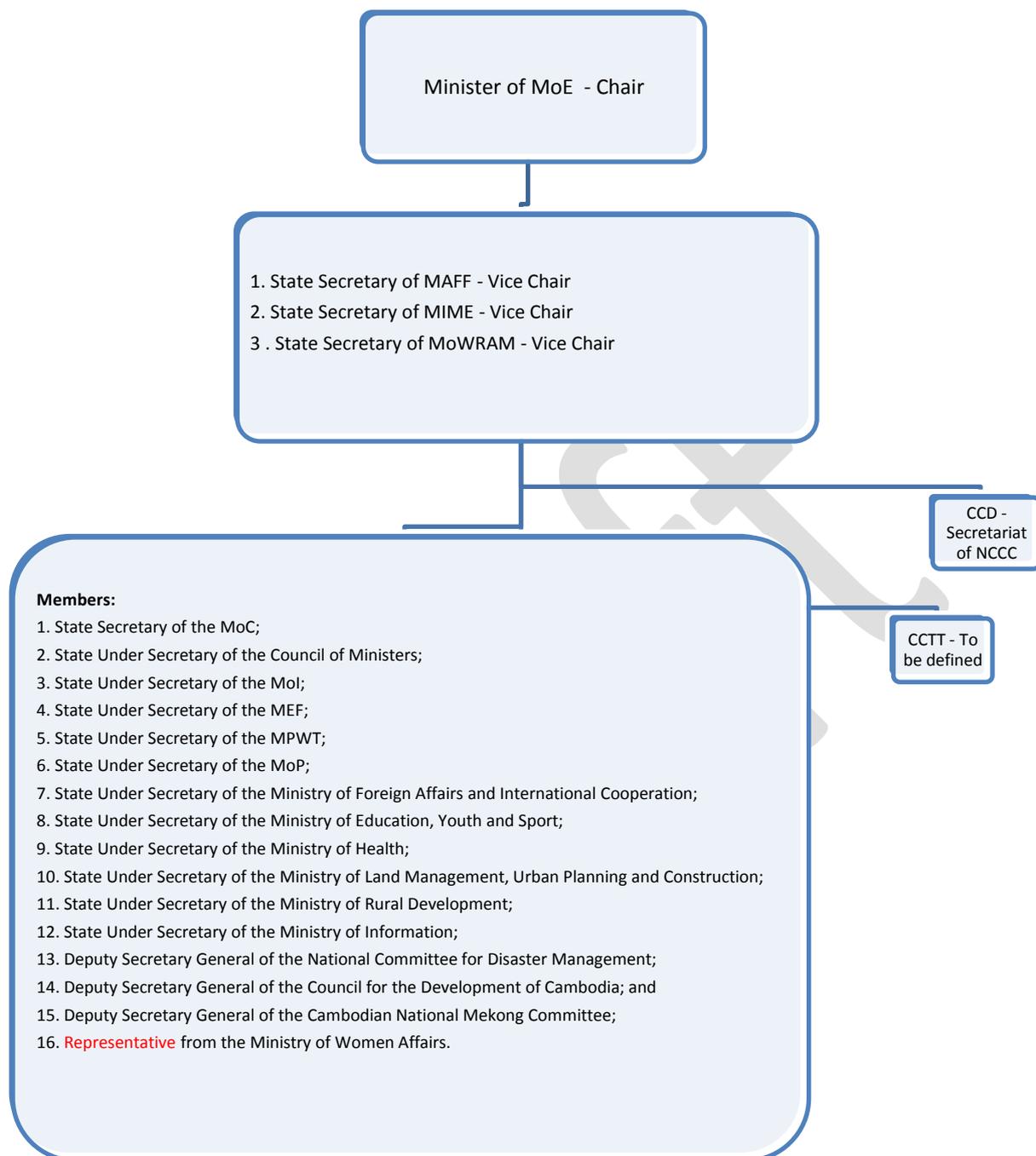
**Table 3.4.9:** Planned budget figure for 2009 – 2013 (see annex 3 for detail)

Year	National Budget	Donor and Foreign investment		Total
		Signed agreement	Donor needed	
2009	13,902,000	31,200,000	0	45,102,000
2010	23,962,000	38,700,000	211,785,000	274,447,000
2011	22,645,000	50,300,000	2,249,63,000	297,908,000
2012	18,000,000	46,500,000	245,746,000	310,246,000
2013	20,991,000	39,500,000	261,830,000	322,321,000
Total	99,500,000	206,200,000	944,324,000	1,250,024,000

For the current time, developments in hydropower and urban water supply in cities, provincial towns and densely populated areas are being taken into government consideration. At the same time there are investments by local and foreign investor, donor and donated-funding agencies. To address the current issues, the RGC has committed to the following policies:

- Encourage and facilitate investors, private enterprises, and communities to participate in water resources management and development;
- Gradually transfer small and medium scale irrigation systems to FWUCs to manage, operate and maintain among themselves;
- Monitor, and if necessary, modify water fees for operation and maintenance of irrigation systems by FWUCs;
- Privatize RGC owned water supply systems through leases or contract-management by openly bidding process;
- Modify service fees of private water supply systems;
- Modify service fees of private hydropower facilities;
- Take full responsibility of costs of flood and drought management and mitigation; and
- Coordinate for donor funds while increasing national budget for water resources management and development (Annex 3)

**Figure 4.4:** National Committee for Climate Change (NCCC) Structure.



## 10 Monitoring and Evaluation Framework

With the closely coordination among relevant agencies both government ministries and non-government agencies including private sector, the CC Strategic Plan (CCSP) will be strictly monitored by the mandated general departments and technical departments of MOWRAM. Following the steps of the National Water Resources Policy for the Kingdom of Cambodia (2004) and Law on Water Resources Management of the Kingdom of Cambodia (2010), the MOWRAM ensure that the CCSP will be monitored and water resources development secured.

With the other members of NCCC, especially the Chairman of the NCCC, the CCSP will be evaluated according to the comprehensive implementation and continued to develop as emerging tasks required. In coordination with other national policies such as SAW (RGC, 2010), the CCSP will be assessed its effectiveness and lessons learned; and based on these lessons learned future development of water resources management and development will be improved.

A system is needed to guarantee the release of transparency information and reports simultaneously to all stakeholders. Furthermore, it must ensure that “reporting” is translated into “feed-back”, which in turn is translated into “lessons learnt” that are incorporated in management routines. Monitoring levels include all aspects of water resources development, such as water uses for industry, irrigation, and private portable water, especially water for farmer water uses communities. Strengthening in law enforcement of water resources uses, conflicts and their resolution, social and environmental indicators and benefit sharing are needed to be taken into consideration. Indicators and instruments for gathering this information will be developed in consultation with stakeholders.

Monitoring outcomes and impacts is necessary for long term CCSP. As part of the monitoring process, key indicators of the CCSP for water resources and meteorology will be evaluated to milestones. Internal monitoring of implementation performance and efficiency at the activity/output level shall be undertaken. Internal finance monitoring and auditing should be developed as a standardized task.

## **11 Conclusion**

The climate change issues are ones of natural disaster hazards occurred in the country mainly flood and drought that affect mostly to socio-economic development and environmental problem. Lacking good practices in water and related management is the key that human activities are involved to climate change issues. The holistic approach of water resources management shall be incorporated to all sector aspects to response to climate change adaptation promoting capacity building and adaptive capacity of vulnerable people in affected areas. The sectors cooperation is appropriate though for this challenging process to support climate change adaptation. The National policies, strategies and regulations have been set as national framework to response the climate change issues and challenges of climate change adaptation of related hazards.

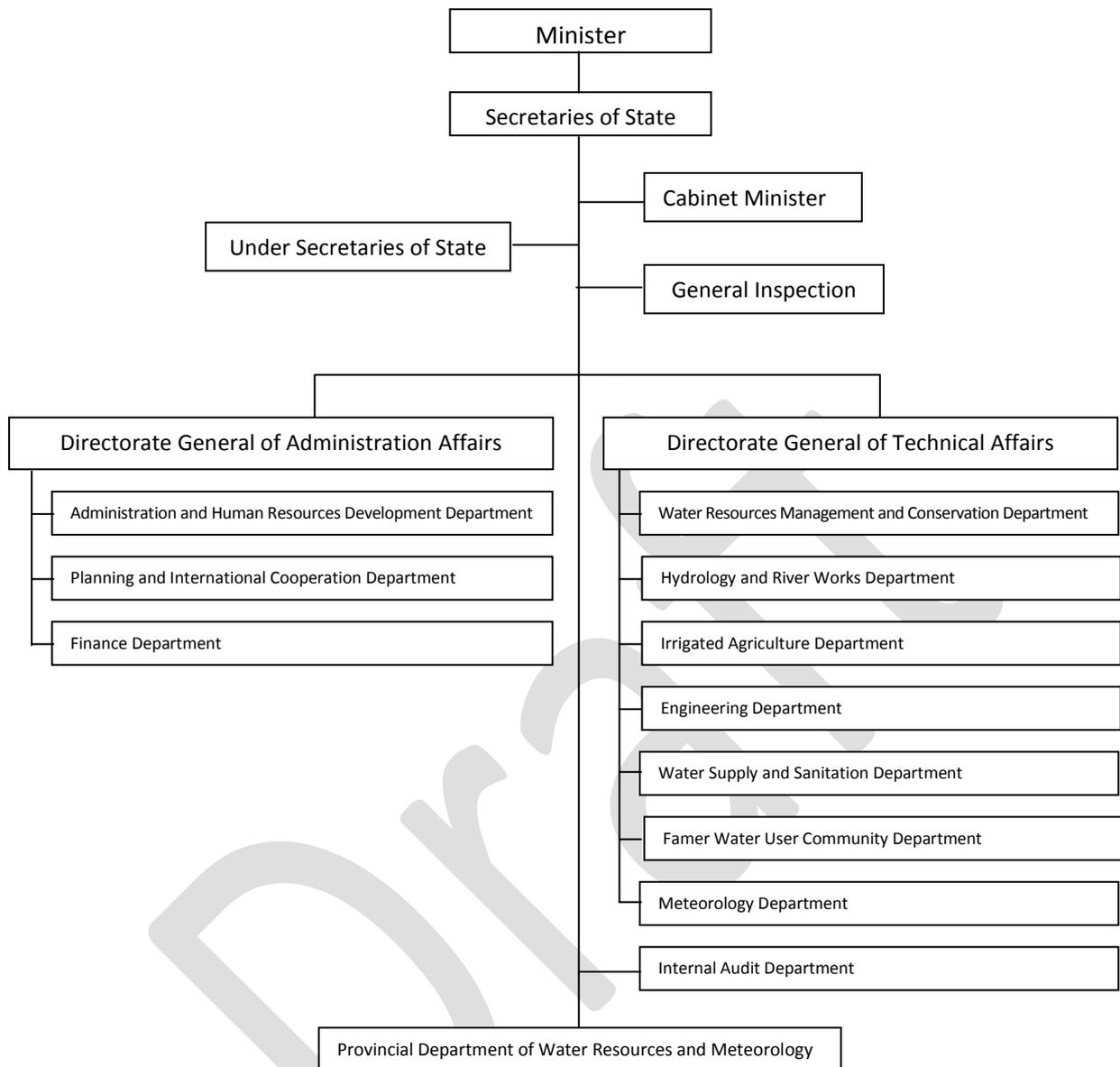
Being as Vice-Chair of the NCCC, the MOWRAM commits own strong involvement in the Global Climate Change mechanism though the implementation of NAPA and other water resources management legislations. Moreover, the Climate Change Strategic Plan for Water Resources Management will be taken into the Ministry’s principle for addressing CC in sustainable water resources management and development.

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**Annex 1:** Ministry of Water Resources and Meteorology Organization Chart



## **Annex 2: The Need for Coordination in the Tonle Sap Basin**

The need for improved coordination in the Tonle Sap Basin has been expressed from a number of perspectives. There is concern in Cambodia about the management of water resources, although water is not the only element to receive attention. Major concerns are:

- The natural regime of the Tonle Sap Lake, its tributaries and the Tonle Sap River joining the Lake to the Mekong River, is potentially under threat with unknown consequences for the Lake;
- Other important environmental and natural resources surrounding Tonle Sap Lake (in particular forested areas) have been degraded significantly and further deterioration might affect the value of the Lake;
- Considerable funds have been spent on social programs in the past 15-20 years, although there has been criticism that poverty in the Basin has not improved significantly;
- There are large numbers of projects in the Basin which, it is claimed, should be better coordinated.
- It is certainly true that the Tonle Sap Lake is potentially threatened by activities, both external to Cambodia (upstream development on the Mekong River) and within the basin (for instance development of water uses on tributaries flowing into the Lake). As has been extensively studied and reported, further damage could be caused to the Lake and its fisheries by the continued removal of natural forests and vegetation, as well as pollution and water degradation resulting from unregulated and inappropriate development.

The creation of the TSBA brings to attention two main fields of activity for coordination:

1. Social and economic programs whose objectives are to improve the wellbeing, livelihoods and financial status of people in the Basin;
2. Natural resources and environmental programs whose objectives are to ensure that the values of resources and the environment are maintained and not allowed to become degraded.

Possible coordination mechanisms relevant to improvement in these fields include:

- Coordinated development planning through strategic planning – a regional planning and development role;
- Coordination of planning and activity for specific natural resources, such as:
  - River basin planning, dealing with water utilization and protection of water bodies;
  - Coordinated forest management planning and control activity;
  - Watershed planning and coordination programs;
  - Coordinated planning and controls for environmental protection within the Basin.

Not all of the above need to be configured on river basin or sub-basin boundaries to the same extent or even at all – for example, forestry is usually coordinated on bio-regional zones and social programs according to administrative territory boundaries.

Coordination mechanisms can include:

- Organizations that control the activities of others and require or cause action to be consistent;
- Organization that brings together members or representatives of various agencies to agree on common action;

TSBA confirmed that it does not expect to have a direct role in water resources planning at river basin or sub-basin scales. That is a function for water sector river basin organizations (RBOs), as traditionally understood. Instead, the TSBA planning activity will focus on multi-sectoral strategic planning for the Basin and will cover economic, social and other programs. Since water resources-based technical planning will not be undertaken by TSBA, it needs to be undertaken by others. MOWRAM has the mandate for such planning and the sub-decree on river basin planning being drafted by that ministry would provide for the establishment of river basin or sub-basin scale organizations and hydrology-based planning to assess water resources availability and water quality characteristics and impacts. Such planning is needed to evaluate the viability of new or upgraded projects that use water – as to whether conflicts will arise due to water scarcity. (text excerpted from Paul Taylor and Bouy Kim Sreang. 2008. Cambodia: Preparing the Water Resources Management (Sector) Project. The Asia Development Bank)

**Annex 3:** Budget estimated for 2009 – 2013 To be updated by MOWRAM (Unit: US\$1,000)

Project name	Source of fund	Project duration	Project cost	Annual investment cost						Approved fund		Additional fund needed
				2009	2010	2011	2012	2013	Total investment cost, 2009 - 2013	Government	Donor	
<b>A. Government Budget Project</b>												
<b>I. On-going project</b>												
Building Construction of Department of Water Resources Management and Meteorology in provinces	government	2002-2013	2,093	100	250	250	300	342	1,242			
Strengthening FWUC in 25 sites	government	2002-2012	348	30	80	80	100		290			
Multiple development project in the areas of western Phnom Penh	government	2004-2010	12,378	4,869	1,621				6,490			
Rehabilitation of 29 irrigation sites	government	2007-2011	21,850	1,714	1,611	1,720			5,045			
Rehabilitation of 19 irrigation sites	government	2008-2011	12,400	1,465	1,500	1,385			4,350			
Maintenance of irrigations	government	2009-2011	8,000	2,000	3,000	3,000			8,000			
Irrigation data collection and data entering	government	2009-2013	80		20	20	20	20	80			
Rehabilitation and establishment of 26 irrigation sites	government	2009-2013	24,863	3,724	5,000	5,000	5,000	6,139	24,863			
<b>Total I:</b>			<b>82,012</b>	<b>13,902</b>	<b>13,082</b>	<b>11,455</b>	<b>5,420</b>	<b>6,501</b>	<b>50,360</b>			
<b>II. High Priority project – under discussion</b>												
Establishment of FWUC	government	2010-2012	9,000		2,000	2,000	2,500	2,500	9,000			
Rehabilitation of 30 irrigation sites	government	2010-2013	10,000		2,000	2,000	3,000	3,000	10,000			
Rehabilitation of 35 pumping stations	government	2010-2013	9,000		2,000	2,000	2,000	3,000	9,000			
Establishment of 20 pumping stations	government	2010-2013	6,000		1,500	1,500	1,500	1,500	6,000			
Reparation of 420 small pumping machines	government	2010-2013	2,100		500	500	500	600	2,100			
Rehabilitation and improvement of 85 canals	government	2010-2013	4,300		1,000	1,000	1,000	1,300	4,300			
Rehabilitation of main canal in Koah Kralar	government	2010-2013	4,500		1,000	1,000	1,000	1,500	4,500			
Establish synoptic meteorological stations in provinces	government	2010-2013	300		60	70	80	90	300			
Provide meteorological	government	2010-2013	240		120	120			240			

Equipments in provinces												
Hydrological and river activities	government	2010-2013	3,700		700	1,000	1,000	1,000	3,700			
Total II			<b>49,140</b>	<b>0</b>	<b>10,880</b>	<b>11,190</b>	<b>12,580</b>	<b>14,490</b>	<b>49,140</b>			
Total I + II			<b>131,152</b>	<b>13,902</b>	<b>23,962</b>	<b>22,645</b>	<b>18,000</b>	<b>20,991</b>	<b>99,500</b>			
<b>B. Donor Budget Project</b>												
<b>I. On-going project</b>												
Center for irrigation training services	Japan	2002-2011	5,250	500	500	500			1,500		1,500	
Irrigation development in northwest areas	ADB+AFD	2005-2013	30,870	3,500	5,000	6,000	6,000	6,500	27,000		27,000	
Basac Dam reparation in Battambang province	Japan	2008-2010	2,100	1,300	200				1,500		1,500	
Reparation of Kamping Poy irrigation for the second step	FAO	2006-2010	1,600	500	500				1,000		1,000	
Stung Tasal River Basin Develop	India	2009-2012	15,000	2,000	4,000	4,000	5,000		15,000		15,000	
Rehabilitation of irrigation infrastructure in east and northeast areas	IMF	2007-2011	33,800	13,000	8,000	2,000			23,000		23,000	
Krang Ponley River Basin Development	Korea	2006-2013	26,700	4,000	3,500	5,000	5,500	6,000	24,000		24,000	
Water resource and irrigation management in Kampot, Takeo and Kg. Thom	Australia	2009-2013	13,400	400	2,000	4,000	4,000	3,000	13,400		13,400	
Rehabilitation of Kandal Stung irrigation step 2	Japan	2009-2011	3,200	1,000	1,000	1,200			3,200		3,200	
Reparation of Roleang Chrey Watergate, Kg. Speu province	Japan	2009-2011	4,600	1,500	1,500	1,600			4,600		4,600	
Rehabilitation of canals along Cambodia-Vietnam borderlines	WB	2009-2012	3,000	500	500	1,000	1,000		3,000		3,000	
Sustainable Tonle Sap Lake	ADB	2009-2013	28,000	3,000	3,000	7,000	7,000	8,000	28,000		28,000	
Stung Sen River Basin Multipurpose Water Resources Development Project , Kg. Thom province	Kuwait	2010-2015	356,000		8,000	16,000	16,000	16,000	56,000		56,000	
Stung Sreng reservoir rehabilitation	India	2010-2012	5,000		1,000	2,000	2,000		5,000		5,000	
<b>Total I</b>			<b>528,520</b>	<b>31,200</b>	<b>38,700</b>	<b>50,300</b>	<b>46,500</b>	<b>39,500</b>	<b>206,200</b>	<b>0</b>	<b>206,200</b>	
<b>II. High Priority project – under discussion</b>												
Enhancement meteorological services	Japan	2010-2013	7,200		1,000	1,400	1,400	3,400	7,200			7,200
Rehabilitation of 30 hydrological system sites	Donor needed	2010-2012	370		120	120	130		370			370
Water Policy awareness raising	Donor needed	2010-2012	100		30	30	40		100			100
Develop irrigation system	Donor	2010-2013	30,000		5,000	5,000	5,000	15,000	30,000			30,000

Vayko	needed											
Assessment study on monitoring system of hydrology improvement	Donor needed	2010-2013	5,000		500	1,500	1,500	1,500	5000			5,000
Repair Prey Nup reservoir	Donor needed	2010-2012	1,400		400	500	500		1,400			1,400
Repair O Damrey Chhlorng irrigation system	Donor needed	2010-2011	600		300	300			600			600
Develop Ang Stung Slakou irrigation system	Japan	2010-2013	14,000		1,000	1,000	6,000	6,000	14,000			14,000
Flood prevention project along the Mekong River	GMS	2010-2013	10,800		1,000	2,000	2,000	5,800	10,800			10,800
Repair irrigation system and flood control in lower Mekong River	GMS	2010-2015	31,200		1,000	2,000	3,000	4,200	10,200			10,200
Develop irrigation system and flood control in Stung Pursat River Basin	GMS	2010-2015	101,200		2,000	3,000	3,000	4,000	12,000			12,000
Repair 6 irrigation system sites	Donor needed	2010-2011	565		200	365			565			565
Build irrigation system in Tamear and Sambo	Donor needed	2010-2013	15,180		4,000	4,000	4,000	3,180	15,180			15,180
Improve irrigation system in Kg. Thom province	Donor needed	2010-2013	10,000		2,000	2,000	3,000	3,000	10,000			10,000
Develop Stung Phleach	Donor needed	2010-2013	12,000		1,000	2,000	4,000	5,000	12,000			12,000
Manage and monitor groundwater	Donor needed	2010-2012	309		135	98	76		309			309
Develop irrigation system in Stung Sva Slap	India	2010-2013	15,900		3,500	3,500	4,000	4,900	15,900			15,900
Develop irrigation system in Kanghot, Battambang province	China	2010-2013	31,000		7,000	7,000	8,000	9,000	31,000			31,000
Flood prevention dam in Kampong Trabek River, Prey Veng province	China	2010-2013	22,500		5,000	6,000	6,000	5,500	22,500			22,500
Rehabilitation of irrigation and releasing systems in West Tonle Sap (Kg. Chhnang, Pursat and Battambang)	Japan	2010-2015	47,100		5,000	6,000	7,000	8,000	26,000			26,000
Rehabilitation of Mekey Chak, Svay Rieng province	Donor needed	2010-2012	3,000		1,000	1,000	1,000		3,000			3,000
Build Charek irrigation system, Pursat province	Donor needed	2010-2011	1,200		600	600			1,200			1,200
Rehabilitation of canal, Battambang province	Donor needed	2010-2011	1,000		500	500			1,000			1,000
Build M'Kak irrigation system,	Donor	2010-2013	6,000		1,000	1,000	2,000	2,000	6,000			6,000

Siem Reap province	needed											
Develop Monkol Borey dam, Banteay Meanchey province	Korea	2010-2013	19,000		4,000	5,000	5,000	5,000	19,000			19,000
Develop multiple purpose Dauntry dam, Battambang province	Korea	2010-2015	31,000		5,000	6,000	7,000	8,000	26,000			26,000
Rehabilitation of Stung Tauch and Bati reservoir, Kandal and Takeo provinces	Japan	2010-2013	22,000		5,000	5,000	6,000	6,000	22,000			22,000
Assess water resources in Pursat river	Donor needed	2010-2012	700		200	200	300		700			700
Assess Multiple purpose Battambang project	Korea	2010-2012	1,300		400	400	500		1,300			1,300
Assess water resources in Sangke river, Battambang	ADB	2010-2012	1,000		300	300	400		1,000			1,000
Management and development water resources program	ADB	2010-2015	45,000		6,000	6,000	6,000	7,000	25,000			25,000
Develop water resources in Stung Keo, Kampot	China	2010-2015	40,000		5,000	5,000	5,000	5,000	20,000			20,000
Develop water of Stung Pursat at dam 3 and dam 5	China	2010-2015	60,000		7,000	7,000	8,000	8,000	30,000			30,000
Water resources development in Stung Stong River Basin	China	2010-2015	80,000		20,000	20,000	20,000	20,000	80,000			80,000
Water resources development in Stung Sreng River Basin	China	2010-2015	100,000		25,000	25,000	25,000	25,000	100,000			100,000
Water resources development in North of Stung Prek Thnot reservoir	Korea	2009-2013	50,000		10,000	10,000	15,000	15,000	50,000			50,000
Water resources development in Stung Pursat River Basin	Korea	2010-2015	250,000		50,000	50,000	50,000	50,000	200,000			250,000
Rehabilitation of Sala Ta Aon dam, Battambang	Donor needed	2010-2012	5,000		1,000	2,000	2,000		5,000			5,000
Build Kamping Poy irrigation system, Battambang province	Donor needed	2010-2012	5,000		1,000	2,000	2,000		5,000			5,000
Rehabilitation of Koma main canal, Banteay Meanchey province	Donor needed	2010-2012	2,000		500	500	1,000		2,000			2,000
Build Bamnork irrigation system, Pursat province	Donor needed	2010-2013	10,000		2,000	2,000	3,000	3,000	10,000			10,000
Repair M'Sa Kraong reservoir, Kg. Thom province	Donor needed	2010-2012	1,200		400	400	400		1,200			1,200
Establish water quality monitoring stations around Tonle Sap lake	Donor needed	2010-2013	700		100	150	200	250	700			700
Establish meteorological forecasting stations along main	Donor needed	2010-2013	1,000		100	200	300	400	1,000			1,000

rivers												
Awareness raising on water resources management law	Donor needed	2010-2013	400		100	100	100	100	400			400
Mapping projects on wetland	Donor needed	2010-2013	800		200	200	200	200	800			800
Collect and entry irrigation system data	Donor needed	2010-2013	750		150	200	200	200	750			750
Gender mainstreaming in water resources management	Donor needed	2010-2013	1000		250	250	250	250	1000			1000
Assess and repair 14 water released system sites	Donor needed	2010-2013	6000		1500	1500	1500	1500	6000			6000
Build 5 portable water systems	Donor needed	2010-2013	5000		1000	1000	1000	2000	5000			5000
Study and collect groundwater data	Donor needed	2010-2013	350		50	100	100	100	350			350
Rehabilitate Tatam river, Prey Veng province	Donor needed	2010-2013	1400		300	300	400	400	1400			1400
Repair Chan Thnal irrigation system, Kg. Speu province	Donor needed	2010-2011	900		400	500			900			900
Repair Achang irrigation system, Kg. Chhnang province	Donor needed	2010-2011	800		300	500			800			800

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