Kingdom of Cambodia

Nation Religion King

Ministry of Water Resources and Meteorology

Climate Change Strategic Plan for Water Resources and Meteorology

(2013-2017)

Phnom Penh, 2012

Executive Summary

The Kingdom of Cambodia is considered one of the most water-abundant countries in the region. Rivers and streams, lakes, aquifers and marine water 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's 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 meters of surface water runoff; and 17.6 million cubic meters of aquifer ground water. 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 their systems play vital roles in maintaining aquatic ecosystems, and provide natural resource bases for national economic and social development. Agriculture and fisheries are the main sources of national and family incomes. Agriculture alone generates some 31.4% (2005) of the country's Gross Domestic Product (GDP) annually.

However, it has been accepted 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 shortages and floods. Challenges are more threatening to a developing country like Cambodia, where meteorological systems are not yet able to forecast extreme weather, like flash floods and unpredicted drought, which have often happened in Cambodia.

The approximate cost for the implementation of the Climate Change Strategic Plan (CCSP) for Water Resources and Meteorology is estimated at US$1,250,024,000 over four years. Financial sources vary from national, bilateral, multilateral and NGO support. There could be some small contribution from the private sector for the CCSP implementation.

For successful implementation of the CCSP for Water Resources and Meteorology, capacity building and climate change awareness-raising are vital priorities, and should be initiated at the very beginning of the strategy. Most importantly, there must be strong commitment to coordination and collaboration by all relevant stakeholders from each sectoral agency.

Introduction

Climate change poses immense threats and new opportunities for development of water resources in Cambodia. The Royal Government of Cambodia (RGC) understands that, increasingly, climate change impact is an urgent and critical issue. Climate change could potentially have negative impacts on Cambodia's society and natural resources, including natural ecosystems.

The Ministry of Water Resources and Meteorology (MoWRAM) has committed itself to overcoming the impacts of climate change, introducing a law on water resource management, a national water resource management policy and strategy, and many more guidelines and regulations for better climate change-adapted management and development. The ministry considers the development of Farmer Water User Committees as chief among its many immediate tasks, as farmers are the group most vulnerable to climate change impacts. A countrywide master plan for water resource management is in the process of being developed, with the support of the Republic of Korea and the RGC, under the leadership of ***Samdech Akka Moha Sena Padei Decho Hun Sen***, the Prime Minister of Cambodia.

The CCSP for Water Resources and Meteorology is another outcome that MoWRAM has developed. It is believed that the CCSP for Water Resources and Meteorology would contribute to further development of a national climate change strategic plan, which would address climate change impacts on the country's socio-economic development, while adapting as much as possible.

Acronyms and Abbreviations

ASEAN	Association of South-East Asia Nations
CC	Climate Change
CCSP	Climate Change Strategic Plan
CMDG	Cambodia Millennium Development Goal
CNMC	Cambodia National Mekong Committee
FWUC	Farmer Water User Committee
GDP	Gross Domestic Product
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 and Meteorology
MRC	Mekong River Commission
NAPA	National Adaptation Plan of Action
NCCC	National Committee for Climate Change
NCDM	National Committee for Disaster Management
NSDP	National Strategic Development Plan
RGC	Royal Government of Cambodia
RS	Rectangular Strategy
SAW	Strategy for Agriculture and Water
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change
WHO	World Health Organization

Contents

1 National endeavour and sustainable use of water resources

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

During the monsoon wet season, the Mekong River swells, with water reaching a flood discharge of 32,000 to 35000 m^3/s at Phnom Penh Chroy changvar. 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 four to seven months. During this period, floods damage large areas 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 with plenty of water for family use and national economic development, especially agriculture. The 42 sub-basins are located along the tributary rivers of the Mekong and Tonle Sap rivers.

1.1 Water resources, agriculture and the national economy

The Kingdom of Cambodia is considered one of the most water-abundant countries in the region. Rivers and streams, lakes, aquifers and marine water 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 meters of surface water runoff; and 17,600 million cubic meters of aquifer ground water. 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 their systems play vital roles in maintaining aquatic ecosystems, and provide natural resource bases for national economic and social development. Agriculture and fisheries are the main sources of national and family incomes. Agriculture alone generates some 31.4% (2005) of the country's GDP annually.

Water is used for household, agriculture, industry, hydropower, navigation and tourism. The maximum quantity of water used each year is estimated to be 750 million cubic meters (10% of the country's total available water), of which 95% (710 million cubic meters) is used for irrigated agriculture. There is no 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's Rectangular Strategy on Growth, Employment, Equity and Efficiency (Phase 2, 2008), the NSDP Update (2009-2013), and the SAW (2009-2013). It has been accepted that climate change 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 shortages and floods. Challenges are more threatening to a developing country like Cambodia, where meteorological systems are not yet able 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 normally occurs during the 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 due to contaminants being diluted to a much smaller extent. In addition, due to human population growth and socio-economic development, water quality has been increasingly threatened, especially during the dry season, and particularly during years of less rainfall.

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 areas of agriculture, water resources management and rural development. It also has taken particularly strong action in the areas of forest policy and management, including watershed management, and aims to achieve and maintain food security.

The RGC commits itself to the United Nations Conventions and various regional economic development programs and initiatives of the Association of South-East Asia Nations (ASEAN) and those in the Greater Mekong Sub-Region. Significantly, for the water sector, the RGC policy resumed membership of the Mekong River Commission since 1995. The RGC is committed to achieving 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 use. The Law includes several articles that deal with rights, organization and participation of water users. It emphasizes the integration of farmer water user committees (FWUC) into water resources sustainable management as the most important and decentralized scheme of the RGC for poverty alleviation. The Law makes 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, including a 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 resource management have yet to be taken into consideration, due to the country's capability.

2 Water resources related to variability and the climate change situation

2.1 Climatic information

The dominant features of the Cambodian 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-quarters of the country area, are the Elephant Mountains and the Cardamom Mountains of the southwest and western regions; Dangrek Mountain to the north adjoining the Korat Plateau of Thailand; and the northeast Plateau of Ratanakiri and the Chhlong Highlands on the east, merging with the Central Highlands of Vietnam.

Like in many countries in the Southeast Asia region, Cambodia's climate is dominated by the 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; while the northeast monsoon blows during November to March, bringing dry, cool air, with and hotter localized air during late March to late April.

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

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

Table 2.1: Variability temperature (Unit in Degree Celsius, ^{o}C) throughout the year

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg. tem.
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 after evaporation, transpiration, infiltration and percolation. Surface water is sourced from rain water flowing down to the Tonle Sap Lake and Mekong River, before going further down to the Mekong Delta and South China Sea. Surface water plays a vital role in Cambodia's agricultural and economic development.

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

Use of water in development: The total amount of water resources in Cambodia is 289.4 billion m^3, and average runoff is 45%. Average annual rainfall is 1,598.4 mm, and the land area is 181,086km^2. Total use of water for all purposes amounts to 7.9 billion m^3 (Table 2.2). Water used for agriculture is estimated at 7.59 billion m^3 (96% of total use), for domestic use is 0.24 billion m^3 (3% of total use) and for industrial use, 0.07 billion m^3 (1% of total use).

Table 2.2: Annual water use (2005)

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

Source: MOWRAM, 2008 p 4-31

Coastal and marine water: Cambodia has 440km of coastline from the northwest to the southwest areas, covering the provinces of Koh Kong, Sihanouk, Kampot and Kep. These provinces are becoming increasingly populated, due to economic and tourism development. Oil and gas production in the offshore areas are subject to development activities in the short term.

Concerns: There is growing concern at the possible impact of agrochemicals, particularly of pesticides on fisheries, although data is lacking on the actual quantity of chemicals used 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 problems; the environmental impact and monitoring provisions of environmental legislation will become increasingly important. Bacteriological contamination is of great concern from a public health point of view, with Cambodia having high levels of morbidity and mortality from diseases that often are water-related. The bacteriological quality of

Mekong/Bassac waters deteriorates from Phnom Penh, and particularly so downstream from the Vietnamese border, across the densely populated delta.

Most Cambodian people face a shortage of fresh water during the dry season, and also during the "small dry season" in the wet season; but in the rainy season they face too much water, and flooding. 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 water resources. The Kingdom's marine waters require careful management, particularly along the coastline and in estuaries, to ensure 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 tributaries 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 with catchments underlain by metalliferous rocks is, in some cases, degraded naturally. There are high concentrations of toxic metals in stream flows from areas where mining is done. 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 (PO_4-P 0.03mg/l, total-P 0.08 mg/l, NH_4-N 0.1 mg/l, total-N 0.5 mg/l, NO_3-N in the range 0.1-0.4 mg/l) (MOWRAM, 2000).

The most concerning issue for ground water quality is arsenic content. There are many wells exceeding World Health Organization (WHO) guidelines on arsenic content; this is known to be caused naturally, not by human-induced activities. Increased arsenic content in ground water also affects surface water quality.

2.3 Floods

Floods normally occur in Cambodia's 42 river basins, especially in the Mekong and Tonle Sap basins. Two types of floods occur: flash and long-month (three to four month) floods. Flash floods occur during the rainy season, especially near the Cambodian plateau, whereas long-month floods normally occur along the river basins of the Mekong, Tonle Sap and their

tributaries. According to historical records, a serious flood happens in the Mekong Delta approximately every four to six years. Serious floods result in damage to agricultural production, human life and property. Since the 1960s there have been more than seven serious floods in Cambodia. While flooding is one of the most serious problems in Cambodia, it can affect the country in both positive and negative ways.

Seasonal floods play an important role in increasing fishery production, maintenance of ecological environments in marshes, improving land productivity by supplying silt sediment, and improving agricultural water supply. Floodplains are essential to fish hatching areas and fish habitats. Large fish lay eggs on bushes inundated by floods. Floodplains are closely related to farming, providing a field for seeding, floating rice and flooded rice crop. Most rice crop rotation is conducted by farming rice floating in the deep water of the floodplains.

However, severe floods damage infrastructure, interrupt economic activities, and cause loss of human life, livestock and farm products. In the 2000 floods, about 370,000 ha of farmland were inundated and 6,081 houses were destroyed, affecting 3.44 million people living in 132 districts. The estimated amount of flood damage from 1900 to 2012 is shown in Table 2.3.

Flood status has changed over the last few decades, with: 1) an increase in the number of unexpected floods in the Mekong River; 2) Heavy rain on the Mekong tributaries; and 3) an increase in flood levels.

2.4 Droughts

The most recent droughts occurred in 1992, 1993, 1998 and 1999. The drought of 1999 was the most severe across the country. The impact of drought has been addressed, with a number of programs aiming to improve the irrigation system, rehabilitation of pumping stations and water pumps, water supply and sanitation, and the establishment of Farmer Water User Committees (FWUC). For example, MOWRAM's objectives for 2001-2005 have been achieved, with 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 cost of some 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 were wet season and 63,766 ha were dry season (MoWRAM, 2003).

Tabal 2.3: Top 10 Natural Disaster in Cambodia for the period 1900 to 2012

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

(Source: www.emdat.net)

2.5 Storm

Extreme weather events, such as storms or typhoons, are not usually considered a major problem in Cambodia as 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 in a given year. The storm incursions into the Mekong basin spread from the South China Sea towards the east, and southeast across Vietnam and 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, damages human property such as houses, as well as agriculture and ecological systems. Typhoon Ketsana damaged hundreds of houses in Kampong Thom and Siem Reap in 2009.

3 General legal framework

3.1 National legal framework

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 2009-2013 (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 FWUC, (ii) river basin management, (iii) water allocation and water use permits, and (iv) water quality.

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 (reports its activities to the Council of Ministers)
- Cambodia National Mekong Committee (CNMC)
- Tonle Sap Biosphere Reserve Secretariat, an agency of the CNMC
- National Committee for Disaster Management (NCDM) (reports its activities to the Council of Ministers).

All 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 water resources of the Kingdom of Cambodia, and to improve the socio-economic development and welfare of the people. The Law determines:

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

MOWRAM is mandated to manage, lead and supervise the implementation of the present law on water resources management. MOWRAM shall conduct consultation with other concerned ministries. If needed, the RGC will 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): For the purposes of flood protection, MOWRAM, in collaboration with other concerned agencies, may designate any floodplain area as a Flood Retention Area. Within a Flood Control Area, MOWRAM, together with other agencies and local authorities, shall develop plan(s) on measures for flood prevention and mitigation to ensure the safety of human life, animals and property. 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 use, development and management of an equitable and reasonable share of the international river basins in its territory, consistent with the obligations arising from international agreements to which Cambodia is a party. MOWRAM shall pay particular attention to the optimum and effective use of the Mekong River Basin in all fields, including navigation and transport, consistent with the governing principles of the CNMC.

The Law focuses on efforts towards sustainable use of water resources, equitable water sharing and poverty alleviation, but has yet to take climate change into detailed consideration. However, the climate change hazard and climate change related response measures are in the National Water Resources Policy (section 3.2).

3.2 National Water Policy

The National Water Resources Policy (2004): The National Water Resources Policy aims to:

- Protect, manage and use water resources in an effective, equitable and sustainable manner
- Foresee problems, and take measures to assist related institutions to settle problems which might occur in the water sector
- Develop and implement the national strategy, and formulate the national policy and sector policies on water resources management
- Direct water resources development, management and use in Cambodia to all activities of institutions, the private sector and the public sector
- Improve and uplift people's standard of living, to achieve the national policy on poverty reduction and sustainable national economic development.

The policy raises issues and shows guiding measures to cope with these issues in a couple of sectoral economic developments, including agriculture, energy, industry and services, domestic use, navigation and tourism. Water resources use, effectiveness, and use of partnerships are among the main concerns the policy takes into consideration.

The policy focuses on research and development, and institutional capacity building and strengthening. It states its commitment to coordinating with line ministries and neighbouring countries, especially Mekong River Commission (MRC) members.

3.3 Strategy

Since its establishment, MOWRAM has implemented two national water resources management and meteorology strategies: the 2006-2010 and the 2009-2013 strategies. Both aim at sustainable water resources management and development for all sectors consuming water, such as agriculture, livestock, domestic use, industry and other. Both strategies align with the country policy and development goals such as the National Strategic Development Plan (NSDP) and the Cambodia Millennium Development Goals (CMDG). The main strategy efforts are to rehabilitate and improve irrigation systems, build new canals, establish pumping stations, establish FWUCs, conduct research and

development studies and develop human resource capacity in water resources sustainable management.

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

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

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

- Water resources management and development
- Flood and drought management
- Strengthening law, regulations and water resources sustainability
- Managing water resources and meteorology data and information
- Improving administrative management and human resources development.

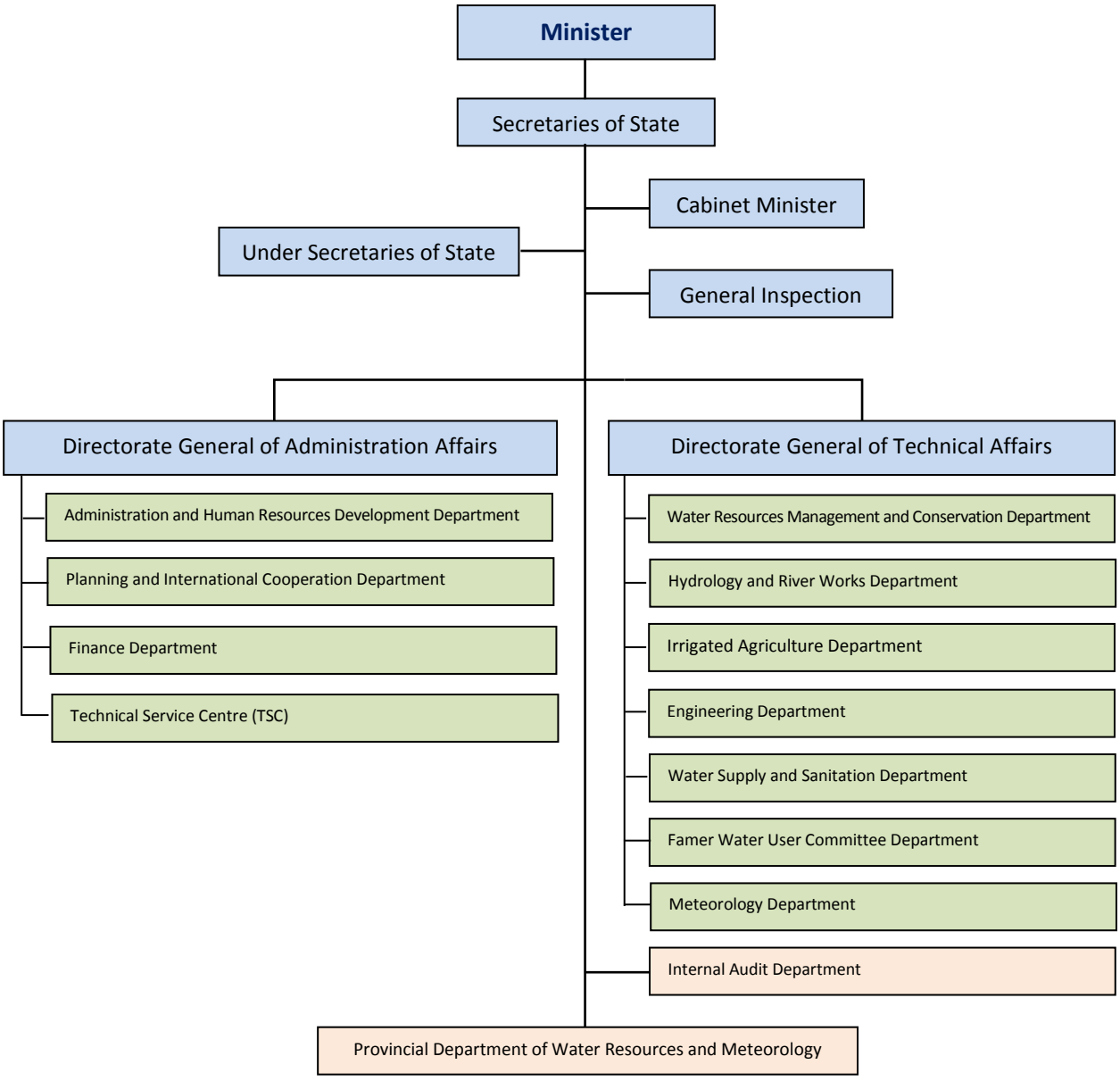
3.4 Institutional framework

MOWRAM is responsible for water resources management in the areas of the river basin, sub-basins, watershed run-off, ground water 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 23 June 1999 (see Annex 1 for detailed 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 the 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 World Bank's Pilot Program for Climate Resilience (PPCR). These programs will be implemented in collaboration with MAFF, MoE and the NCDM in 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 a main coordination role for the RGC in project/program related water resources management and development. MOWRAM, on behalf of the RGC, consists of dozens of central departments and provincial departments, in every province and the capital. At the national level, there are two main technical departments: the Department of Water Resources Management and Conservation, and the Department of Meteorology.

MOWRAM has a two-fold role: coordination at the government ministry level, and managing line departments that represent MOWRAM at sub-national levels (each province consists of one DoWRAM).

Annex 1: Ministry of Water Resources and Meteorology Organization Chart



4 Climate Change Strategic Plan for Water Resources and Meteorology

4.1 Vision

The vision of the Climate Change Strategic Plan (CCSP) for Water Resources and Meteorology is sustainable use of water resources in adapting to climate change; and timely, trusted weather and climatic information.

4.2 Mission

The mission is to ensure water resources and meteorology are effectively and sustainably managed, and that serviced warning systems and climatic information are equitably

accessed, shared and adapted to the changing climate, for the better livelihoods of the Cambodian people.

5 Climate Change Strategic Plan for Water Resources

5.1 Goal and objective for water resources

5.1.1 Goal for water resources

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

5.1.2 Objective for water resources

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

1. Protect, manage and use water resources in effective, equitable and sustainable manners, protecting them from the negative impacts of climate change;
2. Along with climate change adaptation and mitigation schemes, regulate, modify and subsidizeater resource service fees for all water resource development activities;
3. Maximize sustainable water resources contributions to poverty reduction, enhanced livelihoods and equitable economic growth;
4. Adapt to climate change and mitigate its effects on water resource-based livelihoods;
5. Apply Integrated Water Resources Management (IWRM) that allows for holistic planning across sectors, jurisdictions and local government borders for climate change adaptation and mitigation;
6. Create stronger community participation, such as FWUC, in water resource management and development, to address impacts or obtain benefits from climate-change induced opportunities;
7. Raise awareness and 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;
10. Partner with the private sector to develop sustainable financial systems.

5.2 The Strategy Framework for water resources

Responding to the urgent need to address climate change issues and impacts, 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 acceded to the Kyoto Protocol. The National Climate Change Committee (NCCC), which was established by sub-decree in April 2006 with representatives 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 (MoWA) has been included into this committee. Being one of the Vice-chair Ministries (Figure 4.4), MOWRAM has played crucial roles in NCCC coordination and policy development, such as the National Adaptation Plan of Action (NAPA) for Climate Change and especially in development of Cambodia's climate change position for the annual UNFCCC conference. The NAPA identified water resources management and development as one of the 20 priority items, which puts MoWRAM in an important position in Cambodia to develop policies to address climate change issues.

The climate change framework for water resources management and meteorology is laid out as: sustainable use 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.

5.3 Priority Water Resources and Irrigation climate change-related issues

In water resources management and development in Cambodia, there are barriers related to the capacity to address climate change, including:

a) Limited financial resources or funding for water resources/climate change related activities, especially in irrigation systems for the 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 strategies;
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.

5.4 Climate Change Impacts on water resources, and Opportunities

5.4.1 Climate Change Impact

The impacts 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 negatively affect ecosystems. Coastal communities and eco-systems are likely to be affected by rises in sea levels, and 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 has faced various problems due to increasing natural resource degradation, with forests, water, land and mineral resources being over-used for economic development and pro-poor development activities. These problems have a major effect on the environment, manifesting as higher temperatures, more precipitation, and sea-level rises. It is important to start teaching people about climate change in Cambodia. In a simple explanation on climate change, shown by the website chinaview.com, "climate change" is described as 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. It is accepted that climate change is due to human activities, and the release of greenhouse gases into the atmosphere. Carbon dioxide (CO_2) is produced when fossil fuels are used to generate energy, or when forests are cut down and burned. Methane (CH_4) and nitrous oxide (N_2O) are emitted in many ways, including agricultural activities and change in land use, among others.

The impacts of climate change on water include:

a) ***Water resources sector:*** problems of increased flood and drought, changes in water supply and water quality, and increased competition for water. The irregular seasonal times of wet and dry months caused by climate change, especially during the last few decades, impacts on water resources management and development efforts. At the same time, there is increased demand for water from emerging sectors, including industry, livestock, domestic use, and especially agriculture; coupled with seasons changing due to climate change, this creates many more social problems. With global warming, Cambodia's temperature has increased making it difficult to prevent loss of water from evaporation. Ground water requires

recharging annually from rain water. Due to climate change impacts on the amount of rain water needed to recharge ground water, the recharge rate is seriously reduced, leading to Cambodian farmers having insufficient ground water for farming. It is worth noting that ground water shares 3.1% of the total 4.5% of current irrigation water, while surface water takes the rest (MOWRAM, 2008).

b) ***Reservoir:*** Many reservoirs are gradually getting shallower because of sedimentation, which leads to reduced capacity for water storage.
c) ***Irrigation systems and hydraulic infrastructure:*** Irrigation systems and hydraulic infrastructure have not yet been modernized, or taken climate change 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 low land areas.
d) ***Dam/weir:*** Frequent floods destroy dams; most of them are old and the impacts of climate change on them have not been considered.
e) ***Flood Protection Dike (FPD):*** Most dikes have been destroyed by floods, as during each flood, water overflows on these Flood Protection Dikes. The potential impacts of climate change were not taken into account during the construction of the FPDs. Moreover, these FPDs are made from soil.
f) ***River Bank and Coastal Areas:*** the erosion of beaches/banks caused by floods and/or high speed waves, brought on by the impacts of unpredictable climate change, leads to negative impacts on rural livelihoods, especially on farmers who are completely dependent on limited land areas.

5.4.2 Climate Change Opportunities

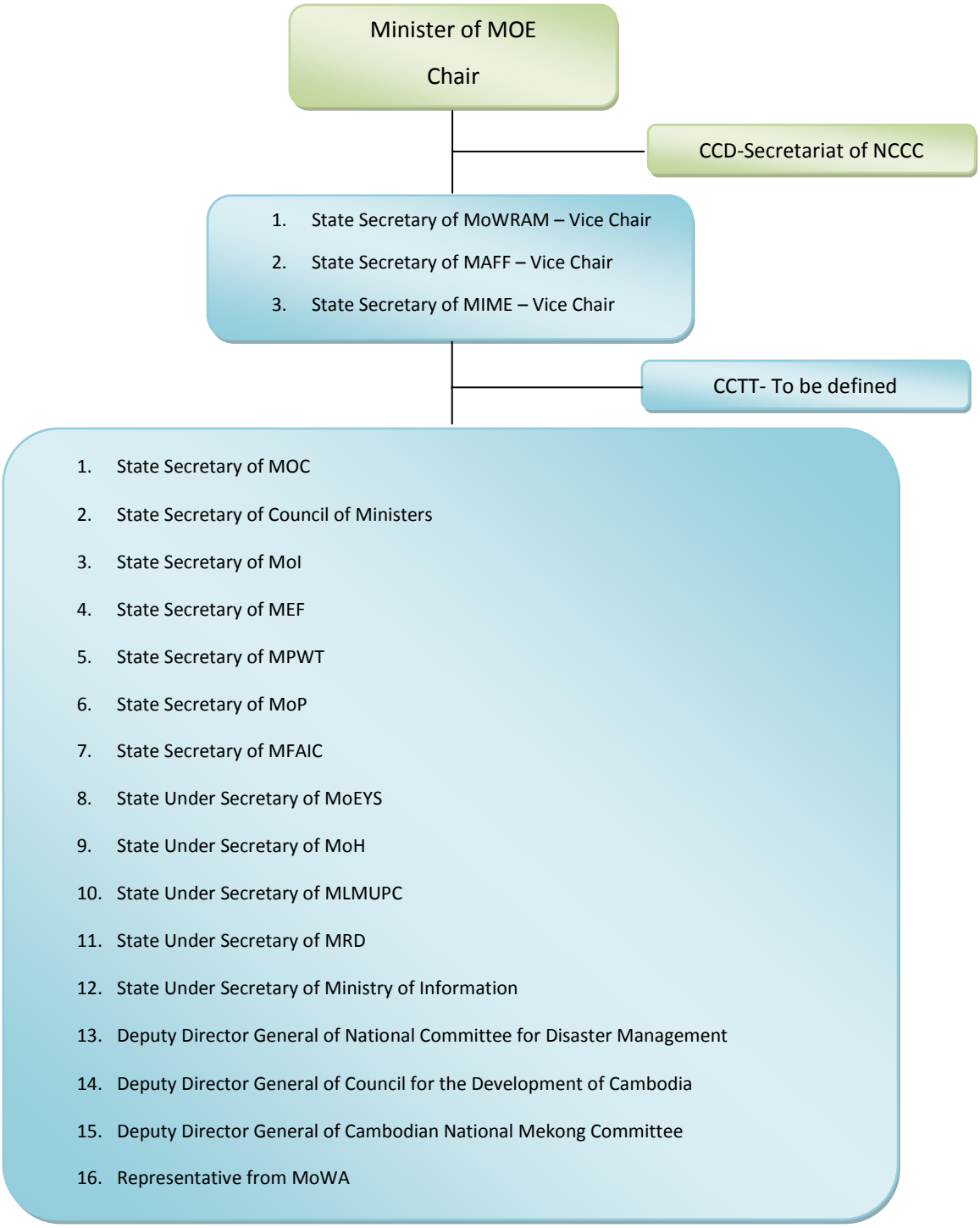
Being Vice-Chair of the National Committee for Climate Change, MOWRAM has played an important role in water-climate change related coordination and facilitation. With the Chair-Ministry, the Ministry of Environment, MOWRAM has committed itself to addressing climate change issues, in particular sustainable water development and good governance of water resources. This should be seen as a significant opportunity for MOWRAM to implement water-related laws and regulations to achieve the vision, missions and objectives of water resources management and sustainable development in Cambodia. This should also be an excellent opportunity for MOWRAM to fulfil another of its tasks in sustainable water management and development: mainstreaming gender balance into climate change responses.

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

Because climate change is an emerging global issue, most laws and regulations related to water resource management and meteorology are yet to address it. Therefore, it is the right

time for Cambodia to include national climate change strategic planning in water resources and meteorological management and development.

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



5.5 Climate Change Strategy for water resources

Several challenges for adaptive capacity, and responses to climate change, are summarized as follows:

i. Awareness and knowledge on climate change related to water resources management and development must be mainstreamed into the development aspects of all water-related sectors at local, provincial and national levels, through TV spots, radio and media campaigns;
ii. Staff capacity building on water resources/climate change through long-term studies, short-course training and exchange study tours in and out of the country and the region;
iii. Establishment of a data management system for collecting and sharing data and information on water resources/related climate change issues, and adaptation/ mitigation capacity of related stakeholders;
iv. Establishment and/or improvement of networks for meteorology and hydrology to manage and control the impacts of, for example, temperature, rainfall, flood, drought and weather;
v. Mobilization of secured financial resources from government agencies and development partners for programs/projects, research and development on water resources/climate change adaptation or mitigation;
vi. Strengthening the capacity of local farmers, especially FWUC members, on the selection of lower-water crop varieties, and the planning of a lower-water crop system for climate change adaptation;
vii. Development of long-term water resources integrated planning, to provide the best chance of minimizing the negative effects of sea-level rises;
viii. Strengthening the cooperation and coordination mechanism among different sector agencies at local, national, regional and international levels, applying IWRM aspects to respond to climate change adaptation and/or mitigation;
ix. Improve and introduce technologies in water work development to respond to the negative impacts of climate change.

5.6 Climate Change Roadmap and Implementation Plan for water resources

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

1. Capacity building for staff and farmers/public on climate change adaptation/mitigation in regard to water resource development and management.
2. Mobilize technology and financial resources for water resources and meteorology development in responding to climate change impacts.
3. Data management in regard to water resources and meteorology for timely climate change responses.
4. Develop integrated long-term water resources and meteorology countrywide plans for climate change adaptation and mitigation.
5. Establish national policy and legislation in responding to water resources and meteorology management.

6. Strengthen inter-ministerial coordination in the framework of climate change adaptation and mitigation.

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

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

5.7 Water Resources Climate Change Adaptation Strategy

Based on previous excellent achievement, such as improvement of the irrigation system, rehabilitation of pumping stations and water pumps, water supply and sanitation, and the establishment of FWUCs, the water resources climate change adaptation strategy should be included in future plans. As the Master Plan of Water Resources Development in Cambodia has been developed with very detailed and specific management plans for water schemes (MOWRAM, 2008), our water-climate change adaptation strategy should focus on main adaptive strategies and activities 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 aspects at local, provincial and national levels through TV spots, radio and media campaigns. The detailed activities are as follows:
   - 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 existing, and install new, hydrological and meteorological stations and rain gauges in selected rivers and locations; include data collection and dissemination;
   - To establish a 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;
   - To encourage and promote, to people and institutions at all levels, participation in flood mitigation measures and drought intervention.

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 strengthen the technical and institutional capacity of MoWRAM to implement the National Irrigation and Drainage Strategy (NIDS);
   - Development and management plans;
   - To establish the capacity of FWUCs in Participatory Irrigation Management and Development (PIMD);

iii. Establishment of a data management system for collecting and sharing data and information on water resources-related climate change issues and adaptation/mitigation capacity to related stakeholders. The detailed activities are as follows:
   - Timely data collection on water resources/related climate change disasters, and possible strategies to overcome these;
   - 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 climate change vulnerability;
   - Improve and strengthen weather and flood forecasting in real-terms related to natural hazards;
   - Respond immediately, paying attention to pumps and heavy equipment, and intervening where there is suffering among those affected by drought, flood, and other water-related hazards;
   - Develop and enhance a national groundwater data and information base.

iv. Establishment and/or improvement of networks for meteorology and hydrology to manage and control, for example, the impacts of temperature, rainfall, flood, drought and weather. The detailed activities are as follows:
   - Provide timely prior warning information and trusted data;
   - Use all means of the meteorology systems to inform about all possible risks caused by weather;
   - Strengthen the implementation and enforcement of the law on water resources management, sub-decree on water management, irrigation management and transfer, and other water-related regulations to control and prohibit all construction projects that negatively impact water resources and eco-systems;
   - Develop and apply procedures for social and environmental impact assessments and mitigation;
   - Preserve river flows and minimum water levels of rivers, streams and lakes to protect ecosystems, social and cultural values, and navigation;
   - Prohibit and take necessary measures to protect against the infilling or excavation of, or encroachment on, watercourses, seasonally inundated

depressions, permanent water bodies, and the sea, where there would be an impact on water resources, aquatic ecosystems or the environment;
- 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 government agencies and development partners. The detailed activities are as follows:
   - Develop financial plans 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 climate change;
   - Facilitate increased income in the irrigated agriculture sector, to ensure continued investment in water for crop production.

vi. Strengthen the capacity of local farmers, especially FWUC members, on the selection of less-water crop varieties, and the planning of a less-water crop system for climate change adaptation. The detailed activities are as follows:
   - Conduct research and development (R&D) paying attention to climate change adapted crop species;
   - Closely engage members of FWUCs in climate change adapted crop species;
   - Conduct study tours for selected members of FWUCs in climate change adaptation agriculture development;
   - Mobilize participation of farmers, stakeholders and the private sector in all stages of design, development and improvement of I&D systems;
   - Enable FWUCs, beneficiary and private sector participation in all stages of the development and management of I&D (PIMD);
   - Strengthen and expand FWUCs to enable them to participate in water management and allocation, and to maintain irrigation infrastructure with effectiveness and sustainability;
   - Promote investment by international funding agencies and the private sector in supporting PIMD.

5.8 Water Resources Climate Change Mitigation Strategy

Water ecosystems, such as wetland and marine water, are considered areas for carbon sequestration and carbon stock. When water areas, such as wetlands, change for other development purposes, for example, agriculture activities, carbon stock areas will be lost. In this regard, the climate change mitigation strategy in water resources management should be to reduce the change of land use as much as possible. As the law on water resources management states, the MOWRAM strategy in climate change mitigation should be to uphold the enforcement of the law as much as possible. At the same time, all water resources management regulations must be strongly implemented. Water resources

management and meteorology in regard to climate change mitigation, which can be related to main mitigation strategies and activities, are as follows:

vii. Develop long-term water resource integrated planning, providing the best chance of minimizing the negative effects of sea-level rises. The detailed activities are as follows:
   - Prepare a strategic plan for prevention methods/means to cope with sea-level rises that could negatively affect agricultural development;
   - Expand surface water storage (reservoirs, ponds), channel capacities and drainage systems to ensure water supply and environmental sustainability;
   - Extend the land area served by sustainable irrigation and/or drainage systems, particularly in areas with a high incidence of poverty;
   - Provide members of FWUCs with research and development in biofuel and biogas development and use;
   - Mobilize all means to assist the rural public in biofuel and biogas use, in order to minimize greenhouse gas emissions;
   - Prepare a river basin inventory and database;
   - Develop the Nationwide Flood Hazard Map;
   - Study the preparation of short-, medium- and long-term development plans for river basins by taking a comprehensive account of modifications to the hydrological system, particularly river flows and aquifer levels, to ensure that use of water resources at present and in future is sustainable;
   - Establish the Nationwide Irrigation and Water Sources Inventory, including monitoring system;
   - stakeholders and beneficiaries in, the preparation and implementation of river basin management and development

viii. Strengthen cooperation and coordination mechanisms among different sector agencies at local, national, regional and international levels, applying IWRM aspects to the climate change adaptation and/or mitigation response. The detailed activities are as follows:
   - Coordination among ministerial agencies in law enforcement on water resources management;
   - Strengthen coordination of all water resources and meteorology line ministries, from national to sub-national levels, to mitigate the impacts of climate change;
   - Strengthen cooperation with MRC on flood mitigation and international programmes related to water hazards;
   - Strengthen an integrated approach to water resources and agriculture development and management, that considers all sources of water, links between water resources and agriculture, and other aspects such as land management, natural environment, the varying human and ecological demands on water resources, and the need for many different disciplines to carry out effective management;
   - Promote and facilitate knowledge among, and participation by, line agencies.

ix. Introduce technologies in water work development and rehabilitation in order to respond to the negative impacts of climate change. The detailed activities are as follows:

- To rehabilitate and reconstruct the existing irrigation system, in order to respond to the urgent need for the use of water for agricultural production;
- To develop and extend appropriate water management technologies that are particularly suited to rain-fed agricultural areas;
- To study, rehabilitate and construct a system of flood protection embankments and drainage, to reduce the damage from natural disasters related to water;
- To focus management efforts on priority river basins and to conserve the ability of groundwater aquifers.

6 Climate Change Strategic Plan for Meteorology

The Department of Meteorology (DoM), under MOWRAM, is responsible for national meteorology services in Cambodia. DoM is a single public agency responsible for activities including observing surface and atmospheric weather conditions and providing weather information necessary for preventing and mitigating natural disasters that can have negative impacts on human societies, communities and socio-economic development. DoM generates many types of meteorological information, which can serve several purposes in different sectors, 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 disaster warning at local, national and regional level. The climate change situation urgently requires DoM to improve its meteorological services including weather information forecasting and dissemination to the public, and to fulfill its function and responsibility as a national meteorological organization.

DoM has five offices and 44 staff; four with Masters Degrees, five engineers and 35 technicians. They all need to have regular capacity building with up-to-date knowledge and technology. The following facilities and instruments have been applied for weather observation and forecasting:

- 8 Automatic Weather Stations (countrywide)
- 24 Manual Weather Stations (countrywide)
- 124 rainfall gauges (countrywide)
- Global Telecommunication System (GTS) is installed. It is a member of the World Meteorology Organization (WMO) data collection platform system, and can transmit meteorological (synoptic) data to Japan's Meteorological Agency (JMA) as a GTS hub of WMO, who then disseminate the data, with the cord number of Cambodia, onto a GTS network to the world
- Satellite Imagery Receiving System: Receives and displays GMS (MTSAT) satellite imagery
- Weather Doppler Radar System (WDRS) is used to support short-term nowcasting and logging of meteorological phenomena. It provides 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. It supports atmospheric research on regional climates and climate change.

As Cambodia is frequently faced with natural disasters and extreme events, for example, heavy rain, flooding, strong winds and drought, the national capacity for weather control is still a concern, as is providing high quality and timely forecasts and warning information to the public. Therefore, improvement of meteorological services and activities for hazardous weather is indispensable, to know what Cambodia's weather conditions are, and where natural disasters might occur.

6.1 Goals and Objectives for Meteorology

6.1.1 Goals

Goal 1: To become a national organization with accountability and responsibility in providing excellent weather forecasting and climate information services in Cambodia.

Goal 2: To be fully coordinated and engaged in a comprehensive study on climate change impacts, as well as climate change responsible measures for the public and development of national climatic information systems for agricultural activities.

6.1.2 Objectives

The objectives of the department of meteorology are:

1. To build a reliable and predictable meteorological service;
2. To improve human resource capacity at national and provincial levels to meet the requirements of a high-quality meteorological information service provider;
3. To extend climate networking nationally and internationally;
4. To set up a national early warning system, and give information related to air pollution.

6.2 The Strategy Framework for Meteorology

In the context of climate change, the Meteorological Strategy Plan (MSP) will help improve the quality and quantity of meteorological development services, build capacity of meteorological institutions, including human resources, and improve modeling for climate risk assessment and management. These are important elements contributing to the development of sectoral climate change plans, national sustainable development plans, the Government's rectangular strategy, and the Cambodia Millennium Development Goals. It aligns with international efforts in combating global climate change.

6.3 Priority meteorology climate change related issues

Based on a current situation analysis of DoM, the key issues were identified and discussed. The issues relate to lack of:

1. Legal tools and guidelines
2. Human resources and skilled personnel
3. Hardware, software and spare parts
4. Financial resources and funding
5. Coordination and networking.

These are among the key issues to be taken into account for present and future strategic and action plans (See development matrix for detail).

6.4 Climate Change Impacts on Meteorology, and Opportunities

Climate change poses severe challenges to human society and its development activities. DOM's overall responsibility is to administer and operate the meteorological service in Cambodia. As per WMO charter, DOM, through MOWRAM, shares its meteorological information with other interested countries. To achieve its goals and objectives, DoM must review, update and integrate new concepts, knowledge and information related to climate change into its sectoral strategic plan, which is principally based on key issues, and must align with national policies and plans.

6.5 Climate Change Strategy for Meteorology

Programs	Goals	Objectives	Activities
1. Institutional strengthening, coordination and networking	1. To become a national organization with accountability and responsibility in providing excellent weather forecasting and climate information services in Cambodia. 2. The ultimate goal is to be an organization fully coordinated and engaged in a comprehensive study on climate change impacts and climate change responsible measures for the public, and particularly the development of a national climatic information system for agricultural activities.	- Develop legal tools and guidelines - Coordination and networking	- Collect information related to policy and laws - Review legal tools, policy gaps and recommendations - Coordinate the preparation of legal instruments pertaining to meteorology - Develop long-term work plans for the preparation and dissemination of meteorological laws - Monitor and evaluate implementation of strategic plans at national and sub-national level - Support MoWRAM in terms of policy-making related to meteorological work activities - Collaborate with provincial departments to prepare climate change related projects and planning - Review institutional structure, its term of reference, implementation procedure, human resource allocation, management schemes - Develop early warning system - Develop leaflet for department - Improve institutional structure, networking with mass media for public weather forecasting dissemination - Identify appropriate measures to encourage staff to work better
2. Human resource development		- To enhance human resources and strengthen skilled personnel - Coordination and networking	- Conduct capacity needs assessment for the department and provincial departments, for climate change knowledge improvement, climatic data collection, recording and reporting - Conduct local training courses on climate change, which cover adaptation, mitigation and modelling, data base management, data recording and processing, climate-hydro map development, agro-climatology, strategic planning preparation, M&E, logical logframe, project proposal writing - Networking with national, regional and international institutions/organizations to extend knowledge and know-how on climate change - Develop self-evaluation system by sector, to engage in deeper involvement with meteorology-climate change research and study
3. Financial resource mobilization		- Develop Financial resources and funding	- Coordinate international donor programs for meteorology sector - Develop new project proposals for donor funding - Communicate with other potential financial resources for funding

4. Research and Development		- Install hardware, software and spare parts	- Establish climate data base management system, daily weather forecasting and early warning system, - Develop regional and international knowledge/information exchange networks - Coordinate/facilitate with other research institutes/government agencies to identify new potential issues to support/improve quality of weather forecasting and early warning system - Conduct scientific researches and studies on climate change modeling, climate change impacts and prevention - Share research and study information with the public, particularly to the most sensitive climate-threatened areas within the country.

6.6 Climate Change Roadmap and Implementation Plan for Meteorology

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

Four strategic roadmaps of meteorology for climate change related management and development plans

Strategic plan	Action Plan
1. Meteorology management and development within the changing 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 accurate weather forecasting and climate information dissemination.
3. Data management and methodology analysis and technology development in regard to meteorology	- Develop and manage based on sufficient data and information, capacity analysis and technology.
4. Improve administrative management and human resources development	- Strengthen and improve administrative and management systems, and human resources, for better meteorology management.

6.7 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 change; 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 includes many goals of the Department of Meteorology, such as:

Strategy	Goal	Objective	Activity
Develop capacity and meteorology management to reduce vulnerability against actual or expected climatic stimuli and their	- Enhance climate services to help communities understand and adapt to climate-related risks.	- Enhance national weather service to support development of climate services.	- Create a suite of forecast services to address local needs. - Engage national and local users to understand climate

effect on society, the economy and the environment.			issues.
	- Improve weather decision services for events that threaten safety, health, water resources, the environment and economic productivity.	- Provide demand-driven, impact-based weather services. - Use emerging science and technology to improve weather prediction.	- Define warnings to focus on targeting impacting events. - Generate integrated observing systems to access real-time weather and climate data.

7 Water Climate Change Cross-Sectoral Issues

The sources for the 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, Articles 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";
- The Law on Water Resources Management 2007.

With these laws and regulations, and with the mandates of MoWRAM, there are some key agencies, government and non-government, that need to closely coordinate work 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	- Define policies relating to strategic development of water resources - Research and investigate water resources - Prepare plans for water resources development and conservation - Manage direct and indirect water resource use, and mitigate water-related disasters - Gather and manage hydro-meteorological data and information - Provide technical advice - Administer international collaboration, including within the Mekong River basin
2	Ministry of Industry, Mines and Energy	- Planning for industrial water uses and hydropower - Water supply provision to provincial towns - Develop water supply and sanitation policy - Administration of single-purpose schemes involving hydro-power
3	Ministry of Rural Development	- Study and collect ground water data - Provision of water supply, sanitation and drainage in rural areas - Develop water supply and sanitation policy in rural areas
4	Ministry of Public Works and Transport	- Land drainage and sewerage in Phnom Penh and provincial towns

		- Study, survey, construction and maintenance of river works for navigation and water transport
5	Ministry of Environment	- Protect natural resources and environmental quality - Monitor and control water pollution and water quality, create provision for licensing waste water discharge
6	Ministry of Agriculture, Forestry and Fisheries	- Develop policy and strategy for agriculture, forestry and fisheries that relate to water resources use
7	Cambodia National Mekong Committee	- Advise the Cambodian representative to MRC on all matters relating to activities within the Mekong River basin that could affect Cambodian interests - Review proposals prepared by RGC agencies in light of the Mekong agreement - Liaise between MRC and RGC agencies
8	Cambodia National Committee for Disaster Management	- 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

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

Table 4.3.8b: Uses of water in Cambodia and government ministries' responsibilities

Water use	Million m^3/year and Percentage (number shown in parenthesis)	Responsibility of Government Ministry
Agriculture	455 (56)	MoWRAM, MAFF
Domestic Use	136 (17)	MoWRAM, MIME, MRD and city administrations
Livestock	100 (13)	MAFF
Industry	30 (4)	MIME
Other	79 (10)	MoWRAM

7.1 At National Level

Regarding water governance and rule of law, and the legal frameworks put in place to regulate water, the starting point for analysis of a regulatory framework as it pertains to water resources management is firstly to identify, and secondly to evaluate, 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 provision of law enforcement which may be the result of jurisdictional overlap, the absence of transparency mechanisms and a lack of political will. It is 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 FWUC (see Annex 2 for an example of institutional coordination).

7.2 At sub-national Level

As government officials of provincial departments, particularly the provincial department of water resources management and meteorology (DoWRAM), are limited in their knowledge of climate change, it is difficult for them to coordinate among themselves at the provincial level, and between themselves and national offices. It is worth noting that MOWRAM (and DoWRAM) is one of the younger ministries, established in 1999. Therefore, there is scope for improvement in:

- Capacity and human resources
- Staff movement and relocation
- Financial support
- General knowledge of water/climate change related issues, sustainable development, and water uses.

8 Key Water Resources Climate Change Response Activities and Risks

MOWRAM has been identified as one of the key ministries to address climate change (Table 4.3.9). The World Bank's PPCR program (RGC-c, 2011) proposed $33 million investment in the water resources sector. The proposed budget will be implemented in 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 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, MOWRAM implements the Strategy for Agriculture and Water (SAW, 2010-2013). The climate change related focus of SAW has been on post-disaster emergency relief (SAW, 2010). SAW takes into account climate change impacts such as flood and drought through interventions in food security and water resources management, and recognises climate change as one of the threats to the long-term management of agriculture and water.

Table 4.3.9: Key Water Resources Climate Change Response Activities and Risks			
Main Items	**Activity**	**Risk**	**Assumption**
Farmer Water User Committee (FWUC) improvement and establishment	- Mobilize all efforts and resources in order to improve existing FWUCs - Identify and establish new potential sites/areas for FWUC establishment	- Lack of financial support - Capacity of farmers in participation	Government policy supported
Integrated Water Resources Management (IWRM)	- Enhance IWRM mechanism to manage water resources in the face of climate change - Continue to coordinate among related key ministries for the process of IWRM	- Matter of coordination and willingness of key stakeholders - Unpredictable climate change vulnerability	Government policy supported
Private sector involvement and responsibility	- Engage private sector in Payment for Environmental Services (PES), - Specific awareness raising for private companies in adapted climate change development - Encourage private companies in low carbon development and sustainable development	- Lack of financial support for dissemination national water resources policy - Financial support to continuous law enforcement	Government policy supported
Decentralization and good governance in water resources management	- Deliver more mandates on water resources management to sub-national levels - Capacity building in water resources management and uses of modern weather technologies at sub-national levels	- Lack of national financial support	Government policy supported
"Master Plan" for water resources management and development			
Comprehensive water control schemes	- Develop a long-term plan of national water control to prepare for possible heavy rain casualties caused by abnormal climate change - Establish flood prevention measures in the riskier regions such as populated areas and potential agriculture sites - Build flood warning system	- Lack of financial support - Lack of human resources	Government will is committed
Preparation for the urbanization problem	- Take measures against negative impacts on water resources from urban development such as stream flow reduction, worse water quality, and draining water	- Lack of coordination among relevant agencies - Lack of knowledge of climate change among relevant agencies	Government will is committed
Securing stability of water use	- Prepare water use, giving consideration to drought - Build stabilized irrigation systems addressing reduced precipitation caused by climate change		
Safe water supply	- Preserve quality of water supply sources (river, lake, etc) coping with climate change vulnerabilities		
Ground water use	- Develop ground water preservation plans - Develop ground water restriction regulation		
Comprehensive plan on river environment	- Build foundations for river water use and control - Shore up functions of the river environment, including ecological system preservation and water-familiar functions		
Water research and development	- Conduct research on what matters most in water resources, with regard to the impacts of climate change - Prioritize climate change coping activities on sustainable water resources development and management		

9 Financial Resource Planning

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

There are two sources of funding: government and donor support. The current and proposed project budget for 2009-2013 is estimated at US$1,250,024,000.00, of which the national budget is US$99,500,000.00 and donor support is US$1,150,524,000.00. Currently, the donor budget is pledged (with agreements with donor partners) at 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	224,963,000	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 investors, donors and donor-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 open bidding process;
- Modify service fees of private water supply systems;
- Modify service fees of private hydropower facilities;
- Take full responsibility for cost of flood and drought management and mitigation;
- Coordinate for donor funds while increasing the national budget for water resources management and development (Annex 3).

10 Monitoring and Evaluation Framework

With close coordination among relevant agencies, both government ministries and non-government agencies, including the private sector, the Climate Change Strategic Plan (CCSP) will be strictly monitored by the mandated general departments and technical departments of MOWRAM. Following the National Water Resources Policy for the Kingdom of Cambodia (2004) and the Law on Water Resources Management of the Kingdom of Cambodia (2010), MOWRAM ensures 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 its comprehensive implementation, and continue to develop as emerging tasks require. In coordination with other national policies such as SAW (RGC, 2010), the CCSP will be assessed for 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 transparent information and reports simultaneously to all stakeholders. It must ensure that "reporting" is translated into "feed-back", which in turn is translated into "lessons learnt" that are incorporated into management routines. Monitoring levels include all aspects of water resources development, such as water uses for industry, irrigation, and private potable water, especially water for FWUCs. Laws on water resource use need to be enforced, taking into consideration conflict and resolution, social and environmental indicators and benefit sharing. 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 against 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

Natural disasters, such as flood and drought, affect socio-economic development and the environment. Human activities, such as lack of good practices in water and related management, affect climate change. The holistic approach of water resource management will be incorporated to all sectors in responding to climate change, promoting capacity building and adaptive capacity of vulnerable people in affected areas. The sectors' cooperation is needed for this challenging process to support climate change adaptation. National policies, strategies and regulations have been set as a national framework to respond to climate change issues, challenges of climate change adaptation, and related hazards.

Being Vice-Chair of the NCCC, MOWRAM commits to be involved in the Global Climate Change mechanism through the implementation of NAPA and other water resources management legislations. The Climate Change Strategic Plan for Water Resources Management will be used by the Ministry to address climate change and sustainable water resources management and development.

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	
A. Government Budget Project												
I. On-going project												
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 irrigation sites	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			
Total I:			**82,012**	**13,902**	**13,082**	**11,455**	**5,420**	**6,501**	**50,360**			
Ii. High Priority Project – Under Discussion												
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 equipment in provinces	Government	2010-2013	240		120	120			240			
Hydrological and river activities	Government	2010-2013	3,700		700	1,000	1,000	1,000	3,700			
Total II			**49,140**	**0**	**10,880**	**11,190**	**12,580**	**14,490**	**49,140**			
Total I + II			**131,152**	**13,902**	**23,962**	**22,645**	**18,000**	**20,991**	**99,500**			
B.Donor Budget Project												
I. On-going project												
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 Development	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	
Total I			**528,520**	**31,200**	**38,700**	**50,300**	**46,500**	**39,500**	**206,200**	**0**	**206,200**	
II. High Priority project – under discussion												
Enhancement of 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 Vayko	Donor needed	2010-2013	30,000		5,000	5,000	5,000	15,000	30,000			30,000
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, Siem Reap province	Donor needed	2010-2013	6,000		1,000	1,000	2,000	2,000	6,000			6,000
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 of 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 resources 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	80000		20,000	20,000	20,000	20,000	80,000			80,000
Water resource development in Stung Sreng River Basin	China	2010-2015	100,000		25,000	25,000	25,000	25,000	100,000			100,000
Water resource development in North of Stung Prek Thnot River Basin	Korea	2009-2013	50,000		10,000	10,000	15,000	15,000	50,000			50,000
Water resource 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	Donor	2010-2013	700		100	150	200	250	700			700

Tonle Sap lake	needed											
Establish meteorological forecasting stations along main rivers	Donor needed	2010-2013	1,000		100	200	300	400	1,000			1,000
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 enter irrigation system data	Donor needed	2010-2013	750		150	200	200	200	750			750
Gender mainstreaming in water resource 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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