CGIAR INITIATIVE ON Asian Mega-Deltas

Legal and institutional Analysis of Water Resource Management and Development in Cambodia

Mak Sithirith, Sok Sao and Sanjiv De Silva

November, 2023

CGIAR

INITIATIVE ON

Asian Mega-Deltas

Contents

List of abbreviations

ASEAN	Association of Southeast Asian Nations
BDD	Basin Development Plan
CNMC	Cambodian National Mekong Committee
GDP	Gross Domestic Product
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
LMB	Lower Mekong Basin
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCs	Member Countries
MEF	Ministry of Economics and Finance
MIH	Ministry of Industry and Handicraft
MoE	Ministry of Environment
MoI	Ministry of Interior
MME	Ministry of Mine and Energy
MLMUNC	Ministry of Land Management, Urban Planning and Construction
MPWT	Mistry of Public Work and Transport
MOWRAM	Ministry of Water Resources and Meteorology
MRB	Mekong River Basin
MRD	Ministry of Rural Development
MRC	Mekong River Commission
NMC	National Mekong Committee
PBAP	Project Based Action Plan
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDEF	Provincial Department of Economic and Finance
PDIH	Provincial Department of Industry and Handicraft
PDME	Provincial Department of Mine and Energy
PDOWRAM	Provincial Department of Water Resources and Meteorology
PDPWT	Provincial Department of Public Work and Transport
PDRD	Provincial Department of Rural Development
UN	United Nations
UNEP	United Nations Environment Program
UNESCO	United Nations Education, Scientific and Cultural Organisation

1. Background

Cambodia covers an area of 181,035 km^2. About 86% (156,000 km^2) of Cambodian territory falls in the Mekong catchments. Geographically, Cambodia is lowland and downstream country in the Mekong River basin (MRB). Hence, Cambodia has abundant water resources. About 120.6 km^3 of water comes from within the Cambodian territory, and another 355.5km^3 flows from outside via the Mekong River. The total renewable water resources (TRWR) in Cambodia are estimated at 476 km^3 annually. The TRWR per capita in Cambodia is estimated at 30,352 m^3 (Table 1).

Only a small proportion of water resources flowing through Cambodia are used. About 2.18 km^3 of water is used in Cambodia each year, with agriculture being the largest user, accounting for 94% of usage. Irrigation water withdrawal consumes an estimated 1,928,000 m^3 annually. The rest of the water is used for domestic and industrial applications. The total amount of water withdrawal per capita is estimated at 134.4 km^3/year (Table 2).

Water governance is key to the development of Cambodia. RGC has made concerted efforts to manage water resources in Cambodia and in the region through developing a water policy, legal frameworks, strategies, planning, and water development program. It has also participated in various regional cooperation and development frameworks to ensure that Cambodia's interests are taken into account by national and regional actors. It is also engaged in the regional forum to advocate and voice its concerns about the impacts made by riparian states on Cambodia.

This paper reviews Cambodia's water policy, water-related legal and institutional framework, the Cambodia's Rectangular Strategies (RSs), the Cambodia's National Strategic Development Program (NSDP) 2019-2023, the Cambodian Sustainable Development Goals 2016-2030, the Strategic Development Plans for Agriculture 2019-2023, the MOWRAM's Strategic Development Plan 2019-2023, the MOWRAM's Irrigation Investment Program 2019-2033, the Roadmap of MOWRAM in the long and short terms, and policy and strategic documents of concerned ministries, including MOE, MRD & MIME.

Table 1. Availability of water resources and their uses in Cambodia.

Water Resources	Volume of Water
Internal renewable water resources	120.6 km^3/year
External renewable water resources	355.5 km^3/year
Total renewable water resources (TRWR)	476.1 km^3/year

Source: *FAO, 2020.*[1]

(Units of volume: *1 km^3 = 1 billion m^3 = 1000 million m^3 = 109 m^3)*

Table 2. Water Utilizations in Cambodia between 1998 and 2022.

Sectors (10^9 m^3/year)	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Agricultural water withdrawal				2.053	2.053	2.053	2.053
Industrial water withdrawal	0.012516	0.019832	0.027147	0.033	0.033	0.033	0.033
Municipal water withdrawal	0.044947	0.063895	0.082842	0.098	0.098	0.098	0.098
Total water withdrawal				2.184	2.184	2.184	2.184
Irrigation water withdrawal				1.928	1.928	1.928	1.928
Total water withdrawal per capita				159.6496	147.7627	136.4198	134.4017

Source: *FAO Database, 2021*[2]

[1] FAO. FAO Database. Available online: http://www.fao.org/nr/water/aquastat/data/query/results.html (accessed on 16 July 2022).
[2] Ibid. FAO. FAO Database.

2. Water Resources in Cambodia– Challenges and Opportunities for Water Resource Developments in Cambodia

Cambodia has abundant water resources. It has 39 river basins which are classified into five sub-regions in Cambodia, which contribute to the richness of water resources. These include: (1) the Tonle Sap, (2) the Upper Mekong, (3) the 3S river basin, (4) the Mekong Delta, and (5) the coastal river basin.

The Tonle Sap River basin comprises 16 sub-river basins, the Upper Mekong River basin has 5 sub-river basins, the 3S basin has 3 sub-river basins, the Mekong Delta has 8 sub-river basins, and the coastal river basin has 8 sub-river basins. These rivers and sub-rivers provide abundant water resources for Cambodia. The Mekong River is the source of external water resources flowing into Cambodia and then to the South China Sea, providing Cambodia with abundant water resources. The abundant water resources can be too much sometimes, causing flooding in the wet season, but these waters discharge into the sea, emptying many canals and rivers, causing drought in Cambodia.

Figure 1. Map of Cambodian Sub-river System.

Source: *MOWRAM, 2020*

2.1. The Cambodia's Upper Mekong River

Mekong River in Cambodia flows over 480 km from the border with Lao PDR in the North and Viet Nam in the South, and it has an average width of about 1.5 km in the territory of Cambodia with annual flow of 475,000 MCM. The upper Mekong River Basin in Cambodia is extended between Cambodia-Laos border to areas about 20 km downstream of Kratié provinces. It covers two provinces—Stung Treng and Kratie, with a total land area of 21,186 km^2 and it is home to about 540,468 people (Table 3).

Five Sub-river basins originate in the Upper Cambodian Mekong River Basin. These Sub-river basins cover 10,373 km^2 and waters from the watershed areas of the Sub-river basins flow into the Upper Mekong River Basin. On the other hand, when the water level in the Mekong River rises up from May to October, it then flows into the Sub-river basins. The average annual discharge from the 3S Sub-river basin into Cambodia is more than 300 billion m^3 and it is estimated that with contributions from the downstream tributaries, some 500 billion m^3 is discharged into the South China Sea annually (ADB, 2021)[3].

Two main stream hydropower dams are proposed to be built in the upper Mekong River Basin in Cambodia—the Sambor dam in Kratie Province and the Stung Treng Dam in Stung Treng Province. The installed capacity of the two dams are about 4280 MW. The full storage capacity is 2,070 million cubic meters (MCM). Ministry if Mines and Energies (MIME) has signed the MoU with China (Cambodia) Rich Investment Co., Ltd to conduct the feasibility studies of the Sambo and the Stung Treng Dam[4]. The The Huadong Engineering Corporation Limited is sub-contracted to from the China (Cambodia) Rich Investment Co., Ltd to carry out the feasibilities of these two proposed hydropower dams.[5] Nevertheless, the Don Sahong hydropower on the mainstream of the Mekong River in the Laos PDR at the border area with Cambodia has induced water level fluctuation in the downstream areas in Cambodia and made tremendous impacts. These have raised concerns about the impacts of the hydropower dams on aquatic resources in the Upper Mekong River Basin in Cambodia. Further, MIME with support from ADB has developed the Energy Development Plan 2021-2040. Perhaps, in line with the concerns about the impacts of hydropower dams on the Cambodia's Upper Mekong River, these two dams on the mainstream of the Mekong River in Cambodia (the Sambo and Stung Treng) have been removed from the the Energy Development Plan 2021-2040 (MIME, 2022)[6]. In addition, Fishery Administration (FiA) in Cambodia with supports from the USAID under the Mekong Wonderer Program and World Bank through the Mekong Integrated Water Resources Management has undertaken the conservation of aquatic resources management and improving the livelihoods of communities along the upper Mekong River in Cambodia.

At the provincial level, there is no specific plans for investments in water infrastructures other than hydropower. However, responding to frequent floods and drought at the community levels is a key priority, which need an attention. Climate change adaptation is also key response to current flooding and drought in the upper Mekong River in Cambodia. NGOs and DPs have provided supports to local communities in the upper Mekong River in Cambodia to address the flooding and drought, and in adapting to climate change, but it is in small-scale.

Table 3. The Upper Mekong River in Cambodia.

Upper Mekong River Basin in Cambodia	Areas (km^2)	Population
Stung Treng	11,092	165,713
Kratie	11,094	374,755
Total	**22,186**	**540,468**

Table 4. The proposed hydropower dams in the Upper Mekong River Basin in Cambodia.

No	Project Name	River	Province	Rated Head (m)	Design Plant (m^3/s)	Installed Capacity (MW)	Peaking Capability (MW)	Mean Annual Energy (GWh)	Firm Annual Energy (GWh)	Full Supply Level (mamsl)	Low Supply Level (mamsl)	Live Storage (mcm)
1	Sambor	Mekong	Kratie	32.9	19,163	3,300	2,030	14,870	9,150	40	38	2,000
2	Stung Treng	Mekong	Stung Treng	15.2	18,493	980	591	4,870	2,937	55	50	70
Total						**4,280**	**2,621**	**19,740**	**12,087**	**95**	**88**	**2,070**

[3] ADB. 2021. Surface Water Resources Assessment of the Tonle Sap and Mekong Delta River Basin Groups: Improving Climate Resilience, Productivity, and Sustainability. ADB Brief, No. 171. March 2021. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.adb.org/sites/default/files/publication/689106/adb-brief-171-surface-water-resouces-rbgs-cambodia.pdf.

[4] MIME Letter dated 04 March 2022 to Okha Kith Meng, Director of China (Cambodia) Rich Investment Co., Ltd., about the feasibility studies of the Sambo and Strung Treng Dams.

[5] Phnom Penh Post dated 25 March 2022 states that Royal Government of Cambodia agrees to allow the Royal Group to cooperate with Chinese Company to study the feasibilities of the proposed hydropower dams. Available online: https://www.postkhmer.com/business/2022-03-25-1350-233862.html. Accessed on 23 August 2022.

[6] Letter from MIME to Royal Group, dated 04 March 2022, informing about the decision of RGC to not build the Sambo and Stung Treng Dam.

2.2. The 3S River Basin

The Sesan, Sre Pok, and Sekong rivers, referred to as the 3S river basin, are shared by three countries and constitute a significant part of the Lower Mekong river basin. The 3S River Basin in Cambodia consists of 8 sub-river basins, located in the northern region of Cambodia in Stung Treng, Ratanakiri and Mondulkiri Provinces, covering 26,377 km^2. It is home to nine ethnic groups, and about 267,993 people live in the 3S region, living dependent on water, fisheries and agriculture (ADB 2010a; Constable, 2015).

The Mekong River Basin has the potential to generate 30,000 megawatts of hydropower. The 3S Sub-river basin is a potential region for hydropower development, approximately 6,400 MW (MRC, 2009), mostly in Vietnam and Laos (Constable, 2015a; Piman et al., 2013; ADB, 2010a). In the late 1990s, the 3S region has changed due to the rapid development of the hydropower dams along the 3S river system. Some 42 hydropower dams have been planned and built in the 3S river basin—3 hydropower dams were built on the Sekong River, 8 dams on the Sesan River, and 7 dams on the Srepok River—and 23 hydropower dams are under planning (Constable, 2015; Piman et al., 2013). Vietnam as a downstream country in the Mekong has planned for 20 dams, of which 15 dams completely built in the 3S rivers[7], while Laos has built 2-3 dams in the Sekong river in Laos. In Cambodia's 3S region, two dams were built—O Chum 2 with one megawatt and the Lower Sesan 2 Dam with 480 MW, and five other dams are under planning (see Table 5).

Following the construction of many hydropower dams along the Sesan and Srepok Rivers in Vietnam, dry-season flows at the confluence of the 3S rivers in Cambodia have increased by 28%, while wet-season flows have decreased by 4%. As a result, the dry-season flows are sometimes comparable to the wet-season flows, a phenomenon described as homogenized flow. Thus, the increased dry-season flow has resulted in area permanently inundated and areas that are permanent dry, leading to reduced river productivity, changing river ecology and systems, changing the livelihoods of river dependent communities.

Dams have blocked fish migration routes upstream. No migratory fish species will be able to migrate past the dam onto the upstream tributaries of the Sesan and Srepok Rivers when it is operational. The 3S rivers are home to 329 fish species—133 species in Sesan, 213 species in Sekong, and 240 species in Srepok. The LS2 has impacted fisheries, and fish catch would drop by 9.3% basin-wide, amounting to approximately 200,000 tons of fish each year (Baran et al., 2013; Ziv et al., 2012).

Table 5. The hydropower Projects in the 3S Region in Cambodia.

No	Project Name	River	Full Storage Volume (m^3)	Installed Capacity (MW)	Year of Completion
1	O Chum 2	O Chum	740	1	1992
2	Lower Se San2	Se San	2,296,500	480	2017
3	Lower Se San 3	Se San	3,120	243	Not yet
4	Prek Liang 1	Prek Liang	110	35	Not yet
5	Prek Liang 2	Prek Liang	180	25	Not yet
6	Lower Sre Pok 3	Sre Pok	5,310	204	Not yet
7	Lower Sre Pok 4	Sre Pok	2,700	143	Not yet
	Total		**2,308,660**	**1131**	

The 3S region falls in the cooperation framework of b Cambodia, Laos and Vietnam, known as the Cambodia-Laos-Vietnam Development Triangles (CLV). The CLV Master Plan developed in November 2010 covers various sectors and priority areas: transport, energy, telecommunications, irrigation and water supply, agriculture, tourism, industry, education and health, environmental protection and land management, security and defence, trade and investment. First, the CLV promotes the building of hydropower dams in the 3S Rivers to generate electricity for exports to Vietnam (Ojendal et a. 2002; ADB 2010b; ICEM 2010). In Cambodia, the CLV has made a plan to build the LS2 on 2012-2017 and the Lower Sesan 1/5 (LS1/5), the Lower Sesam 3, the Prek Leang 1 and the Prek Leang during 2015-2020. In Laos, the CLV has prioritized ten hydropower projects, including the Sekong 4 and Sekong (CNMC 2010; ABD 2010b). In addition, the CLV has planned to build the power grid connecting hydropower stations in Laos and Cambodia to Vietnam's national power grid for electricity exports to Vietnam, and also for electricity imports from Vietnam to Laos and Cambodia (CLV-DTA 2010).

As part of the CLV, EVN representing Vietnam signed a memorandum of understanding with the Cambodian government to connect the LS2 and the LS1/5 to the Cambodian and Vietnamese power grids (EVN 2010). The agreement stated that about 50 percent of the electricity from LS2 would be sold in Cambodia, but the rest would be exported to Vietnam, given that transmission capacity in the Cambodian power grid beyond the northeastern provinces is not ready yet, and electricity

[7] The CGIAR Research Program on Water, Land and Ecosystem. https://wle-mekong.cgiar.org/wp-content/uploads/unnamed-11.jpg. Accessed on 13 July 2018.

demand in northeast Cambodia is far less than what LS2 can produce. Contrary to the above, in June 2011, the Cambodia's Ministry of Environment confirmed that only surplus electricity after local use would be sold to Vietnam (*Phnom Penh Post*, February 25, 2011a). That statement was quickly corrected in July 2011 when the Cambodian prime minister announced that 100 percent of electricity generated from the LS2 dam would be used in Cambodia[8].

Apart from the hydropower dam building, the CLV has promoted the investments of Vietnamese companies in the 3S regions in Cambodia and Laos. In Cambodia, the government granted 620,987 hectares of land, just over half of the total 1.2 million hectares, to foreign concessionaires. Of the 82 foreign companies, 34 are Vietnamese (granted 253,623 hectares) and 25 Chinese (960 hectares) (*Phnom Penh Post*, June 20, 2014a). Nearly 40,000 hectares of forestland in Ratanakiri has been granted to Vietnamese companies as economic land concessions (*Cambodia Daily*, December 24, 2015). More conflicts between companies and local communities have occurred and solutions to these conflicts have been fragmented but in favor of investors. In late 2018, Cambodia has condemned the EU to ban log purchases from Vietnam, as they imported from Cambodia illegally.

2.3. The Tonle Sap River Basin

The Tonle Sap river basin is located in the northwest part of Cambodia between approximate latitudes 102° 15′ to 105° 50′ E and longitudes 11° 40′ to 14° 28′ N. It covers an area of about 85,000 km², of which 95% lie in Cambodia, including the Tonle Sap lake, while the remaining 5% (about 5,000 km²) lies in Thailand. The Tonle Sap River Basin covers nine main provinces, 83 districts, 542 communes, and 3,742villages. It constitutes more than 44% of Cambodia's total land area. It includes partial or entire part of the following provinces—Banteay Meanchey; Battambang; Kampong Chnnang, Kampong Thom, Ouddar Meanchey; Pailin, Preah Vihear, Pursat, and Siem Reap (ADB, 2004; Wright et al., 2004). It is home to about 32% of Cambodia's population, equivalent to about 5 million people in 2019. The majority (72.3%) of the population are rice farmers who are practicing rainfed farming more than dry season rice. The Tonle Sap river basin geographically is classified into the Tonle Sap Lake, the floodplain, and tributaries.

The Tonle Sap river basin is rich in water resources. Some 16 rivers, big and small, originating within the basin flow through the basin catchment into the Tonle Sap lake, covering 81,663km^2. These sub-rivers contribute 24.5 Km^3 of water to Tonle Sap Lake (TSL) (Kummu et al., 2014). The lake areas expand horizontally from 2,500km^2 ha in the dry season to 15,000km^2 ha in the wet season; and vertically from 1.4m water level in the dry season to 8-9m in the wet season. Third, the lake volume has increased from around 1.5km^3 in the dry season to 60-70km^3 in the wet season (Kummu et al., 2006; Kummu & Sarkkula 2008; Sithirith, 2015).

Water flowing in the Mekong River reverses to TSL and it is an essential driver of the Tonle Sap unique ecosystem. The hydrology and flood-pulse in Tonle Sap are driven by the Asian Monsoon regime that brings approximately 65% of the total annual rainfall to the Mekong Basin between July and October (MRC, 2005). More than half of annual flows into the Tonle Sap come directly from the Mekong via TSR (53.5%), 34% from 16 tributaries in the Tonle Sap catchment, and 12.5% from rainfall precipitation (Kummu et al., 2014). The Mekong is also the source of 72% of the suspended sediments entering the Tonle Sap (Kummu et al., 2008; ADB, 2005)[9].

The reverse flow of water from the Mekong River to TSL plays an essential role in sustaining the TSL functionality, productivity, and sustainability in terms of its starting date, the ending date, the duration, and the RF volume. The reverse flow starts in late May or early June and ends at the end of September or early October. The total average duration of the reverse flow extends over 120 days, varying between 140 days in 1999 (heavy floods in 2000) and 86 days in 2014 (very drought in 2015 and 2016). Kummu et al., (2014) estimate that the reverse flow volume from the Mekong to TSL was about 42km^3 annually between 1997 and 2006, ranging between 30km^3 in 2006 and 54km^3 in 2002. However, according to MRC, the long-term average (LTA) annual reverse flow volume from the Mekong River to TSL is estimated at 40.38km^3 between 1996 and 2015, varying between 54 km^3 in 2002 and 28.52 in 2015 (MRC, 2016; MRC, 2020). The reverse flow to TSL constitutes about 50.3% of the total volume of water in TSL in the wet season or about 9% of the total flow volume of the Mekong River to South China's Sea.

Some of these sub-rivers are potential for hydropower developments. Five hydropower dams have been proposed on the sub-rivers around the lake—2 in Stung Sangker River, 2 in Stung Pursat River and one in Stung Sen River, with a total installed capacity of 179 MW and the storage capacity of 5,025 MCM (Table 6). The Battambang II, Pursat I and Stung Sen Projects are multi-purpose, mainly concerned with irrigation projects, and at the moment are subject to a feasibility study. The Battambang 1 and the Pursat Projects have been constructed, and they are suffering from shortage of water to generate electricity due to heavy deforestations in the watershed areas.

Large land areas around the TSRB have been granted to the private companies for 99 years concession. Of the total land areas, about 432,420 ha of arable lands within the TSRB have been concessioned to 18 private companies between 2000 and 2010. In addition to the economic land concessions discussed above, another 486,900 ha in the TSRB has also been granted to mining concessions programme managed by the Ministry of Mines and Energy. The RGC has granted the mining concessions to 28 local and international companies have concessions to exploit mineral resources in the Tonle Sap River Basin.

---

[8] Letter from Prime Minister Samdech Hun Sen, *Letter No31: Clarification to the request by HE Son Chhay, Phnom Penh Parliamentarian, for delay in the implementation of the Hydropower Project of Lower Sesan II of the Vietnamese Company EVN in joint venture with the Royal Group Company,* 28 July 2011.

[9] ADB (2005). Tonle Sap and its fisheries: Future solutions now. The Tonle Sap Initiative; Asian Development Bank, Manila, Philippines.

Tonle Sap Lake and The Tonle Sap floodplain are surrounded by National Highway No.5 & 6, which are critical components of the GMS Southern Economic Corridor (SEC), adopted by the GMS countries in 1998 to help accelerate the pace of sub-regional economic cooperation. The SEC connects Cambodia with Laos, Myanmar, Thailand, Vietnam, and major markets and hubs/nodes in the region to serve as centers for enterprise development. The SEC Northern Sub-Corridor goes along the National Highway No.6 and No. 64 in Cambodia, cutting across Banteay Meanchey, Siem Reap, Stung Treng, Ratanakiri, and the central highland of Vietnam. The SEC Central Sub-Corridor goes along the National Highway No.5 and No.1 in Cambodia, through Banteay Meanchey, Battambang, Kampong Chhnang, Phnom Pen,h and Ho Chi Minh City. Banteay Meanchey, Siem Reap, Battambang, Kampong Chhnang, Pursat, and Kampong Thom have 'high' to 'very high' Economic Potential Index (EPI). These provinces are located along a regional economic corridor, having high economic potentials due to their strategic location and accessibility to inter-regional (global) trade and value-added industries. Such provinces also benefit from intra-regional (local) development through economies of scale and inclusion/ integration (World Bank, 2018).

Furthermore, ADB has provided USD 125 million in loans to Cambodia to upgrade the provincial towns around TSL and to improve urban environmental services; including capital cities of Pursat, Kampong Chhnang (ADB, 2021a), Battambang, Serey Saophoan in Banteay Meanchey, and Stueng Saen in Kampong Thom between 2018 and 2024 (ADB, 2021b). These projects are part of the GMS strategies to stimulate the economic activities in these provinces. Furthermore, the Cambodian Government has planned to build a bridge across Tonle Sap River, connecting Kampong Chhnang and Kampong Thom Provinces. Cambodia has reached out to China for USD200 million in loan to construct a road and a bridge. These initiatives promote economic developments in the TSL regions (Khmer Times, 2021).

The hydropower development in the MRB, including in the TSRB, the infrastructure development around the TSL, and the climate change in the region have undermined the hydrological regimes of the Mekong River and the reverse flow of water from the Mekong River to TSL. The reverse flow to TSL has changed slightly between 1997 and 2020, including the starting date, the ending date, and the duration. The RF starting date has shifted from May to later June in 2019 and in 2020, to August. The ending date of the RF has also moved from August toward later September or early October. Between 2015 and 2016, TSL and Mekong Regions in Cambodia experienced a severe drought.

Forest fire took place in TSL between Battambang and Siem Rep Provinces. Severe drought in Cambodia resulted in a state emergency declared by the Royal Government of Cambodia (RGC) due to a lack of water for human consumption. RGC took a step to distribute water to its populations throughout the country (Eyler, Kwan & Weatherby, 2019).

Table 6. Hydropower Projects in Tonle Sap River Basin.

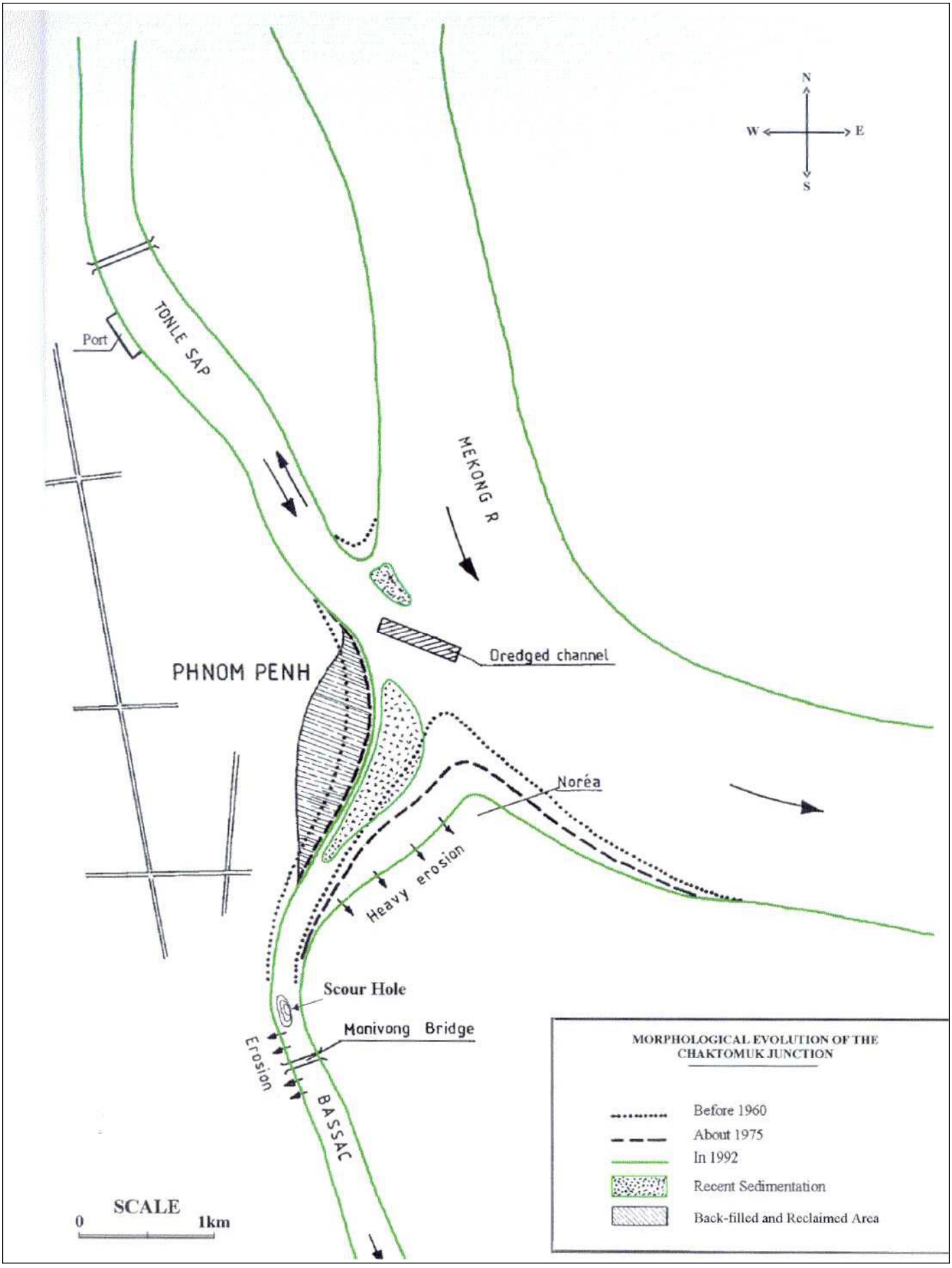
No	Project Name	River	Province /District	Head	Design Discharge	Capacity	Annual Energy	Annual Energy	Supply Level	Supply Level	Storage
				m	m3/s	MW	GWh	GWh	mamsl	mamsl	mcm
1	Battambang 1	Sangker	Banttambang/Ratanak Mondul	34	104	24	123.2	105.7	76	58	1,040
2	Battambang 2	Sangker	Battambang/Samlot	450	6	22	114.4	114.	670	658	110
3	Pursat 1	Pursat	Pursat/Veal veng	115	99.2	100	442.9	321.4	200	185	690
4	Pursat 2	Pursat	Pursat/Kravanh	23	57	10	42.1	42.1	50	41	295
5	Stung Sen	Stung Sen	Preah Vihear/Rovieng	19	145	23	124.2	124.2	43.5	35	2,890
	Total					**179**	**846.8**	**707.4**	**1,039.5**	**977**	**5,025**

2.4. The Mekong Delta

The Mekong Delta Sub-River Basin covers the Mekong River from downstream of Kratié to the border of Cambodia and Vietnam. The Mekong Delta in Cambodia covers approximately 29 sub-river basins, and is home to six million people who live in 3840 villages in 10 provinces. About one-third (approximately 840,000 ha) of Cambodia's Mekong Delta is low-lying ground with elevation at 10 m above sea level or even lower (0 m). This area is prone to flooding during the wet season and is used for rice farming. Rice is the most abundant crop. A flood could last from 3 to 6 months and with a depth varying from 1 to more than 4 m.

The upper Cambodian Mekong Delta has been heavily developed and large areas has been urbanized. The head of the Bassac River in Phnom Penh has been urbanized which has altered the physical landscape of the Bassac River. On the lower Mekong River in Phnom Penh at Koh Norea, some areas along the Mekong River Bank has been concretized which could potentially narrow the Mekong River channel below Phnom Penh.

Figure 2. The map of the inter-section of Mekong, Tonle Sap and Bassac River.



The Vietnam's Mekong Delta (VMD) is home to about 20 million people by 2020. About 1.2 to 1.9 million ha of land in the VMD has flooded annually, and about 30,000 km^2 for agriculture, which is required to be flooded to a depth of about 20cm. For this purpose, Vietnam has built heavy embankments and dike systems to control floods and protect agricultural lands from flooding. It needs about 6000 million m^3 of water, about 1.5% of the Mekong River discharge in the wet season, and Vietnam has built conduits, ditches, embankments, and dike systems to mitigate these problems. Vietnam has constructed 1300km of high ring dikes and 13,300km of low ring dikes for flood controls and protecting the second rice crop. Some 980 sluice gates of 3 to 100 m width and 20,500 sluice gates with widths less than 3m were constructed. There are more than 1000 man-made canals—massive engineering structures for transport, salinity protection, land reclamation and urbanization, and storm protection. The channel network has about 45,000 segments equivalent to 87,500 km in total length. At the Cambodia-Vietnam border areas, along the Vinh Te Canal, in 1999, Vietnam built five rubber dams to control floods flowing from across the Cambodian border, for instance, the Tha La and Tra Su rubber dams. The flood control dykes and the rubber dams are closed during the peak flood seasons between July and September every year to allow farmers in Vietnam's Mekong Delta to complete their rice harvest. The closures of the rubber dams and flood control dykes result in heavy floods in Southern provinces of Cambodia, including Takeo, Prey Veng and Svay Rieng Provinces, damaging rice crops and properties of rural households in the provinces. However, after Vietnamese farmers complete their rice harvests, the rubber dams and the flood control systems are opening, allowing water to enter Vietnam's Delta from Cambodia, which could clean up the Delta rice farming areas and take more water for other development. These result in droughts in Cambodia every year, and some years for instance in 2015 and 2016 got severe droughts, leading to State declaring the state emergency of water shortage.

The urban developments, flood controls, embankments and infrastructure developments in the upper and lower Mekong Delta have altered the hydrological flow of the Mekong and Tonle Sap rivers, and so does the volume of water entering into the Bassac river. As the hydrological regime of the Bassac river has changed, it has affected the hydrological regimes at the Chaktomuk area, and so does the reverse and returned flows of TSL. The decrees of the changes cannot be covered by this study, but it require more studies. In addition, the expansions of the Tonle Sap Provincial towns would transform the lake landscapes and floodplains. It would further change the hydrological flows of the lake. Transboundary water management in the delta has failed to address water security concerns on both sides of the border. A regional mechanism, such as the MRC, has been dumped with many principles and procedures but without ground solutions.

2.5. The Coastal River Basin

The coastal region is located in the southwest part of the country, bordering Vietnam in the east, Thailand in the west, and the South China Sea in the south. According to the Royal Kret 77/70CE and Kret dated 01/07/1972, Cambodia has claimed its Exclusive Economic Zone (EEZ) up to 370 km from the coastline, and thus, it covers 95 000 Km^2 (FAO, 2005). The Cambodian coastline is extended over 435 km with 75 islands, encompassing 17,237 km^2 of coastal waters (MoP, 2020). Administratively, the coastal region is structured into four provinces, situated along this coastline, namely Koh Kong, Preah Sihanouk, Kep, and Kampot. It substructures into 22 districts with 156 communes. It has 734 villages, of which 192 villages are coastal villages. It is home 1,072,468 people or 6.9 % of the population (MoP, 2020).

The marine water is included in the water resources of Cambodia, which require the management under MoWRAM to ensure that they continue to support healthy ecosystems and fisheries and provide the basis for sustainable economic activities, particularly fishing and tourism. However, marine water resource management are not well-stated in water policy and legal frameworks. Thus, water resources in the coastal region concern mainly the freshwater resources that flow from eight sub-river basins in the coastal region, covering 18,045km^2.

Given the rapid development in the coastal region, particularly the Chinese investments, electricity demands are highly increased, and thus, hydropower plans have been developed and built in the sub-river basins in the coastal region of Cambodia. Six hydropower dams are located in the coastal provinces of Cambodia, including in Kampot and Koh Kong Provinces and one hydropower dam (Lower Sesan 2) is located in 3S region in Cambodia. These hydropower dams could generate 1,336 MW of electricity (Table 7). China is especially supportive to Cambodia's plans for hydroelectric development and has invested over USD2.23 billion in seven hydropower projects in Cambodia, six in the coastal region between 2010 and 2015, including the Kamchay, Stung Tatay, Stung Atay, Lower Stung Russey Chrum and Stung Cheay Areng Dams and the LS2 Dam in the Mekong Region (Mathews and Motta 2015; Urban et al. 2018).

In the 2014s, MIME signed the MoE with Metuk Hydropower Co., Ltd to conduct the Pre-feasibility study for hydropower development in the Metuk River that flows from Koh Kong Province in Cambodia to Thailand. The Metuk hydropower dam could generate electricity to sell to Thailand and provide water for irrigation in Cambodia. In the visit to Thailand on 18-19 December 2015, Prime Minister Hun Sen met with Thailand's Prime Minister, Prayooth Chan Ochar to discuss the Metuk Hydropower Plan. On 15 November 2019, the Pre-feasibility study report was completed by Chinese Company, Bejing Engineering Corporation Limited, and submitted to MIME. Further, the feasibility study will be conducted and RGC will recruit local company to invest in development of Metuk Hydropower Project in the future[10].

[10] MIME, 2021. Letter from Minister of MIME to Prime Minister Hun Sen on the proposed development of Metuk Hydropower Project, dated 21 December 2021.

Table 7. The hydropower projects in the coastal river basin.

No	Hydro-dam Financed by China	Installed capacity	Cost (US$ million)	Year of Completion	Chinese Companies	Status
1	Kamchay	193	280	2010	Sino-hydro Corporation	Complete
2	Kirirom III	18	47	2012		Completed
3	Stung Atay	120	255	2012	Yunnan Corporation for International Techno-Economic Cooperation (CYC)	Completed
4	Stung Tatay	80	215	2010	China National Heavy Machinery Corporation	Completed
5	Lower Stung Russey Chrum	235	290	2015	CYC and Yunnan Southeast-Asia Economy and Technology Investment Industrial Co Ltd	Completed
6	Stung Cheay Areng	260	327	2015	China Southern Power Grid Company Limited	Completed
7	Lower Sesan 2	430	816	2017	China's Hydrolancang International Energy	Completed
Total		**1,336**	**2,230**			

2.6. Hydropower Development in the Mekong River Basin

Cambodia is situated in the Lower Mekong River Basin (LMB). Since the 1950s, nearly 6,000 large and small dams have been built in the LMB (FACT, 2001). Between 1965 and 2005, 22 major dams, both hydropower and irrigation, were constructed in four lower Mekong countries: Thailand, Laos, Vietnam and China. About 40% of these dams were built for irrigation purposes, the rest for hydropower. The active storage capacity of these dams was estimated at about 15,328 million cubic metres (mcm). At Kratie, the average annual flow is estimated at about 440,000 mcm/year. The total storage capacity of dams in the Mekong is about 3.5% of the average annual flow of the Mekong at Kratie.

Thailand built 12 dams between 1965 and 1995; of these, 9 provide water for irrigation over an estimated area of 275,000 ha of wet rice and 227,000 ha of dry rice, mainly in northeast Thailand listed in the Table 8. These dams provide electricity to modernize Thailand, as industries boomed in Bangkok and other provinces of Thailand in the early 90s. Thailand was the first country in the Mekong Region that moved massively with the construction of dams during and after the Cold War.

After the 1990s, more hydropower projects have proposed by different countries in the Mekong region. In total, some 156 hydropower projects have been planned in the Mekong Region, some of them have completed, some are under the constructions and some are under the planning. These dam projects could potential produce a total capacity of 52,043 MW with the storage capacity of 126,890 MCM (see Table 8).

Some 24 hydropower projects have been planned and built on the mainstream of the Mekong Rive, 13 of them are in Lancang River in China and 11 dams are in the Lower Mekong River Basin (LMB). Eleven of 13 Chinese dams were completely built between 1990 and 2020, and they are put in the ope-ration. Among 11 mainstream dams in the LMB, 9 are in Laos and 2 in Cambodia; one dam in Laos, Xayabuiri dam, is completed and is operational in 2019, another dam, Don Sahong, is under the construction, one dam (Pak Beng dam) completed the Procedures for Notification, Prior Consultation and Agreement (PNCA) and is under the planning, and two other Laos dams are under the PNCA. Some 132 hydropower projects are proposed, planned, and built on the tributaries of the Mekong River, all of them are situated in the LMB, of which 25 dams are operational, 13 dams under construction, 23 dams licensed and 74 dams planned (MRC, 2017) In the 3S river basin, 42 dams are planned, of which, three major hydropower dams completely built on the Sekong, eight on the Sesan and seven on the Srepok and 23 dams are under the planning (Constable, 2015; Piman et al., 2016; Piman et al., 2013).

Laos has planned to build 100 hydropower dams, 91 dams are on the tributaries, with a total capacity of more than 20,000MW and the storage capacity of 57,477 MCM. Cambodia has planned 21 dams in the Mekong basin in Cambodi, two of them are on the mainstream (Sambo and Stung Treng), and the rest is in the 3S region and around the Tonle Sap Lake. Vietnam as a downstream country in the Mekong has planned for 20 dams, of which 15 dams completely built in the 3S rivers[11], while Thailand continues to finance the hydropower projects in Laos to import electricity to Thailand.

[11] The CGIAR Research Program on Water, Land and Ecosystem. https://wle-mekong.cgiar.org/wp-content/uploads/unnamed-11.jpg. Accessed on 13 July 2018.

Table 8. Major water resource projects in the Mekong.

Project	Country	Main purpose	Power characteristics		Irrigation potential (ha)		Active storage
			MW	GWh/yr	Wet season	Dry season	(mcm)
1965-1975							
Nam Ngum (No.1)	Laos	P	150	1,000			4,700
Nam Phrom (Chulabhorn)	Thailand	P	40	115			165
Lam Phra Plerng	Thailand	I			10,000	10,000	145
Nam Pong (Ubol Ratana)	Thailand	P, I	25	65	53,000	53,000	1,920
Nam Pung	Thailand	P	6	15			112
Lam Thakong	Thailand	I			38,000	38,000	290
Lam Dom Noi (Sirindhorn)	Thailand	P, I	36	73	24,000	24,000	900
Lam Pao	Thailand	I			54,000	54,000	1,260
Nam Oon	Thailand	I			30,000	10,000	520
Total 1965-1975			**257**	**1,268**	**209,000**	**189,000**	**10,012**
1976-1986							
Upper Huai Luang	Thailand	I			13,000	3,000	110
1986-1995							
Pak Mun	Thailand	P	136	280			200
Rasi Salai	Thailand	I			44,000	26,000	500
Huai Mong	Thailand	I			9,000	9,000	100
Xe set	Laos	P	45	180			0
Manwan	China	P	1,500	7,870			920
Total 1975-1986			**1,681**	**8,330**	**66000**	**38000**	**1,168**
Total 1965-1995			**1,938**	**9,598**	**275,000**	**227,000**	**11,180**
Completed after 1995, under construction, or nearing construction phase (1995-2005)							
Nam Leuk	Laos	P	60	185			88
Hoay Ho	Laos	P	150	725			523
Nam Theun-Hinboun	Laos	P	210	1,645			15
Yali Falls	Vietnam	P	720	3,643			779
Nam Theun 2	Laos	P	680	5,130			2,607
Nam Ngum ext	Laos	P	40	184			7
Nam Mang No.3	Laos	P	30	155			129
Total 1996-2005			**1,890**	**11,667**			**4, 148**

Note: P=Power and I=Irrigation

Source: *CNMC and NEDECO, 1998*

Table 9. Hydropower dams in the Mekong River Basin.

Country	Mainstream Dam	Tributary Dam	Total	Total Capacity (MW)	Storage capacity (mcm)
Cambodia	2	19	21	5,073	20,555
Laos	9	91	100	20,907	57,477
Thailand	0	7	7	745	3.6
Vietnam	0	15	15	2,583	3,156
China	23	65	88	21310	47,644
Total	**34**	**197**	**231**	**50,618**	**128,835.6**

Source: *MRC, 2017*

China has intensified the building of the mainstream dams in the Lancang River in the post-Cold War. The first Chinese dam was a Manwan dam completed in 1993 with the electricity generating capacity of 1500MW and storage capacity of 920 million cubic meters. Between 1993 and 2020, China completed 10 mainstream dams with electricity generating capacity of 19280 MW and the storage capacity of 43,617MCM.

The Xiaowan and Nuozhadu Dams have large reservoirs that generally take years to fill, leading to substantial falls in water levels during the dry season. However, in the dry season (November to April), when the inflow is not enough, Xiaowan and Nuozhadu will generally release the water to downstream dams so as to ensure other dams can run at full capacity. Xiaowan and Nuozhadu are the two-yearly regulated dams with big regulation storages, while all the others have very limited seasonal regulation capacity. The Gongguoqiao Dam has the smallest power generating capacity of only 900 MW compared with other dams in China, but it is a large dam compared with other dams in the Lower Mekong Basin (Table 10).

China dams would withhold water in the dry season to maintain its hydroelectricity output and release water to protect the dams during floods with a total storage capacity of about 41 km^3. In addition, the Chinese dams possess the flow regulation with a total regulation storage capacity of about 22.2 km^3. The flow regulation entails fewer seasonal floods downstream during normal years. Fewer seasonal floods, however, are likely to result in a decline in soil fertility over wide areas of rice cultivation in the Lower Mekong Basin. Fewer seasonal floods would also mean less natural capacity to constrain saltwater intrusion from the sea into the Mekong Delta. As a result, aquatic life long adapted to the Mekong ecosystems could be seriously jeopardized by the changing flow regime. Fish migration could be blocked by dam building. If the Mekong's biodiversity dropped, this would likely be accompanied by falling productivity in the wild fisheries. The economic component of soil fertility and wild fisheries is obvious, as these factors directly affect both the food supply and the economic viability of the Mekong's downstream countries. Technically speaking, China's dams on the upper Mekong put Beijing in a position to control the quantity of water flowing downstream. The dams thus represent a potentially powerful tool to exert influence on the downstream countries and pose a possible diplomatic threat (Biba, 2012).

Table 10. Chinese hydropower projects in the Lancang Mekong River Basin.

No.	Projects	Year of completion	Installed capacity (MW)	Storage Capacity (m^3)
1	Manwan	1993	1750	920,000,000
2	Dachaoshan	2002	1250	940,000,000
3	Jinghong	2008	1750	249,000,000
4	Xiaowan	2009	4200	15,000,000,000
5	Gongguoqiao	2012	900	120,000,000
6	Nuozhadu	2012	5850	27,490,000,000
7	Miaowei	2017 (January)	1400	660,000,000
8	Huangdeng	2017 (November)	1900	1,613,000,000
9	Dahuaqiao	2018 (February)	900	293,000,000
10	Lidi	2018 (June)	420	75,000,000
11	Wunonglong	2018 (December)	990	284,000,000
	Total		**21310**	**47,644,000,000**

Source: *MRC, 2017*

China has built more than 50 large-scale dams (over 50 MW) in Lower Mekong countries: Myanmar 30, Lao PDR 14, Cambodia 7, Vietnam 3, and Thailand with some Chinese dam projects, but none over 50 MW (Matthews & Motta 2015). In Cambodia, the dam-building industry is considered by China an instrument of economic growth and development. China has built seven dam with the total power generating capacity of 1,336 MW with the total cost of USD 2.23 billion (see Table 7). These dams are constructed under the "build-operate-transfer (BOT)" arrangement, in which the project company builds the dam and operates it for about 20-40 years before the dams are then handed over to the Cambodian government (unless the concession period is extended). BOT projects are common in contexts where domestic building and operations expertise is lacking. Furthermore, in Cambodia, the project owner is responsible for commissioning the EIA and for planning and implementing any necessary resettlement.[12] Kamchay Dam is an example of such a project. Built-in Cambodia in 2011 by Sinohydro under BOT for 44 years, the revenues generated from selling electricity are accrued to Sinohydro until 2050, with the management of the dam firmly in Chinese control.[13] LS2 Dam is another example, built in Cambodia under the BOT by Chinese companies for 45 years.[14]

[12] Olivier Hensengert, 'Regionalism, Identity, and Hydropower Dams: The Chinese-Built Lower Sesan 2. Dam in Cambodia. Journal of Current Chinese Affairs, 46(3), (2017), pp.85-118. https://nbn-resolving.org/urn:nbn:de:gbv:18-4-11097.
[13] Urban, Siciliano and Nordensvard, 'China's dam-builders', pp. 747-770.
[14] Chu Ta-Wei. 2017. Riparians versus the State in Southeast Asia. Asian Survey, 57(6):1086–1109. doi:10.1525/as.2017.57.6.1086; Ian Baird, 'Non-government Organizations, Villagers, Political Culture and the Lower Sesan 2 Dam in Northeastern Cambodia. Critical Asian Studies, 48(2), (2016), pp. 257-277; Sithirith; Evers & Gupta, 'Damming the Mekong Tributaries', pp.1420–1435.

The hydropower dams in the upstream of the Mekong River held large volume of water in the upstream. Thus, hydropower has induced the hydrological changes in the Mekong River. In the wet season, the hydropower dams retain water in the reservoirs which reduce the water flow downstream. However, in the dry season, the hydropower dam releases water to generate electricity, which cause the increased dry season flows in the Mekong Reiver. These changes to natural flow have a pronounced impact on communities that rely on fishing and other resources for livelihoods and food security. The ecological processes in this part of the river, and the social practices that rely them, have likely been inexorably altered by these changes. These processes range from fish migration to the flooding of wetlands to nesting patterns of birds that rely on exposed riverbanks in the dry season, among other yet-to-be documented ecological changes. All these changes to the Mekong's ecology threaten the habitats and viability of numerous species. Higher dry season levels also wash out riverside gardens, which are an important source of food and marketable crops for locals.

The Mekong River Commission continues to promote an evidence-based position that wet-season floods provide a value of 8 to 10 billion USD annually for fisheries, agriculture, and freshwater availability that far outweighs the 60-70 million USD in annual damages caused by extreme flood events. Floods drive important processes in the Mekong such as the Tonle Sap reversal, an event which makes the Tonle Sap Lake the world's largest and most productive inland fishery. Moreover, natural wet season floods drive agricultural production in the Mekong Delta, which provides Vietnam with 20% of its annual GDP, half of its rice production, and most of its fruits and aquaculture[15]. The hydropower dams have althered the flood regimes in the Mekong River, Tonle Sap Lake, and Mekong Delta, and these have undermined the productivity of the lake and Mekong River, and also socio-economic conditions in the Basin.

Drought has affected countries in the Lower Mekong River Basinn. The Mekong Drought in 2016 has led to China released water from a dam along the Lancang River (the Mekong River in China) help alleviate drought conditions in the Lower Mekong Countries, and to provide water "for emergency use" by countries downstream. This is part of China's water diplomacy, which concerns the use of diplomatic instruments to manage existing or emerging water disputes and conflicts to solve or mitigate them for the sake of cooperation. China has established the Lacang-Mekong Cooperation as a platform to promote the water diplomacy.

[15] Stimson Center, Mekong Dam Monitor at one year: What have we learned. Available online: https://www.stimson.org/2022/mdm-one-year-findings/. Accessed on 02 August 2022.

3. The role of the water sector in National Economic Development

3.1. Water Policy and Legal Frameworks

Water resources are state properties, and state is responsible for its management through ministries and authorities across the country. Everyone has the right to use water resources for drinking, washing, bathing and other domestic purposes, including watering of domestic animals and buffaloes, fishing and the irrigation of gardens. However, other types of utilization exceeding the household needs are subject to licensing and following the legal frameworks.

The Constitution issued in 1993 vests water ownership in the State (Art. 58) and assigns to the state the task of planning the management of water resources (Art. 59). By stating that "The control, use and management of State properties shall be determined by law", the Constitution lays down the foundations of the water law. RGC has issued a water policy in 2004, recognizing the important roles of water in the development of Cambodia for agriculture, industry, energy development, navigation, tourism, and domestic uses. The kingdom has been challenged by the abundant water resources in the wet seasons. RGC has laid out the directions, institutional and legal frameworks and strategies to improve water management and utilization (Water Policy, 2004).

The Cambodian Law was passed in 2007 and it provides a legal framework to govern water resources, uses, and management. It determines the rights and obligations of water users, sets the main principles for water management, and outlines the participation of the community of farmers using water in the development of water resources. According to the Law on Water Resource Management, licensing or authorization is required for the use, consumption, or diversion of water for industrial or agricultural purposes beyond basic needs such as drinking, laundering, bathing, raising animals, and watering gardens and crops. The waterworks constructions related to the aforementioned activities also require licensing or authorization from the Ministry of Water Resources and Meteorology (MOWRAM). Before the 1999s, water resources were managed by the Department of Hydrology and Irrigation. Given the important roles of water beyond agriculture, the RGC has established the Ministry of Water Resources and Meteorology (MOWRAM) in 1999. It is responsible for developing and managing water resources in Cambodia. Also, it is in charge of flood and drought control and takes action with concerned Ministries and local authorities. Integrated water resource management (IWRM) is the main tool for implementing the law. MOWRAM keeps an inventory that indicates the location, quantity, and quality of the resources. Data collected is submitted to the Ministry and must be freely available to the public.

In addition, MOWRAM has issued a Sub-decree in July 2015 for effective and sustainable management, protection, and development of surface water and groundwater in 39 river basins in 5 sub-regions of Cambodia, including the upper Mekong, the Mekong Delta, the 3S, Tonle Sap, and the Coastal regions. It states the roles and responsibilities of MOWRAM, relevant ministries, and sub-national agencies in managing surface and ground waters in the river basins mentioned above. It also underlines the setup of institutional frameworks for river basin management, protection and development; the mandates; roles and responsibilities: (1) National Committee on River Basin Management (NCRBM) comprising of 17 representatives from line ministries; and (2) Provincial Committee on River Basin Management (PCRBM) in each province, comprising 15 representatives from each concerned provincial departments plus all district governors. The NCRBM meets once a year while PCRBM meets twice a year to discuss and plan the river basin management, protection and development.

Figure 3. National Committee of River Basin Management.

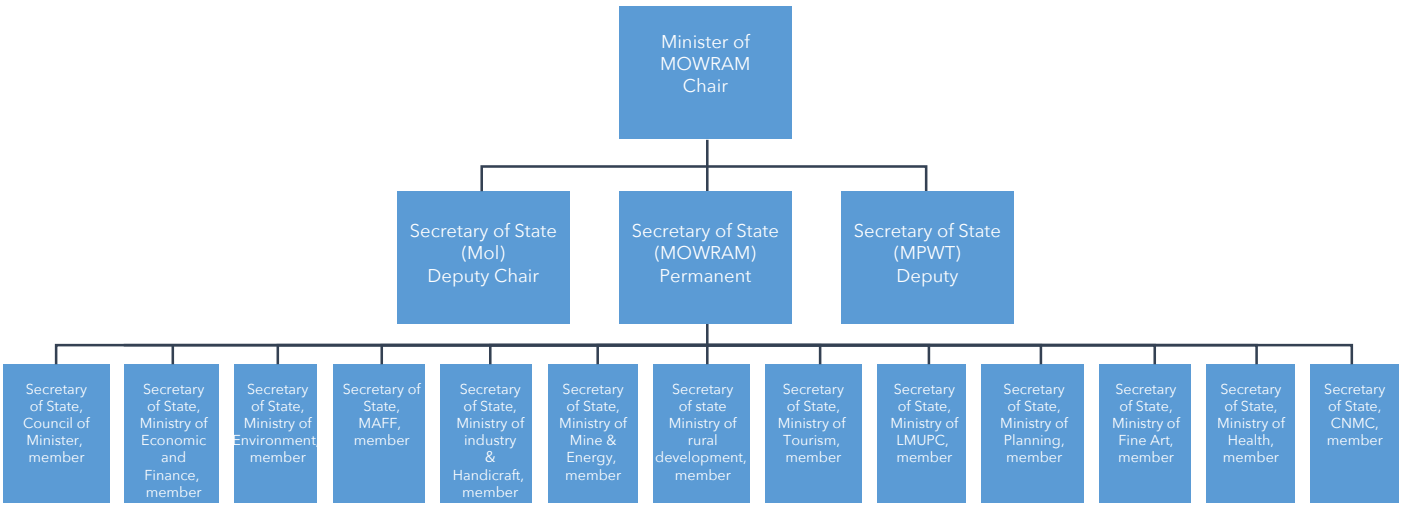
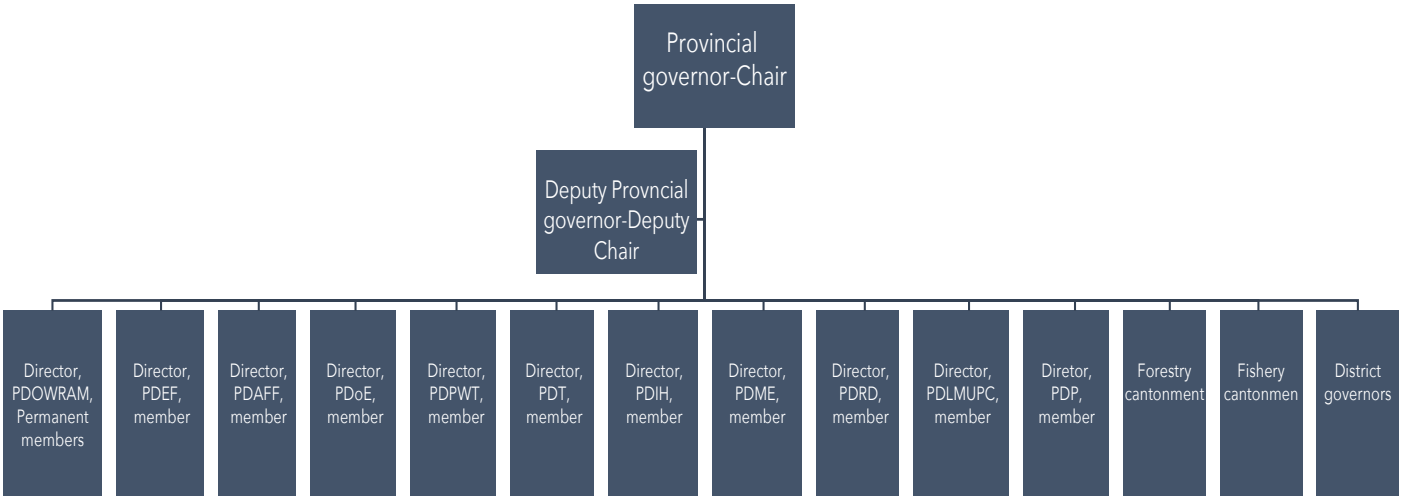


Figure 4. Provincial Committee on River Basin Management.



Prime Minister's Circular No. 01 SR of 11 January 1999, on the Implementation Policy for Sustainable Irrigation Systems, contains model statutes of Farmers Water User Communities (FWUCs) and provisions on the assessment and collection of irrigation fees. In March 2015, MOWRAM issued a Sub-decree on the management and utilization of irrigation systems and water for agriculture in the Kingdom of Cambodia and sets out the legal procedures for establishing and abolishing the Farmer Water User Community (FWUC) for the management and utilization of water resources from the irrigation schemes for farming. It also outlines the characteristics of FWUC membership, the mandates, roles, responsibilities, and benefits from FWUC. MOWRAM is the sole agency responsible for the establishment or abashing the FWUC. FWUC is established to promote community participation in community based water management. Its roles are to manage the irrigation scheme, maintain it and use the water from the irrigation scheme to irrigate rice farming and agriculture under the technical and legal supports from MOWRAM and PDOWRAM. Members of FWUC who use the water from the irrigation should contribute the water fees to finance the maintenance and operations of the irrigations (FWUC Sub-decree, 2015).

However, water management has been the responsibility of the Government long before the laws and Sub-decrees were passed. The policies enacted in recent decades show that water management is usually a part of wider policies regarding economic development, natural disaster, improved sanitation, and more recently, climate change. Several ministries have come up with their own plans for water use, setting various objectives for water development. Inter-ministerial coordination is mandatory since there are overlaps between each plan, all aiming to provide water and food security. Interconnection between land, water, and agriculture makes it harder for coordination between related ministries. Some plans enhancing agriculture intensification might well affect other issues directly or indirectly.

Several ministries and authorities hold responsibility for water management, with MOWRAM taking the lead role. The other relevant ministries are:

- The Ministry of Environment (MoE) is responsible for protecting environment and natural resources. Water resource is considered as part of natural resources, and thus, management of water resources is part of the management of natural resources. The Law on Environment Protection and Natural Resources Management (1996) states the roles and responsibilities of MoE in protecting natural resources, including water. Article 8 states that water "shall be preserved, developed and managed to use in a rational and sustainable manner". This is an area where there is an overlapping mandate between MoE and MoWRAM, but MoE is more concerned with the protection and conservation of water sources, while MOWRAM is more concerned with the management and utilization of water resources. With this overlapping mandate, in Article 10 of the Law, the MoE calls for consultation between the line agencies and the MoE on decisions and activities of relevance to natural resources, including water resources. Measures for the prevention, reduction and control of water pollution are left to be determined by the sub-decree (Article 13). Finally, the Law envisages a duty of the MoE to cooperate with the other ministries in requiring industries and those engaging in polluting activities to install and use monitoring equipment, take samples, and keep records ready for inspection (Art. 14).
- A sub-decree on water pollution control was adopted by MoE on 16 April 1999. This sub-decree assigns water quality control responsibilities to the MoE. Article 27 states that all data on water quality and water pollution are to be administered by the MoE. Article 10 subjects the discharge and transport of wastewater to a license to be granted by the MoE. The application for this license is to be copied to the line agencies concerned (Article 10). In addition,

the sub-decree lists dangerous substances (Annex 1), sets general effluent standards (Annex 2), lists the potentially polluting activities subject to licensing (Annex 3), sets ambient quality standards for rivers, lakes, reservoirs and the sea (Annex 4), and for public water supply sources (Annex 5). It is to be noted that the MOWRAM is now vested with overall water resources management responsibilities, although the Ministry of Environment existed prior to its establishment in June 1999.

- The Ministry of Agriculture, Forests, and Fisheries (MAFF) is responsible for implementing the policies to promote agriculture development, rice farming, planting crops and vegetable, animal raising and management of fisheries. Water plays essential roles in agricultural developments, and MAFF is responsible for promoting agriculture development that water is at the center. The irrigation system plays important roles in providing water to irrigate agricultural land, but irrigation development and control is under the roles and responsibility MOWRAM while the utilization of water for agriculture is under MAFF. The coordination between MAFF and MOWRAM in relation to water for agriculture is not strong, and the development of an irrigation system to some extents does not reflect the needs of agricultural development. Thus, the agriculture sector often suffers water shortage for agriculture, while irrigation development reflects the policy of MOWRAM to control floods and drought. The setting up of FWUCs is mandatory under the MOWARAM in the irrigation schemes to control water in and out of the schemes, while MAFF has no roles and responsibilities with FWUCs, but improving farming productivities for FWUC members is the mandate of MAFF.

- In fishery sub-sector, the Fishery Law of 2006 regulates fishing and aquaculture in inland waters. However, the Water Law and Fishery Law are two independent legal framework, which one is important than the other. Under the Water Law, the development of irrigation system does not pay attention of the impacts on fishery and aquatic resources, which Fishery Law takes for grants that fish cannot live without water, and thus, fish and water cannot be separated, which is naturally under the mandate of Fishery Law. The Law is currently being reviewed and revised with a view to stimulating investment in the fisheries sector and providing a better protection of fish resources.

- The Ministry of Rural Development aspires to assure high quality of life in rural Cambodia; enabling all citizens to live in a healthy rural environment with nurturing social, economic and cultural conditions. Water resources are one resources supporting rural livelihoods, agriculture, water, foods and so on. Increasing access to improved rural water supply and healthcare is one of four policy pillars of MRD's Rural Development Policy 2019-2023. Objectives of the policy and subsequent strategies do aim at integrated rural development, provision of infrastructure (including rural roads), improve quality of rural public services (including water supply, sanitation, healthcare), and local capacity building, as well as concrete actions towards gender equality. Thus, the MRD is specifically responsible for rural water supply, sanitation, and land drainage in rural areas. The Department of Rural Water Supply is responsible for providing rural water supply to rural households through digging the water wells, ponds and small canals. At the provincial level, there are Provincial Department of Rural Development. MRD has set out the policies and strategic plans to promote rural water supply and sanitation. The RGC has adopted the National Strategic Plan for Rural Water Supply, Sanitation and Hygiene (RWSSH) 2014-2025 to achieve its vision of universal access to water supply and sanitation.[16] The RWSSH sets out the target by which 100% of the rural population could access rural water supply by 2025. To achieve the MRD's policy and plans, MRD has its mandates to use water sources, surfaces, and ground waters, to supply water to rural populations, regardless of the Water Law, without reference to MOWRAM.

- The Ministry of Industry, Mines, and Energy (MIME) has mandates related to water into two main areas. First, MIME is responsible for instituting, controlling, and supervising the clean water production and utilization in municipalities and urban areas throughout the country; exploring technical means to exploit the national clean water distribution networks, preparing policies, laws and regulations related to the control and usage of clean water; developing policies and regulations to set the usage rate of clean water in accordance with actual geographical areas; issuing authorizations to conduct clean water business; facilitating and liaising with concerned institutions to provide clean water; engaging international cooperation to develop clean water in collaboration with concerned institutions. Second, MIME has mandated to promote the development of hydropower to generate electricity for industrial development. A volume of water is taken from rivers and ground waters, and thus, MIME needs to coordinate with other concerned ministries, particularly MOWRAM (RGC, 1999)[17].

- The Ministry of Public Works and Transport (MPWT) is responsible for improving, maintaining, and managing public infrastructures in water ways for navigation in rivers and ocean. The Waterway Department in MPWT is responsible for studying and conducting works relevant to traffic along national waterways; preparing maps and plans of rivers and canals; managing any transport along rivers, creeks, small rivers, and lakes; issuing driving licenses, boat and driver identifications, and business licenses; administering local ports; and inspecting the statutes of domestic ships. These roles and responsibilities of MPWT promote the navigations along the rivers and ocean waterways in the Kingdom. However, dredging and digging the river and marine waterways for navigations, to

[16] Data derived from CDHS 2014

[17] RGC, 1999. Sub-decree on the organization and functioning of the ministry of industry, mines and energy. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://portal.mrcmekong.org/assets/v1/documents/Cambodian-Law/Sub-decree-on-Organization-and-Functions-of-MIME-(1999).pdf.

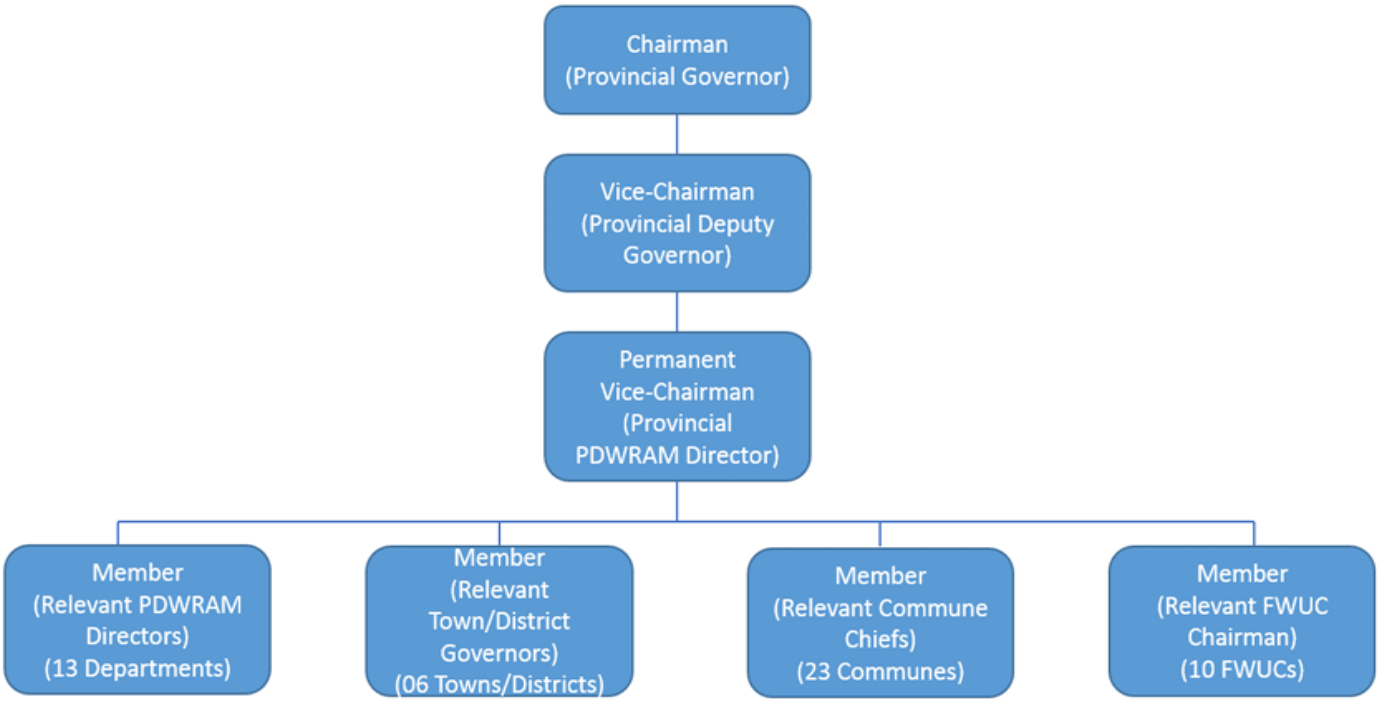
some extents, are unclear and overlap the roles of other ministries such as MOWRAM, MAFF, and other ministries. The dredging of river channels for navigation could affect water bodies, water supplies, water uses, and fisheries, and thus, coordination and facilitation are needed to ensure that each of these ministries fulfill their roles and responsibilities under their legal frameworks[18].

Water is also administrated on a local level:

- At the provincial level, there is a provincial committee of River Basin Management. Figure 5 presents the structure of the Provincial Committee of the Pursat River Basin Management. The Committee is chaired by the Provincial Governor of Pursat and are membered by 13 Provincial Departments in Pursat Province, 06 District Governors, 23 Commune Chiefs, and 10 FWUC Chairmen. Representatives of FWUCs are included in the Provincial Committee of River Basin Management, as they use water from the Pursat River for irrigating their rice farming. This Provincial Committee was established as a pilot following the release of the Sub-Decree on River Basin Management in 2015. It aims at promoting the planning and the management of the Sub-River Basin
- There is also a Provincial Disaster Management Committee (PDMC), chaired by the provincial governor. The PDMC coordinates emergency responses to help local communities, including pumping flood water or distribution of seeds. District, with a hub for disaster information collected from village and commune authorities. This serves as a means of relaying information between province and commune. The Commune Authority prepares annual development and investment plans. Its primary tasks are supporting national policies, representing the state and addressing basic local needs. Village Administration coordinates local interventions and is in charge of emergency plans. Their role is crucial in disaster response. They also provide emergency personnel to help evacuate villagers, organize rescue operations during floods and facilitate emergency relief distribution.

In total, no less than 9 ministries are directly or indirectly involved with water management in Cambodia plus the provincial and local governments. This is complemented by government bodies such as inter-ministerial committees and agencies, the National Council on Sustainable Development, the National Committee on River Basin Management, comprising 17 ministries, the Cambodian National Mekong Committee, comprising 9 Ministries, and the Provincial Committee on River Basin Management, having all provincial governors as members. The coordination between line ministries on water management remains challenging at present, and thus, its governance are still weak. Competition; overlapping mandates, roles and responsibilities of different ministries over the management of water bodies; and the weak coordination contribute weak planning, investments and implementation in water management.

Figure 5. Provincial Committee of Stung Pursat River Basin Management (MOWRAM & JICA, 2019)[19]



[18] MPWT, 1998. ANUKRET (Sub-decree) on the Organization and Functioning of the Ministry of Public Works and Transport. Available online: file:///C:/Users/Sithirith%20Mak/Downloads/3559b32d-ca6a-4a18-b361-d40fc1fb782a%20(2).pdf. Accessed on 25 July 2022.
[19] MOWRAM & JICA. 2019. Guideline For Establishing and Operating River Basin Management Committee (RBMC). The Project for River Basin Water Resources Utilization (RBWRU).

3.2. Economic and Development Strategies in relation to Water

3.2.1. Rectangular Strategy

The RGC has developed the Rectangular Strategy (RS) as a main policy document to promote economic growth, sustainable development, human resource development and private sector engagement. Each RS has five years period. Three phases of RS have been completed and the RS Phase IV started in 2019 and ended in 2023. For RS Phase IV, the RGC aspires to reach the status of an upper-middle income country by 2030 and a high-income country by 2050. To meet this aspiration, the "Rectangular Strategy (RS)" Phase IV (2018-2023) was launched in 2019 as an effective policy instrument to support this Vision. The RS offers successive iterations grounded in four priority outcomes - Growth, Employment, Equity and Efficiency. The established approach is articulated within 4 policy rectangles covering inclusive and sustainable development, economic diversification, private sector development and employment, and human resource development, which each containing 4 further policy components. These are centered around a core good governance rectangle and are in turn informed by an analysis of the external environment (see Figure 6).

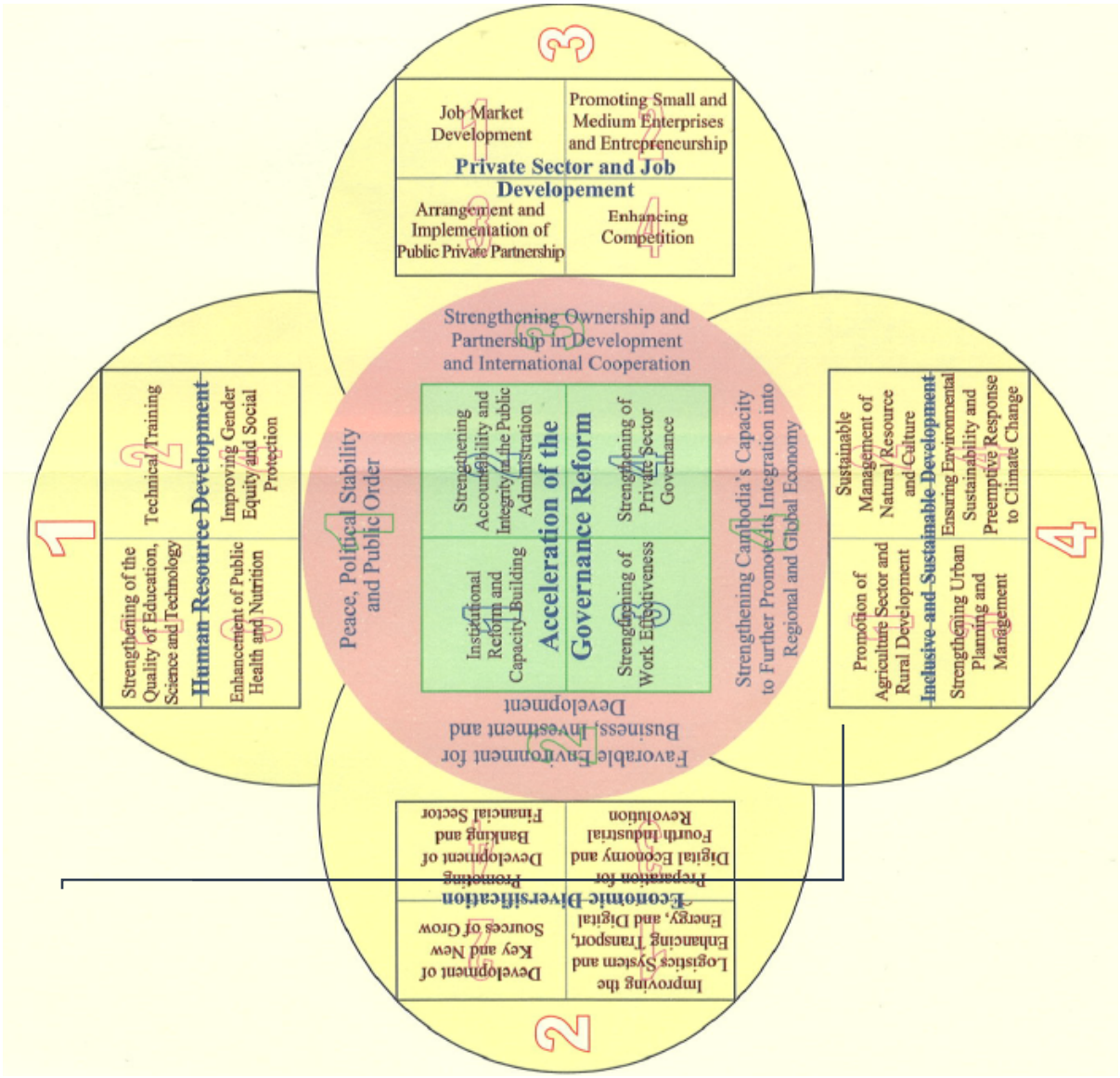
To this end, the Royal Government has set out "Four Strategic Objectives" and "Four Priority Areas" to reaffirm its commitment to continue implementing the "Rectangular Strategy". The Four Strategic Objectives include: (1) Ensuring an average annual economic growth; (2) Creating more jobs for people especially the youth through further improvement in Cambodia's competitiveness to attract and encourage both domestic and foreign investments; (3) Achieving more than 1% reduction in poverty incidence annually, including the realization of Cambodian Sustainable Development Goals (CSDGs), while placing higher priority on the development of human resources and sustainable management and use of environmental and natural resources; and (4) Further strengthening institutional capacity and governance, at both national and sub-national levels, and ensuring the effectiveness and efficiency of public services to better serve people.

The four priority areas of RGC focuses on the road, water, electricity and people. For this 6th Legislature, the Rectangular Strategy – Phase 4 will continue to focus on the same "4 Priority Areas", but gives the top priority to People. In this sense, the 4 "Strategic Rectangles" of the Rectangular Strategy will be revised to reflect the "4 Priority Areas" and other tasks that respond to Cambodia's new phase of development as follows:

- **Rectangle 1 -** Human resource development: 1). Improving the quality of education, science and technology; 2). Vocational training; 3). Improving public healthcare and nutrition; and 4). Strengthening gender equality and social protection.
- **Rectangle 2 -** Economic Diversifications: 1). Improving logistics system and enhancing transport, energy and digital connectivity; 2). Developing key and new sources of economic growth; 3). Readiness for digital economy and industrial revolution; and 4). Promoting financial and banking sector development.
- **Rectangle 3 –** Promotion of private sector development and employment: 1). Job market development; 2). Promotion of SME and entrepreneurship; 3). Public-private partnership; and 4). Enhanced competitiveness.
- **Rectangle 4 –** Inclusive and sustainable development: 1). Promotion of agricultural and rural development; 2). Strengthening sustainable management of natural and cultural resources; 3). Strengthening management of urbanization; and 4). Ensuring environment sustainability and readiness for climate change.

The Priority Area no. 4 (Strategic Rectangle no.4) promotes agricultural and rural development; natural resources management; and climate change resilience, where water plays a central role in realizing this strategic rectangle. The RGC has recognized the importance of agriculture in economic development but has acknowledged that Cambodia's agricultural farming systems are subsistent/family-based for household consumption and they have been adversely affected by natural disasters resulting from climate change. This is due to the fact that these small-scale farming are relying on rainwater and inefficient irrigation system, which leads to fluctuation of annual agricultural production. Rice is the main agricultural crop. The RGC has developed Five-Year Strategic Plan 2019-2023 for Agriculture Sector to accelerate economic growth and alleviate poverty. The strategic goal of the Royal Government is to strengthen the role of agriculture sector in generating jobs, ensuring food security, reducing poverty, and developing rural areas. In fact, agriculture sector account for around 41.5% of total employment. Cambodia produces more food than domestic demand and has also produced and exported many kinds of agricultural products, particularly Cambodia exported more than 600 thousand tons of rice in 2017 and Cambodian rice has also gained great reputation on international arena. Moreover, rural areas have achieved remarkable progress through the construction of road infrastructures, irrigation system, electricity connection, access to clean water and sanitation (Rectangular Strategies, 2018).

Figure 6. Diagram of the Rectangular Strategies, Phase IV.



In 2018, the rice cultivated areas were 3.34 million ha, of which 2.74 million hectares were for the rainy season paddy and 0.59 million hectares were for the dry season paddy. The rice production in 2018 was 10.89 million tons. The RGC has a policy to promote the production of all crops with around 5% growth per year and to increase the export of agricultural products by 7% per year through agricultural modernization, increased productivity, diversification of crops with high potential and strong competition in markets (Rectangular Strategy, 2019).

In addition, the RGC has promulgated the Industry Development Policy (IDP) 2015-2025, of which one of the main goals relevant to agriculture is to promote exports of agriculture processed products to 12% of the total exports in 2025. In the Rectangular Strategy Phase IV (2019-2023), RGC continues to focus on:

1. Promoting the development and implementation of "Mater Plan for Agriculture Sector Development towards 2030" and "Agriculture Sector Strategic Development Plan 2019-2023"
2. Further promoting the preparation, enactment and enforcement of "Law on Plants Protection and Sanitary and Phytosanitary" and "Law on Contract Farming"
3. Improving productivity, quality, and diversification through increasing the investment in Research and Development of highly value-added crops, livestock, and aquaculture; promoting Model Farm development; promoting agricultural extension service; strengthening farmer cooperative management; preparing contract farming production mechanism; continuing to reduce the cost and improve quality of agricultural inputs; conducting studies on the establishment of agricultural insurance services; financial products for serving the agricultural production; and promoting the use of digital and smart technology.
4. Upgrading the processing industry through the promotion of private investment in agricultural products with high potential such as rice, cassava, mango, cashew nuts, banana, rubber, vegetables, etc through the preparation of strategy for each type of crops.

5. Further promoting all kinds of vegetable farming to substitute imports and the establishment of vegetable wholesale market with high sanitation and standard.

6. Promoting agricultural commercialization through further strengthening of the Sanitary and Phytosanitary, trade facilitation, additional investment in quality Laboratory for exportation as well as promoting production and consumption of domestic agricultural products.

7. Fostering livestock and aquaculture through continued implementation of "Law on Animal Health and Production", "Strategic Plan Framework for Livestock Development: 2016 –2025", and "National Aquaculture Development Strategy 2016-2030".

8. Strengthening the management of economic land concessions, continuing to promote the clearance of landmines and unexploded ordnance, and continuing to provide the social concession lands, especially to poor households for family-based farming.

9. Rationalising investment in irrigation systems by increasing attention to enhancing linkage with agricultural production together with regular maintenance and strengthened management of systems.

10. Continuing to promote the rural development to be more vibrant by further investing in rural roads, small-scale irrigation system, expanding the coverage of electricity supply and access to clean water, upgrading sanitation, village and housing arrangement, as well as promoting the livelihood of people through the continued implementation of "One Village-One Product Movement" and "New village Movement".

11. Further strengthening the management of solid waste, waste water, gas and lethal substance by implementing principles of reduction, reuse, recycling and non-use as well as strengthening pollution monitoring and control mechanism and control.

12. Increasing the usage of environmental-friendly and climate-friendly technologies in physical infrastructure and socio-economic development.

13. Further promoting the development and implementation of integrated water resource management plan in order to expand water supply in response to demand, minimize the risks caused by flood and drought, as well as to ensure long-term water security.

14. Continuing to encourage and increase investment in clean energy and renewable energy, especially solar power while reducing the production of energy from unclean sources to ensure long-term energy security.

15. Continuing to strengthen regulatory framework, research, as well as development of skill and capacity for national and sub-national official in terms of environment, green development, climate change, integrated water resource management, and the usage of natural resources in a sustainable manner.

3.2.2. National Strategic Development Plan (NSDP) 2019-2023

Based on each phase of RS, the RGC has developed the National Strategic Development Plan (NSDP). The NSDP is developed every five years. Three NSDPs have been completely implemented by RGC. Following the RS Phase IV, RGC has developed the NSDP 2019-2023, focusing on overcoming binding constraints, bringing about the conditions for the expansion and deepening of the economy, ensuring progressive improvement in socioeconomic conditions, mobilizing resources and monitoring progress. The NSDP in turn, is informed by two further strategic processes. First, by the Rectangular Strategy (RS), which articulates the socioeconomic dimensions of the Government's political platform for the current parliamentary term. Second, by Cambodia's long-term visioning – the Vision 2030, which sets a path to graduation from the group of low-middle income countries and to upper middle-income status, and Vision 2050, which targets attainment of high income status.

The NSDP 2019-2023 has been formulated for the implementation of the Rectangular Strategy Phase IV with the identification of the priorities, indicators and timeframe for the implementation and with the identification of mechanism for the monitoring and evaluation of the Result Framework. It has been informed by the seven themes. These are: (1) promoting poverty reduction and inclusive growth; (2) expanding agriculture; (3) securing greater competitiveness; (4) managing migration and urbanization; (5) combating climate change and deforestation; (6) better governance; and (7) improving the human resource base. In relation to water, the NSDP 2019-2023 has made a plan to use water in the various sector to promote economic development including water for agriculture, drinking water, water sanitation, navigation, hydropower, industrial uses of water, and climate change reliance.

Agriculture Development 2019-2023

Agriculture development is one of seven thematic areas in NSDP (2019-2023) that RGC has planned to improve it in order to address poverty, improving foods and incomes, creating employments and promoting the economic growth. In addressing these, Ministry of Agriculture, Forestry and Fisheries (MAFF) has recently introduced the Agricultural Extension Policy to ensure that farmers and their communities are able to acquire a better agricultural knowledge/skill and technology. MAFF has the policy to expand the rice cultivated area to 3.30 million ha in 2023 and increases the rice production to 10.80 million in 2023. The rice yield per ha shall be increased to 3.34 tons/ha in 2023. In addition, after the RGC introduced the Policy Paper on the Promotion of Paddy Production and Rice Export, milled rice export volume gradually increased to approximately 67% for 5 years from 2014 to 2018. The expansion and strengthening of the support services including research and dissemination of modern technology in all sub-sectors based on the potential geographical areas, the distribution of seed, fertilizers, agricultural materials, and the provision of rural credit, have

been taken into serious consideration and set as a priority by the government in order to elevate agricultural productivity in the response to the market demand focusing on quantity, quality, safety, and international standard (NSDP, 2019).

MAFF aims to promote the production of all crops with around 5% growth per year and to increase the export of agricultural products by 7% per year through agricultural modernization, increased productivity, diversification of crops with high potential and strong competition in markets through:

- Enhancement of high market potential crop production and productivity.
- Promoting plant protection, quality and agricultural product safety.
- Promoting agricultural extension services and agricultural cooperative development.
- Researching the sustainable development of natural rubber.
- Promoting agro-industry development.
- Researching the sustainable agricultural development.
- Building and implementing projects related to cross-sectoral policies.

To improve fisheries resource management to be more effective and sustainable through strengthening the enforcement of the Law on Fisheries, maintaining a natural fish catch of around 600,000 tons per year, increasing from 898,700 tons in 2019 to 1,219,400 tons in 2023, and increasing aquaculture yields by 20% per year from 97,800 tons in 2019 to 171,170 tons in 2023 (NSDP, 2019). To achieve this, the RGC will continue to implement its priority activities as follows:

- Continuing to strengthen sustainable fisheries resource management and conservation in line with the Strategic Planning Framework for Fisheries 2015-2024 and the statements on national policy for fisheries, particularly through fighting all forms of crimes related to fisheries.
- Increasing aquaculture to increase the supply to fish farms, including techniques, fish varieties, credit, markets and the implementation and enforcement of laws through the continued use of existing mechanisms which is the priority in fisheries protection.

Water Management

Water management has been key to the development of agriculture. Ministry of Water Resource and Meteorology (MOWRAM) plays important roles and responsibilities in monitoring and managing all activities related to water and meteorology development and alleviating natural disasters. MOWARAM focuses on five strategies: (1) Administration management improvement and human resources development; (2) Water resources management and development including irrigation hegemony implementation; (3) Water resources and meteorology information management; (4) Flood and drought management and meteorology information management; and (5) Water sustainability and conservation.

MOWRAM will strengthen administrative processes and the capacity of officials, at the central and sub-national levels for both males and females, with FWUC being aware of the advantages of water on daily livelihood and economic development in order to advise them to actively participate in management planning, maintenance, conservation, and effective and sustainable water usage to maintain good eco-system. As part of water resources management and development include irrigation hegemony implementation, the MOWRAM will carry out 14 key activities, focusing mainly on:

- Rehabilitating and constructing the existing irrigation schemes to meet the urgent needs of water for agriculture.
- Prioritizing the rehabilitation and construction of irrigation schemes and drainage systems in areas with high poverty.
- Encouraging the maintenance and expansion of reservoirs, lakes, ponds, intake canals and drainage systems to ensure an adequate water supply for the cultivation zone, aquaculture, daily living and animals.
- Promoting the dissemination of water management innovation technology in rain-fed agricultural areas which depend on rainwater.
- Building and rehabilitating irrigation systems to ensure adequate water supply to farmers.
- Establishing, strengthening, and providing technical support to the Farmer Water Users Community (FWUC).
- Studying and preparing river basin development plan on a short, medium and long term basis, with a consideration placed on the changing of water discharge, water current, and aquifers to ensure the sustainable use of water.
- Implementing integrated water resources management and development, while thoroughly considering a clear link between water sources and other sectors of the environment, including the changing needs of humans and the environment for water and other resources needed to achieve the effective management.
- Increasing the awareness and encouraging the implementation of river basin development and management plans with the cooperation of concerned ministries, stakeholders and beneficiaries, especially women.
- Encouraging the farmers' participation, especially from women, stakeholders, and the private sector to in all stages of project preparation and project improvement as well as irrigation and drainage system development.
- Improving Farmer Water Users Community's (FWUC) capacity on the operation and maintenance of irrigation schemes with farmers' and development partners' participation.
- Strengthening and establishing FWUC to participate effectively in sustainable water resources management, water distribution, and irrigation maintenance.
- Encouraging investments from international donors and the private sector to support the management of irrigation schemes with farmers' and development partners' participation.
- Generating income through irrigated agriculture and continual investments in the water sector for agricultural productivity.

- In relation to FWUC, MOWRAM will encourage the farmers' participation, especially from women, stakeholders, and the private sector in project preparation and improvement as well as irrigation and drainage system development. In doing so, MOWRAM will improving Farmer Water Users Community's (FWUC) capacity on the operation and maintenance of irrigation schemes with farmers' and development partners' participation. MOWRAM will continue to strengthen and establish FWUC to participate effectively in sustainable water resources management, water distribution, and irrigation maintenance.

Flood and drought management

Cambodia has faced frequent floods and drought in recent years. MOWRAM will carry out key activities to improve flood and drought management. First, MOWRAM has promoted and encouraged the study and construction of flood controls and water drainage with the aim of minimizing natural disasters caused by water. Second, MOWRAM will also take actions to mitigate flood in all areas which provide high economic potential by providing education to communities and public information through media. Third, MOWRAM continues to encourage people and all institutions to participate in flood mitigation actions such as preparing safety hills, supplying materials and machinery, educating, and participating in national and international events on flood risk reduction. Last, MOWARAM will set up pumping stations and repairing pumping stations and water pumps to intervene to rescue dry season rice and rainy season rice for people in all provinces in case of water shortage.

In terms of water resources and meteorology information management, the MOWRAM will carry out seven key activities including: (1) strengthening and expanding meteorological and hydrological system; (2) conducting regular forecast and alert on droughts, floods, and storms; (3) improving and installing meteorological and hydrological stations, rain gauges, and water staff gauges at important locations and rivers for data collection and dissemination; (4) weather forecast information as well as education; (5) preparing inventory for and geographical maps of irrigation systems, (6) flood control systems, polders, river basins, inundated land and (7) water resources management based on sufficient data.

As part of water sustainability and conservation, the MOWRAM will carry out six key activities, including (1) Strengthening and encouraging the enforcement of Water Resources Management Law and other related provisions to monitor and prevent all rehabilitation and construction projects which might have adverse impact on water resources and ecosystems. (2) Maintaining water discharge and minimum water level in river, and lake for sustainable ecological systems and waterway transport. (3) Prohibiting and taking urgent action to prevent the invasion of land filling or excavation or the invasion of water in rivers, lakes, ponds, and canals as well as regular inundated or coastal areas without any permission which in turn impacts water resources, eco-system and environment. (4) Strengthening river basin and natural lake conservation which could store water to help reduce flood and maintain ecosystems. (5) Preparing a sub-decree to define the geographical map of irrigation systems, and the reservoir to avoid possible invasion in irrigation system area. (6) Focusing on efforts to prioritize the preservation of river basins and caves.

Water Supply

Water supply and sanitation in rural and urban sectors have been strategized in the NSDP (2019-2023). In rural areas, the RGC has a policy to improve the access to drinking water from 60% of the total population in 2018 to 90% in 2023. Also, the RGC has a policy to increase access to sanitation from 60% of the total population in rural areas in 2018 to 91% in 2023. To implement clean water supply policy for all urban centers at least 80% of urban population have access to clean water by 2015, 85% by 2018 and 100% by 2025. The MRD will continue its key priority activities as follows:

1. Rural road infrastructure development
    - Rehabilitating and constructing rural roads (total length: 45,000km).
    - Improving rural roads to DBST or concrete to be resilient with climate change.
    - Maintaining the rural road periodically.
    - Preparing road inventory and rural road maps a well as putting up traffic signs.

2. Clean water supply development
    - Continuing to build and repair all types of wells, community ponds, rainwater ponds, community water distribution systems, and small scale irrigation systems.
    - Continuing to supply water purifier containers.
    - Continuing to establish and run water quality laboratories.
    - Continuing to organize rural water supply system inventory.
    - Continuing to raise awareness of water safety plans.
    - Continuing to develop rural water supply and sanitation with funding from national and subnational sources and support from development partners and NGOs.
    - Establishing a national monitoring system for rural water supply and sanitation.
    - Developing programs for supporting water supply operation and management at the village level.

3. Rural sanitation
    - Establishing rural water supply and sanitation programs with support from development partners and NGOs.
    - Establishing a national monitoring system for rural water supply and sanitation.
    - Developing a sanitation financing strategy with a particular focus on poor and vulnerable households.
    - Establishing the role of subnational institutions (commune/Sangkat, district/Khan) in delivering rural sanitation programs according to guidelines and capacity building programs.
    - Strengthening national and subnational capacity in promoting rural sanitation.

For Rectangle Strategy Phase IV (2019-2023), to ensure that 100% of the urban population have access to clean water by 2025 and ensure the four conditions: Quality, Sustainability, and Fair Prices. By 2023, the number of population having access to piped clean water supply will be 5.88 million people or 90% of the urban population (NSDP, 2019: 156). The RGC has the following priority activities:

- Developing sector development strategies, including long-term financing and investment plans.
- Ensuring all public entities formulate their 5-year business plans well by 2023.
- Restoring existing production facilities and distribution networks using the RGC's organizational resources and financing from development partners.
- Studying each entity's root causes of the problems that result in the public water supply authorities not having enough revenue to cover all costs, and considering improvements in the the efficiency and productivity of the organization.
- Providing full autonomy to public entities by building public water supply capacity in the provinces to promote the autonomy as the economic public enterprise.
- Following the model and experience of Phnom Penh Water Supply Authority (PPWSA), in which all entities will be approved as economic public entities by 2023.
- Striving to push the public water supply authorities to provide quality services, affordable prices, ensured full payment of costs and resources for re-investment.
- Developing an effective water quality monitoring system to ensure that drinking water supply complies with national drinking water quality standards.

3.2.3. Cambodian Sustainable Development Goals (CSDG) 2016-2030

The CSDG framework, following the endorsement of the United Nations in September 2015, is the result of localization of the SDG goals into Cambodia context. It has been developed alongside the Government's socioeconomic platform – set out in the Rectangular Strategy (RS) and the National Strategic Development Plan (NSDP). The RGC has fully adapted the framework to the Cambodian context to address national needs, challenges and aspiration, with the aim of informing the content of the NSDP and shaping its monitoring framework. The CSDG Framework has four specific objectives:

- Presentation of the national goals, targets, and indicators based on Cambodia's priorities;
- Identification of the agencies responsible for oversight and conducting activities to achieve the targets and monitoring schedules;
- Identification of data sources for each indicator, and the data cycle, with a provision of working definitions and methods for calculating indicators;
- Presentation of pathways towards the achievement of targets, setting (2015) national baselines, setting annual (or cycle-based) target values, and the implementation at a sub-national level.

The CSDG possesses 18 Cambodian Sustainable Development Goals, 88 nationally relevant targets, and 148 (global and locally defined) indicators including 96 as national indicators. Goal no. 6 covers availability and sustainable management of water and sanitation for all, with 5 targets, and 6 indicators. Goal no. 13 concerns the "urgent action to combat climate change and its impacts" with 3 targets and 5 indicators. The Goal no. 14 focuses on "conserve and sustainably use the oceans, seas and marine resources for sustainable development the life below water," with 5 targets and six indicators. Other relevant goal include the Goal no. 15, with 7 targets and 9 indicators. Table 10 provides the details of CSDGs related sto water resources management and the responsible institutions.

Water management and development plays essential roles in the development of Cambodia. Water infrastructure development such as irrigation schemes and canals, water reservoirs, sluice gates, water wells and hydropower could improve water management in Cambodia, particularly it will reduce flood waters during the wet season and it will increase water supply during the dry seasons. In the National Strategy for Rural Sanitation and Hygiene (2011-2025), it was found that for target 6.2, although there were plans to monitor both rural and urban sanitation indicators, there were only specific plans for improving access in rural areas. However, rural sanitation strategies are not a good fit to urban areas and new policy, technologies and budgets will need to be shared between different ministries to solve these problems in more complex urban areas[20]. For CSDG target 6, it was found that the Cambodia Industrial Development Policy (2015–2025)[21] only properly deals with water efficiency for the agricultural sector. It does not have a clear plan for managing water efficiency for urban development[22]. For target 6.5, transboundary cooperation for the integrated management of water from the Mekong River has not been dealt with. To achieve the CSDG 6, the two means of implementation targets for SDG 6 include: (1) the government need to get support from the international community to help resolve the financial and technical limits in order to improve water and sanitation, water efficiency, wastewater treatment, and other ways of reducing water scarcity and (2) the government policies make it for local people and authorities to participate in water and sanitation management.

[20] Ministry of Rural Development 2012. "National Strategy for Rural Sanitation and Hygiene (2011 – 2025)". Accessed October 2022.
[21] Royal Government of Cambodia 2015. "Cambodia Industrial Development Policy 2015 – 2025: 'Market Orientation and Enabling Environment for Industrial Development'. Accessed October 2022.
[22] UNDP 2016. "Rapid Integrated Assessment – Cambodia SDG Scorecard Profile". Accessed October 2022.

Table 11. The CSDG's Goals, Targets, and Indicators related to water management.

Goal	Target	Indicators	Responsible Institutions
Goal 6: Ensure availability and sustainable management of water and sanitation for all.	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	equitable access to safe and affordable drinking water for all 6.1.1 Proportion of Cambodian population in urban areas with access to safely managed and clean water supply services	MIH
		6.1.2 Proportion of population using safely managed drinking water services –rural	MRD
	6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water	MRD
	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of wastewater safely treated	MOE
	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 By 2025, all Cambodian people living in urban areas have access to clean water sustainably with quality and affordable price.	MIH
	6.a By 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1 Amount of water and sanitation-related official development assistance that is part of a government-coordinated spending plan	CDC/CRDB
Goal 13: Take urgent action to combat climate change and its impacts	13.1 Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries	13.1.1 Percentage of communes vulnerable to climate change	MOE
	13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	13.3.2 Percentage of households (farming, animal raising, fish raising, and fishing) and local community forestry members participated workshops and received training on climate change	MAFF
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1 Percentage of the reduction of the sea pollution by the conservation activities	MOE
	14.2 By 2020, sustainably manage and protect marine coastal and freshwater ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans and freshwater ecosystems	14.2.1 Key ecosystem function and service of marine and coast area maintained and restore as necessary	MOE
		14.2.2 Percentage of degraded freshwater flooded forests and mangrove forests (ha) that has been replanted and protected	MAFF
	14.5 By 2020, conserve at least 10 per cent of coastal and marine and freshwater areas, consistent with national and international law and based on the best available scientific information	14.5.1 Percentage of marine and inland fisheries conservation areas protected.	MAFF
	14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism	14.7.1 Value of fisheries aquaculture production as a percentage of GDP	MAFF
	14.b Provide access for small-scale artisanal fishers to marine resources and markets	14.b.1 Percentage of marine resources which small-scale fisheries farmers harvested and sold in a stable market.	MAFF
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.2 Percentage of important sites for terrestrial and freshwater biodiversity that are covered by protected areas and fisheries conservation areas-protected by law	MAFF Collaborate with PA

The CSDG 13 is concerned with the climate change. In relation to climate change, Cambodia regularly suffers both serious floods and droughts, with a high proportion of the labour force (58 percent in 2013) employed by the agriculture sector and almost 80 percent of the population dependent on subsistence, rain-fed agriculture in some way. Changes are predicted for rainfall patterns, temperature and sea levels. These changes are likely to bring impacts such as reduced agricultural yields, damage to infrastructure and the inundation of large areas of coastal lowlands in the south of the country. Rapid Integrated Assessment of Cambodia's National Strategic Development Plan (NSDP) 2014–2018 in 2016 determined that the country has already integrated the SDG 13 targets well. However, economic losses from damage to dwellings, agricultural assets and natural resources are currently remained high. Investments and development assistance are also focusing on climate change in Cambodia, but are not enough. More infrastructure developments are needed in order to reduce the impacts of climate change and build the resilience. The Cambodia Climate Change Strategic Plan (CCCSP) 2014–2023 is a comprehensive plan to promote cooperative efforts between different sectors in Cambodia to meet the SDG 13.2 targets. It is supported by a national Climate Change Action Plan to help mobilise resources for taking action on climate change. A National Strategic Plan on Green Growth (2013–2030) has also been developed to support low greenhouse gas emission growth in Cambodia. The CSDG 13 is linked to a global commitment by developed countries as part of the Paris Agreement to provide at least US$100 billion annually for developing countries to assist with their climate change mitigation plan. Cambodia will be heavily dependent on accessing external financial resources, such as the newly-established Green Climate Fund, due to insufficient government budgets. To make this easier, Cambodia has prioritised 40 different climate change actions through a new National Action Plan for Climate Change. These include building the infrastructures to mitigate the impacts on climate change on livelihoods, agriculture and other development.

All CSDG14 targets were found to be addressed through national policy documents. SDG 14 aims at providing access for small-scale fishers to marine resources and markets, is highly relevant in Cambodia, where the majority of small-scale fishers are poor and their operations unprofitable. The activities of coastal fishers are largely unmonitored and minimal data exists to support initiatives to improve their sustainability. Many small-scale fishers lack the capacity to access target catches and rely on bycatch, which produces low levels of income and has a negative impact on marine ecosystems. In addition, Cambodia will need to cooperate regionally to address marine overfishing and with upstream Mekong countries to address inland overfishing. To realize the CSDG 14, It has included the issues above in the following documents: (1) National Strategic Development Plan (NSDP) 2014–2018; (2) National Biodiversity and Strategy and Action Plan 2016, which has a specific theme (theme 10) relating to the monitoring and protection of Cambodia's 435 km of coastline and 500,000 km^2 marine Exclusive Economic Zone (EEZ); and (3) National Strategy Plan on Green Growth (2013–2020), which has a focus on Blue Economy Development and Sustainability. However, Cambodia still has limited funding to implement these plans. They often rely on donors to provide financial supports.

A key element of SDG 15 is the conservation and sustainable use of inland biodiversity. This supports the healthy ecosystems that are crucial to the provision of the products (such as food and water) and services (such as climate regulation and aesthetic experiences) that also called environmental or ecosystem services. These ecosystem services are closely related to biodiversity, providing access to safe water and coping with the impacts of climate change. Biodiversity is central to the lives and well-being of rural and indigenous communities. The CSDG Target 15.1 ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements. There is growing interest in collaboration on protecting areas of high biodiversity conservation value in the Greater Mekong Sub-Region. The importance of regional cooperation was identified as one of six priority commitments for implementing SDG 15. A lack of clarity regarding responsibilities for managing transboundary resources as an impediment to ecosystem conservation. Cambodia is a member of the Mekong River Commission (MRC) to cooperate with Mekong countries to manage the Mekong River and protect Mekong resources. Cambodia is a signatory to the Convention on Biological Diversity (CBD). At the country level, Cambodia has developed to the Strategic Plan for Biodiversity 2011–2020 and its Aichi Biodiversity Targets, which are aimed at implementing the three objectives of the Convention on Biological Diversity (CBD). In fishery, Fishery Administration (FiA) has developed the 10-years strategic plan for fishery conservation (2020-2030). To achieve these, Cambodia would need fund to implement these plans and activities. Investment are needed to support the government of Cambodia to achieve its CSDG.

3.3. Water-Food-Climate Nexus perspective

Climate change, together with water-development interventions, pose great challenges to sustainable use of ecosystems in general and aquatic ecosystems in particular. Climate change has affected the availability, quality and quantity of water for basic human needs. Accompanied by these changes are various types of ecological and environmental problems, such as droughts/floods, eutrophication, biodiversity decreases and wetland degradation among many others. Cambodia is ranked as one of the most climate-vulnerable countries, not only in Southeast Asia (Yusuf, and Francisco, 2009),[23] but the world. The Climate Risk Index ranks countries most affected by climate change in the period 1996–2015 based on extreme weather events. Cambodia ranked 13th out of 181 countries (German Watch, 2016)[24].

[23] Arief A. Yusuf, Herminia A. Francisco. Mapping Analysis. *Climate Change Vulnerability Mapping for Southeast Asia*. EEPSEA: 2009. Accessed 5 May 2015. http://www.eepsea.org/pub/tr/12324196651Mapping_Report.pdf.
[24] German Watch 2016. https://germanwatch.org/sites/germanwatch.org/files/publication/13503.pdf Accessed 20 July 2017.

Cambodia is highly vulnerable to the impacts of climate change. The 5th IPCC report (2014)[25] indicates that globally the depth of annual rainfalls would be increased from 3.6% to 4.8% in 2050, and the number of raining days would be decreased in the interval of 3.7% -7.4%. These will put pressure on water supply in the dry season and increase demand for the management of flooded water in the wet season. In Cambodia, it is expected to be significantly affected by changes in rainfall, which could result in greater variability of the River flow, with an increasing risk of flooding during the wet season, in particular in low-lying areas downstream of Kratie and in the Mekong Delta. Floods accounted for 70% of rice production losses between 1998 and 2002, while droughts accounted for 20% of losses, induced significant food security (RGC, 2006). The floods in 2000 killed 350 people and caused US$ 150 million's worth of damage to crops and infrastructure (NCDM, 2002). The natural disaster in 2011 resulted in economic losses to Cambodia of about 4.3% of its GDP, and killed 247 people and damaged property worth US$ 521 million, with 220,000 ha of rice fields destroyed (MRC, 2011). The worse and sever flood was in 2013 that killed 184 people and affected national economy at the rate of 525 million, of which rice loss accounts for USD 150 million (MOWRAM, 2019).[26]

Not only floods, but also droughts occurred around the Tonle Sap. The most severe droughts to have occurred thus far were in 2002 and 2012, led to crop damages, a lack of food, and disease (*Phnom Penh Post,* 2012). The drought in 2002 affected more than two million people and destroyed more than 100,000 ha of paddy fields. The drought in 2012 devastated 9,990 ha of paddy fields and affected 122,297 ha across the country (Nguyen & Shaw, 2011).

Climate change has affected the hydrological regime of the Mekong flow to Tonole Sap Lake. Between 2019 and 2021, the water flows in the Mekong River had been reduced from 43km^3 to 18.89 km^3 critically lower. The inland fish production in Cambodia has declined from 535,005 tons in 2018 to 413,200 tons in 2020. The annual fish catch from TSL is estimated at about 250,000 tons, collected from six provinces around the lake. However, between 2018 and 2020, the inland fishery production in TSL has declined from 291,260 tons in 2018 to 144635 tons in 2020, which has shown a 50% in reduction. It has affected the food security of fishing communities (EU Report, 2021).

It is predicted that climate change in Cambodia could reduce Cambodia's GDP by 2.5 percent by 2030 and by almost 10 percent by 2050 (Department of Climate Change, 2018).[27] Cambodia lost $1.5 billion – 10 percent of its gross domestic product (GDP) – in 2015 from the negative effect of climate change (Vannak, 2016)[28]. Also, it is predicted by 2050 the climate change would put 61% of Cambodia's rural GDP per capita at risk. It is projected that the 2050 climate projections would affect around 7 million Cambodians employed in the agricultural sector and about 240,000 people in construction, causing a total economic impact of $1.5 billion (Talberth and Reytar, 2014). The fall is largely the result of reduced worker productivity following temperature increases, extreme events impacting on infrastructure and loss of crops (Department of Climate Change, 2018).[29]

Food security, human health, urban and rural settlements, energy production, industrial development, economic growth, and ecosystems are all water-dependent and thus vulnerable to the impacts of climate change. Climate change adaptation and mitigation through water management is therefore critical to sustainable development, and essential to achieving the 2030 Agenda for Sustainable Development (UN Water and UNESCO, 2020). Cambodia has developed a Strategy to Respond to Impacts of Climate Change 2014-2023. Also, the RGC has developed the "National Strategic Plan on Green Growth 2013-2030", "National Environment Strategy and Action Plan 2016-2023", "National REDD+ Strategy"; and use social and environmental funds effectively to ensure economic development with low-carbon emission and resilience to climate change. The RGC's strategic goal is to minimize environmental impacts, enhance the capacity to adapt to climate change, and contribute to reducing global climate change to ensure sustainable development. Key challenges include an increase in natural resource utilization, deterioration in environmental quality, including water, land and air, limited capacity in mainstreaming technology that is resilient to the climate change, the limited cooperation and participation from stakeholders, and the need to ensure water and energy security in the long term. It promotes the increased uses of environmental-friendly and climate-friendly technologies in physical infrastructure and socio-economic development; and further promoting the development and implementation of integrated water resource management plans in order to expand water supply in response to demand, and minimize the risks caused by flood and drought, as well as to ensure long-term water security.

In the Rectangular Strategy Phase IV (2019-2023), the RGC of Cambodia gives priorities to:

1. Continuing to implement the "National Strategic Plan on Green Growth 2013-2030", "Cambodia Climate Change Strategic Plan 2014-2023", "National Environment Strategy and Action Plan 2016-2023", "National REDD+ Strategy"; and use social and environmental funds effectively to ensure economic development with low-carbon emission and resilience to climate change.
2. Further strengthening the management of protected areas, biodiversity conservation, natural resource conservation, especially the ecosystems of Tonle Sap lake, Mekong river and the coastline areas.

[25] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
[26] MOWRAM, 2019. National Investment on Irrigation System and Water Management 2019-2033.
[27] Department of Climate Change 2018. http://www.camclimate.org.kh/en/policies/ncsd-news/445-445.html Accessed 30 June 2018.
[28] Chean Vannak, 2016, "10% of GDP lost to climate change", *Khmer Times*, 4 July 2016
[29] Department of Climate Change 2018. http://www.camclimate.org.kh/en/policies/ncsd-news/445-445.html Accessed 30 June 2018.

3. Reinforcing the management of solid waste, wastewater, gas and lethal substances by implementing principles of reduction, reuse, recycling and non-use as well as strengthening pollution monitoring and control mechanisms.
4. Promoting resource efficiency and sustainability by implementing the principle of sustainable consumption and production.
5. Increasing the usage of environmental-friendly and climate-friendly technologies in physical infrastructure and socio-economic development.
6. Continuing to promote the implementation of carbon trading mechanisms and related regulatory frameworks, strengthen the capabilities to develop and implement climate change adaptation and resiliency measures as well as explore the possibility of studying financial resiliency to respond to disasters caused by climate change.
7. Further promoting the development and implementation of integrated water resource management plans in order to expand water supply in response to demand, and minimize the risks caused by flood and drought, as well as to ensure long-term water security.
8. Continuing to encourage and increase investment in clean energy and renewable energy, especially solar power while reducing the production of energy from unclean sources to ensure long-term energy security.
9. Strengthening regulatory framework, research, as well as the development of skill and capacity for national and sub-national official in terms of environment, green development, climate change, integrated water resource management, and the usage of natural resources in a sustainable manner.

3.4. Water-Energy Nexus perspective

Cambodia has undergone rapid economic development in recent decades. However, the country still faces shortage of energy and high prices of electricity to supply to the increased economic growth and industrial development. Nevertheless, Cambodia's energy production is totally reliant on imports for oils and gases, despite commercial quantities of oil being found offshore. Due to a high dependence on imported fuels and a fragmented power supply system, Cambodia's electricity prices are one of the highest in the ASEAN region, and the world.[30]
The key challenges facing Cambodia's energy sector are:

- Heavy dependence on imported fossil fuels and imported electricity.
- Electricity shortages and power outages are relatively common.
- Options such as hydropower and coal-fired electricity generators can have high environmental impact.

The ADB has projected that Cambodia's peak electricity demand will be more than double to 2,401 megawatts between 2015 and 2025. As the population increases and industry expands, Cambodia's electricity consumption is forecasted to grow annually at 9.4% until 2020[31]. In 2014, the RGC has made a policy for all Cambodian villages to access to electricity by 2020 as a key top priority.[32] To achieve this goal, laws and policies on development of energy sector were adopted, while cooperation and participation from stakeholders including ministries and other governmental agencies, development partners and private investors have also played an important role. In meeting this increased demand, Cambodia can access more affordable power through imports from neighbouring countries, as opposed to undertaking their own power production.[33]

In early 2018, about 97.6% of Cambodian households have access to at least one source of electricity – 71.5% from the grid and 26.1% off the grid, from sources such as solar home systems and rechargeable batteries.[34] By December 2018, the Electricity Authority of Cambodia (EAC) reported that it was supplying electricity to 12,305 villages (87 percent of all the villages in Cambodia) with distribution networks due to be constructed soon for a further 1,767 villages (12.5 percent).[35]

More generally, the Ministry of Mines and Energy (MME) projects that the country's primary energy demand from all fuels will increase 5.4% annually from 2010 to 2035. By 2018, coal-fired power sources accounted for 35%, hydropower 49% and power imports about 15% and 33 sub-terminals covering 20 capital and provinces. As of March 2019 there were two coal-fired power plants in Sihanoukville Province, one from Cambodia International Investment Development Group (CIIDG), the other from Malaysian firm Leader Universal Holdings, with a third plant due to launch before the end of 2019[36]. The increased use of coal is projected to see CO_2 emissions increase by 6% per year until 2035.[37] By the end of 2018 there were nine hydropower plants operating, with seven feeding into the national grid. The 400 MW Lower Sesan II dam was officially opened in December 2018 in a ceremony overseen by the prime minister.[38]

To have all villages accessed to electricity, the RGC has planned to build more hydropower dams in the Cambodian River System. However, electrical distribution, dam construction and other matters in the energy sector have regional and trans-border implications and there are official bodies and agreements addressing these, such as the Mekong River Commission.

---

[30] Council for Development of Cambodia. "Cost of Doing Business: Utility Cost." Accessed 30 January 2015. http://www.cambodiainvestment.gov.kh/investment-enviroment/cost-of-doing-business/utility-cost.html.
[31] The Ministry of Industry, Mines and Energy. 2013. "National policy, strategy and action plan on energy efficiency in Cambodia." Accessed 13 October 2015. https://data.opendevelopmentcambodia.net/laws_record/national-policy-strategy-and-action-plan-on-energy-efficiency-in-cambodia
[32] *The Cambodia Herald*. "Hun Sen says all villages to have electricity by 2020." 20 February 2013. Accessed 25 November 2014. www.thecambodiaherald.com/cambodia/hun-sen-says-all-villages-to-have-electricity-by-2020-3449
[33] Anthony Jude, Asian Development Bank. "Greater Mekong Subregion (GMS) market coordination." Accessed 5 October 2015. https://www.iea.org/reports/southeast-asia-energy-outlook-2013.
[34] The World Bank, 15 March 2018. *Cambodia beyond connections*. Energy access diagnostic report. Washington DC. http://documents.worldbank.org/curated/en/141011521693254478/Cambodia-Beyond-connections-energy-access-diagnostic-report-based-on-the-multi-tier-framework Accessed 23 March 2018.
[35] Electricity Authority of Cambodia 2018. Salient Features of Power Development in Kingdom of Cambodia. Consolidated Report for the year 2018. https://eac.gov.kh/uploads/salient_feature/english/salient_feature_2018_en.pdf Accessed 21 April 2019.
[36] Cambodia Constructors Association 2019. "150 MW coal-fired power plant in Sihanoukville nearing completion" 19 March 2019. https://www.construction-property.com/read-news-1709/ Accessed 30 March 2019.
[37] Lieng Vuthy. 2013. Cambodia country report in Kimura, S. (ed.) "Analysis on energy saving potential in East Asia, ERIA research project report 2012-19", pp.99-113. ERIA. Accessed 5 October 2015. www.eria.org/RPR_FY2012_No.19_chapter_4.pdf
[38] Construction Property 2018. "Hydro Power Lower Sesan II dam inaugurated" 17 December 2018. https://www.construction-property.com/read-news-1549/ Accessed 28 January 2019.

Table 12. Climate change and its response in 2019-2023.

No.	Indicators	Unit	2017 Baseline	2018	2019	2020	2021	2022	2023
1	No of policies, regulations, principles, MOU, and agreements related to science, technology and innovation	No	5	0	2	2	2	2	1
2	No of municipalities and urban areas approving and implementing the Sustainable City Strategic Plan 2018-230	No	1	8	8	12	12	12	0
3	No of sector development plans with strategic environmental assessment	No	0	0	1	1	1	1	0
4	Proportion of renewable energy in the total energy consumption	%	0.75	0.85	1	1.2	1.4	1.6	1.66
5	Reduced volume of GHS compared with the baselinΩ	Gg CO^2 equivalent	2,443,040	2,497,275	2,798,952	2,835,781	2,887,181	2,917,352	3,018,374
6	Percentage of communes/Sangkats vulnerable to climate change	%	42	40	39	38	37	36	35
7	Institutional level that prepared in response to climate change	%	45	49	53	57	60	63	65
8	Ministries and agencies mainstreaming biodiversity into their sectors	No	2	2	3	4	5	6	7
9	Sites of the protected areas of outside the natural zones	No	0	1	3	5	7	8	8
10	Sites implementing the ecosystem services payment	No	0	1	2	3	4	6	8

4. The need for water infrastructure to solve problems

4.1. Advanced ICT-based hydrologic measurement

For logistics, Cambodia's ranking has been remarkably improved from 129th in 2010 to 98th in 2018 in the World Bank's Logistics Performance Index (LPI). In the digital sector, the Royal Government has promoted the connectivity of backbone fiber optic cables, which have increased to 37,441 km in 2017 along with two undersea optic cable networks in 2017. Furthermore, the use of information and communications technology (ICT) has risen substantially, reflected through rise in mobile number users from 2.7 million in 2012 to 10 million in 2017 (Rectangular Strategy, 2018).

As of the end of 2018, Cambodia has experienced fast development in ICT. The number of mobile users has reached 19,315,892, equal to 118.90 in 100 people, of which 11,559,300 have been connected to mobile internet, equal to 71.15 per 100. Fixed phone numbers are 131,582, equal to 0.81 per 100 people, of which on 171,953 have been connected to fixed internet, equal to 1.06 per 100 people, are relatively low. Fast speed connections or broadband connections are at the lowest level of 150,730 networks, equal to 0.938 networks per 100 people. Slow speed or neroband have only 2,618 networks, equal to 0.016 networks per 100 people across the country, compared with the ASEAN countries and the world. Up to the first semester of 2018, the development and investment of fiber optic infrastructure has a total length of 43,410 kilometers. These backbone structures are connected to Vietnam, Lao PDR and Thailand.

In the water sector, the ICT system has been used to collect hydrlogical data, monitoring of river hydrology, forecasting the weather, floods, and drought. In the river basin management, Cambodia has currently 44 hydrological stations by 2018. MOWRAM is a government agency that is responsible for hydrological management, and so has planned to build 85 hydrological stations between 2019 and 2023, in which it will build 17 hydrological stations a year. These break down into the following:

- Set up 25 hydrological stations along the Mekong, Tonle Sap, and Bassac Rivers.
- Repaired 09 hydrological stations (Mekong-Hycos).
- Set up 42 water level staff gauges and repaired 10 water level staff gates along the river and stream at the checking points.
- Set up 08 automatic equipment along stream in Kampong Speu province. Meteorological Works
- Set up 44meteorological stations and repaired 14 stations in the provinces.
- Installed rain gauge post in 46 stations and repaired 23 stations.
- Equipped automatic equipment in 13 stations.
- Set up 44 meteorological stations and repaired 14 stations in the provinces.
- Installed rain gauge post in 46 stations and repaired 23 stations.
- Equipped automatic equipment in 13 stations.

Thus, to improve water management and to cope with the increased climate change and the frequent floods and drought, Advanced ICT-based hydrologic measurement should be equipped to MoWRAM. MOWRAM shall strengthen and expands meteorological and hydrological system including data collecting and broadcasting, and conducting regular forecast and alert on droughts, floods and storms for short, medium and long period. In doing so, the ICT-based hydrologic measurement systems should be equipped into the hydrological stations.

Cambodia will continue to cooperate with Mekong Member Countries to manage Mekong hydrological regimes. The ICT-based hydrological system development in Cambodia could promote a basin-wide, integrated, and inclusive multi-disciplinary process, and support the sustainable, reasonable, and equitable use of the Mekong water and related resources. It will also strengthen the MRC basin-wide monitoring networks and forecasting systems for floods and droughts, as well as data and information management systems; continuing to improve the dissemination, uptake, and use of the MRC products by relevant line agencies and organizations; as well as identifying opportunities for further cooperation with Dialogue Partners, Development Partners and other concrete cooperation mechanisms such as ASEAN, Mekong-Lancang Cooperation, and Greater Mekong Sub-region

However, there is a lack of common technical framework and ICT mechanism. Also, the quality of the software is limited and duplicated which creates complication and lacks of integration. The resource mobilization and coordination for promoting science and technology remain a challenges. The ICT-based hydrological system can be built through integrating the former National Authority for Information Communication and Technology Development (NiDA) into MoWRAM. MoWRAM should cooperate with relevant ministries, agencies and units in formulating the Policy on Development of ICT 2020. Also, RGC shall builds the capacity of MoWRAM and concerned agencies in ICT-hydrologic system.

4.2. Additional water supply purpose dams and reservoirs

4.2.1. Rural Water Supply Development

Clean water and sanitation is another important milestone in CMDGs-Goal 7. Urban water supply was 88.01% in 2015, exceeding the target (> 80%), while rural water supply reached 50% as in target. In 2018, 62% of the rural population and 85% of the urban population had access to the water supply. Sanitation in the urban area achieved 89% in 2015 exceeding the target (74%), while rural sanitation was 60% of the rural population in 2018 (NSDP, 2018).

The Royal Government of Cambodia has adopted the National Strategic Plan for Rural Water Supply, Sanitation and Hygiene (RWSSH) 2014-2025 to achieve its vision of universal access to water supply and sanitation. The Rural Water Supply, Sanitation and Hygiene (RWSSH) sector envisions that "Everyone in rural communities has sustained access to safe water supply and sanitation services, and lives in a hygienic environment by 2025".

To achieve these targets, the RGC has developed the RWSSH National Strategic Plan (NSP) 2014–2025 as its key guiding document, while the RWSSH National Action Plan (NAP) 2014–2018 put the sector on a path to achieve the vision for 2025. The first NAP period has seen remarkable achievements. Rural sanitation coverage increased by 30.3 per cent from the baseline of 40.9 per cent1. By 2017, it was 71.2, enabling an additional estimated 4 million people, or 909,090 households, to gain access to improved sanitation. Rural water supply increased at the more modest rate of 12.1 per cent, from 46.6 per cent to 58.7 per cent in 2017, giving approximately 1.59 million people or 361,364 households access to the improved water supply. However, challenges remain; the distribution of services is unequal, as evidenced by significantly lower levels of access to services in remote communes and provinces, poor households, and people who live in challenging environments. The second NAP RWSSH (NAP II), for the period 2019–2023, enables the rural population of Cambodia to have increased access to and use of equitable, sustainable, and safe drinking water, sanitation and hygiene facilities. The focus on equality was strengthened through, among other things, specific actions targeted at poor households and people living in challenging environments. Aiming to reach 90 percent of the rural population with access to equitable, safe, and affordable drinking water, sanitation, and hygiene services, NAP II brought the sector closer to the vision of universal access. It contributed to the achievements of the Cambodia Sustainable Development Goals, particularly Goal 6 "Ensure availability and sustainable management of water and sanitation for all", as well as related goals on education, health, gender equality, and climate change. However, Cambodia is not on track to meet national rural water supply, sanitation, and hygiene (WASH) targets, particularly for rural water supply, and with a continuation of the annual rate of change of 0.9% recorded since 2000, Cambodia will not meet universal access to rural water supply until after mid-century. Financing for the investment of rural water supply remains insufficient, which is ranked to have the second largest annual capital expenditure deficit proportionate to annual requirements of all WASH sub-sectors[39]. An analysis conducted by the World Bank Group in Cambodia estimated that capital expenditure requirements for the rural water supply have an annual gap of USD 24 million to meet its 2025 targets compared to the average annual public domestic funding for rural water supply USD1.83 million[40], indicating significant gaps in state budget resource allocation.

In February 2022, the Ministry of Economy and Finance has instructed to implementation of Performance Information Budgeting (PIB) or Performance Budget (PB) and start carrying out Budget Performance Programs by 2023 up on. Budgets allocated to MRD were limited by budget ceiling for the next three years rolling 2023 to 2025, and the agreement budget use shall be signed between Minister of MRD and Minister of MEF with assigned outputs and outcome indicators each program. Through this process, there is potential for MRD to leverage additional government budget for WASH sector. However, government budget alone may not be sufficient to reach the above targets and resources gap following the impact of COVID-19 on fiscal space and continued uncertainty of economic prospect post COVID-19. Therefore, there is a need to consider options to optimise the targeting of pubic investments, and mobilize other resources from development partners, civil society organizations, and households and a tool need to exist to support this process.

4.2.2. Hydropower development for power shortage

The development of electricity generation increased from 1,088 MW in 2013 to 2,650 MW in 2018, of which domestic sources increased from 685 MW to 2,207 MW, making electricity import decline from 56.3% to 14.55%. By 2018, coal-fired power sources accounted for 35%, hydropower 49% and power imports about 15% and 33 sub-terminals covering 20 capital and provinces. In 2020, some 349 areas (regions) across the Cambodia are receiving safe and reliable electricity, and only 10 areas haven't been connected to the national networks. The RGC has implemented a plan to lower electricity tariffs and electricity tariff gaps supplied by the national network for 2015-2020 and implemented a plan to add housing favors and generate different rates of electricity for day and night. However, Cambodia still faces an energy shortage and expensive electricity prices (RGC, 2019)[41].

The Cambodian energy sector needs considerable development in the generation of energy to meet the growing needs of the country and provide a stable and affordable power supply to potential investors in the industry. The government sees hydropower as a priority area for development in the energy sector. The RGC has identified 60 possible sites for hydropower development in Cambodia and estimated the country's total generation potential at 10,000MW, of which 50% is on the mainstream Mekong, 40% on its tributaries, and 10% in the southwest outside the Mekong basin.[42] The total number of hydropower projects in Cambodia's Mekong section is around 21 projects with a total electricity generating capacity of 5,073 MW and a storage capacity of 20,555 MCM (MRC 2018; Piman et al. 2013). Cambodia has previously planned and built hydropower dams outside of the Mekong River Basin. Five hydropower dams are located in the coastal provinces of Cambodia, including Kampot and Koh Kong Provinces with a total capacity of more than 900 MW and two dams in the 3S River Basin (Urban et al. 2018).

[39] World Bank Group 'Service Delivery Assessment - Water Supply and Sanitation in Cambodia: Turning Finance into Services for the Future' (2015)
[40] MRD Programme Budget 2015-2022
[41] RGC. 2019. Cambodia: National Report on Istanbul Program of Action 2011-2020. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.un.org/ldc5/sites/www.un.org.ldc5/files/cambodia_ldcs_country_national_report_on_istanbul_program_of_action_2019_9nov2019_1.pdf.
[42] Cambodia National Mekong Committee (prepared by MIME), National Sector Review 2003: Hydropower, June 2003 (p5, 8-9).

Two large dams have also been considered on the Mekong mainstream at Sambor (465MW) and Stung Treng (980MW). Sambo dam has been studied also by Chinese firm and it has been planned for construction soon, and the Stung Treng has been proposed for another study by Chinese Company in 2021. However, there is considerable controversy related to the development of mainstream dams:

a. Stung Treng; solely within Cambodia, requires a long dam for a limited head, inundation of about 212 km^2, the reservoir length about 50 km, environmental and social conflicts (fishery, resettlement), further development recommended to be delayed. In addition, the economics of the development seems marginal due to the large structure and based on investigations and information gathered during the BDP Scenarios assessment.

b. Sambor; solely within Cambodia, requires a long dam for a limited head, capacity 2 600 MW requires 18 km long dam with more than 600 km^2 inundated area, capacity 1703 MW requires more than 2 km long dam with more than 60 km^2 inundated area, environmental and social conflicts (fishery, resettlement) may also occur and development may be delayed to allow for re-design to be considered.

A number of other projects are being studied particularly in the northeast and southeast regions of Cambodia. These project are currently being studied for feasibility, including the Lower Sesan 3, Lower Sesan 1/5, Lower Srepok 3 & 4, and Prek Liang 1 & 2. In the southeast, the Stung Cheay Areng has also been studied.[43] Around Tonle Sap Lake, five more dams have been proposed. In February 2019, investigation over a potential new hydro dam in Pursat province was reported. With an estimated cost of $160 million, the dam would produce 80 MW of electricity.[44] A new coal plant is being constructed in Preah Sihanouk province instead.[45]

More hydropower dams have been proposed in the Mekong Region, however, between 2020 and 2030, RGC commits to not build mainstream dams on the Mekong River in Cambodia (VOA, 2020)[46]. The RGC is increasing share of clean energy, not developing any new coal power plants and not constructing any new hydropower dam along the Mekong River. Cambodia is also formulating a Long-Term Strategy for Carbon Neutrality to promote activities that can deliver low carbon, climate resilient, and inclusive growth. This also will help Cambodia seizes the opportunities of green economy – a major driver of growth, investment, and innovation in the coming decades. Furthermore, the RGC has commissioned over 400 MW of utility-scale solar energy, representing 15% of our energy mix, to supply solar power to national grid. This is new commitment for future energy development in Cambodia (RGC, 2021).[47]

4.2.3. Flood and Drought Management

Cambodia has faced frequent floods and drought in recent years. The frequency and intensity of floods in Cambodia may increase in the future due to changing climatic conditions, with water resources affected by climate change in a number of ways. It is predicted that by 2100, annual rainfall in Cambodia could increase by between 3% and 35% over current levels[48], but that there will be a reduction in the number of rainfall events, suggesting that the intensity of the rain will increase.

MOWRAM will carry out key activities to improve flood and drought management.

- First, promoting and encouraging the study and construction of flood controls and water drainage with the aim of minimizing natural disasters caused by water.
- Taking actions to mitigate flood in all areas which provide high economic potential by providing education to communities and public information through media.
- Responding urgently to areas severely affected by drought, flood and other destructions caused by water.
- Continuing to encourage people and all institutions to participate in flood mitigation actions such as preparing safety hills, supplying materials and machinery, educating, and participating in national and international events on flood risk reduction.
- Setting up pumping stations and repairing pumping stations and water pumps.
- Being ready to intervene to rescue dry season rice and rainy season rice for people in all provinces in case of water shortage, especially in areas near water resources that are not irrigated by irrigation schemes.
- Preparing a map showing the flood affected areas.
- Restoring the sediment to reduce the flood.

[43] Electricity Authority of Cambodia, Report on power sector for the year 2014. http://eac.gov.kh/wp-content/uploads/2015/07/report-2014en.pdf.
[44] Cambodia Constructors Association 2019. *Government to construct $160 million hydro-power plant in Pursat province*, 13 February 2019. https://www.construction-property.com/read-news-1646/.
[45] May Kunmakara, 2017. "Toshba to build power plant", *Khmer Times*, 28 February 2017.
[46] Khmer.voanews.com/a/cambodian-official-says-no-dam-for-cambodia-mainstream-mekong-till-2030/5331992.html.
[47] RGC. 2021. National Statement by H.E SAY Samal, Minister of Environment, at the United Nations Climate Change Conference COP 26/ CMP 16/CMA 3 Glasgow, UK, November 2021,
[48] Ministry of Environment (MoE). Vulnerability Adaptation Report; Ministry of Environment: Phnom Penh, Cambodia, 2016. Available online: https://ppcrcambodia.files.wordpress.com/2013/02/vulnerability-adaptation-report_moe-comments_20130121.pdf.

Table 13. List of potential projects for future investment.

Project name	Location		Catchment		
	Longitude	Latitude	Catchment area (km^2)	Annual Inflow (m^3/s)	Annual Volume ($mill.m^3$)
Battambang 1	12.800	102.900	2135	78.6	2478.7
Battambang 2	11.250	102.900	120	5.9	186.1
Stung pursat 1	12.533	103.550	1263	41.1	1296.1
Stung pursat 2	12.283	103.617	2080	32	1009.2
Lower Se San 3	14.032	107.024	15435	330	10406.9
Prek Liang 1	14.217	107.251	917	40.2	1267.7
Prek Liang 2	14.283	107.267	580	25.4	801.0
Lower Sre Pok 3 (3)	13.388	107.050	25311	713	22485.2
Lower Sre Pok 4	13.038	107.450	13727	378	11920
Stung Sen2	13.300	105.250	10540	145	4572.7
Se Kong	No data	No data	No data	No data	No data
Prek Por 1	No data	No data	No data	No data	No data
Prek Liang 1A	No data	No data	No data	No data	No data
Prek Ter 2	No data	No data	No data	No data	No data
Prek Ter 3	No data	No data	No data	No data	No data
Prek Chhlong 2	No data	No data	No data	No data	No data
Se San 1	No data	No data	No data	No data	No data

Table 14. Flood and drought management.

Indicator	Unit	Baseline 2018	2019 estimated	2020 Projected	2021 Projected	2022 Projected	2023 Projected
1. Flood prevention and alleviation	Ha	139156	Sustain and expand protection over agricultural area, public property and national infrastructure				
2. Sea water protection and alleviation	Ha	21,043	Sustain and expand protection over agricultural area and all kinds of crops				
3.Rescured rice paddy during drought and water shortage	Ha	93,287	90,000	90,000	90,000	90,000	90,000
4. Set up pumping stations	place	31					
+Outcome in each year	place		5	5	5	5	5
+ Subsequent total	place		36	41	46	51	56
5. Repaired pumping stations	place		9	9	9	9	9
6. Repaired pumping machines			18	18	18	18	18

Source: *MOWRAM, 2019.*

5. Water Governance

Cambodia has abundant water resources in the wet season and a scarcity of water in the dry season. These phenomena undermine the development in this country and pose a threat to long-term development. Recognizing this, various regimes including the current government have promoted water management as a key government priority, aiming at enhancing agriculture and boosting the national economy. Three key approaches concern water governance in Cambodia. First, water governance is concerned with the policies and institutional arrangement, and the processes that seek to enhance efficiency, equity, and effectiveness of water management and share it with users and use it to benefit society and its members. The second approach of water governance is concerned with the decision-making processes, the ensuing allocation of resources and services and the impacts of such decisions on access to resources and services of different players. Third, water governance is intimately linked to the physical infrastructure that has been constructed and operated for the regulation, abstraction, storage, transport and distribution of water. Furthermore, water governance in Cambodia has been structured into: (1) national water governance and (2) regional water governance. The national water governance is structured into two levels: (a) national water governance and (b) local community water governance.

5.1. Cambodia in the Regional Water Cooperation

Regional water development projects in the Mekong River Basin have affected water uses and management in Cambodia. Improving water management is key to the development of Cambodia at present and future. Thus, Cambodia has integrated itself in various regional water related cooperation frameworks in the Mekong Region. The following section discusses key regional water cooperation frameworks.

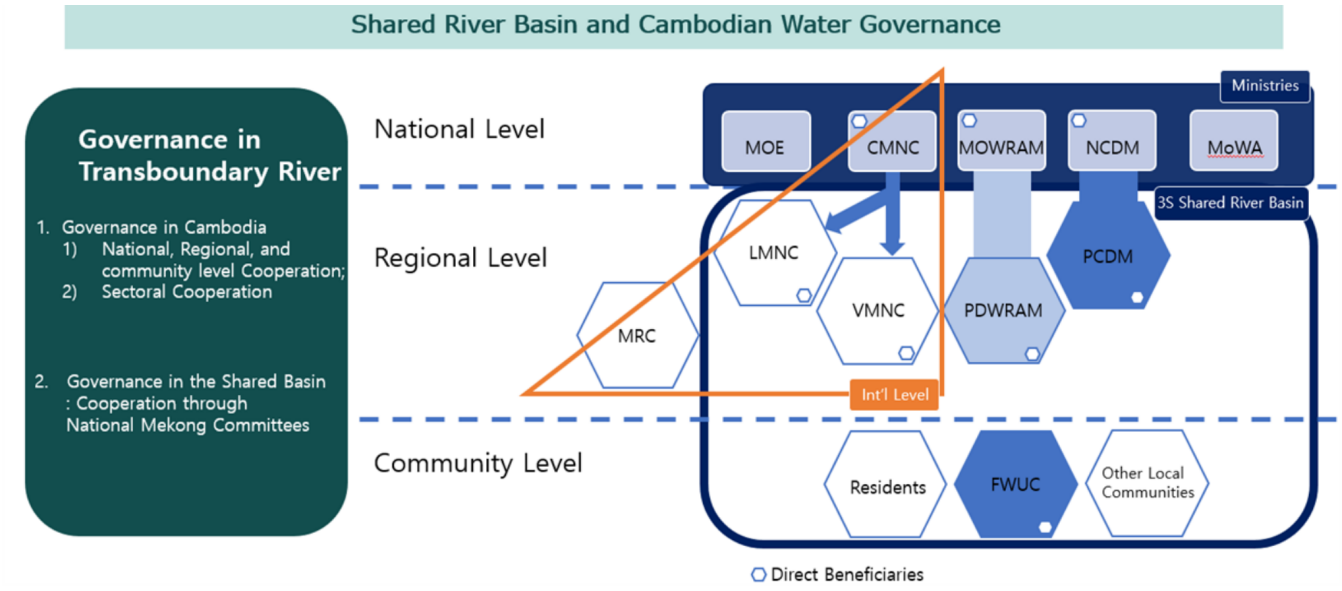
5.1.1. Mekong River Commission (MRC)

In 1957, the UN, with support from the US, set up the Mekong Committee (MC) to provide a mechanism for channeling international aid to create economic and trade projects, including dams, and to help improve navigation along the waterways. The Committee included the four Lower Mekong states[49], and Cambodia was a member of MC. Due to the war in the 70s, development in the Mekong Region was slowed following the dissolution of the MC in the 75s.

In 1995, the UN facilitated the establishment of the Mekong River Commission (MRC), and in April of that year, Cambodia, Laos, Vietnam, and Thailand signed the MRC Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin.[50] The Agreement provided a legal mandate for the MRC to coordinate riparian activities for development and management within in the Lower Mekong Region.

The cooperation promoted the coordination, joint planning and joint action needed to achieve sustainable development, with an intention to protect the environment and maintain the region's ecological balance. It also set out a framework for achieving these strategic objectives, recognizing that development decisions by sector agencies in the sovereign riparian countries might have transboundary consequences and that the MRC as an inter-governmental river basin organization needed to coordinate with all the riparian states to work together so as not to cause harm to their neighbors. Hydropower development is part of the regional cooperation.

Figure 7. Water governance structure in Cambodia.



[49] Hiroshi Hori, The Mekong: Environment and Development (Tokyo: United Nations University Press 2000), pp. 424; Joakim Ojendal, 'Sharing the Good: Mode of Managing Water Resources in the Lower Mekong River Basin' (PhD Diss., Goteborg University 2000).

[50] George Radosevich & Douglas Olson, Existing and Emerging Basin Arrangements in Asia: Mekong River Commission Case Study, (Washington, DC: World Bank, 1999), available at http://siteresources.worldbank.org/INTWRD/918599-1112615943168/20431963/MekgongRiverComCaseStudy.pdf.

Cambodia is located in downstream of the Mekong River Basin. At the regional level, the MRC 1995 Agreement provides an international framework to govern the Mekong water resources. The MRC Agreement in 1995 provides the provisions to protect the Tonle Sap and the Mekong River in Cambodia; first, the Agreement provides a general direction to safeguard the Tonle Sap and second, it provides a specific guarantee to protect the Tonle Sap (MRC Agreement, 1995; Sneddon, 2003). The general direction in the Agreement includes the efforts by all parties "to protect environment, natural resources, aquatic life, and conditions, and ecological balance of the Mekong River Basin from the pollution and other harmful effects resulting from any development plans and uses of water and related resources in the Basin" (Article 3). However, dam or hydropower dam is still possible under this Agreement as states in the Article:

> The parties agree... To cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin including, but not limited to irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use from natural occurrences and man-made activities (Agreement 1995, Article 1).

The Agreement provides the direct protection of the Tonle Sap. The Article 5 of the Agreement guarantees the equitable and reasonable utilization of the Mekong water. It spells out a specific clause to protect the Tonle Sap as a 'tributary' of the Mekong River and any intra-basin uses or inter-basin diversions shall be subject to notification to the Joint Committee. Article 5 also limits the activities of riparian states in using water resources from the Mainstream Mekong River in both the dry and wet seasons as it states:

1. During the wet season:
    a. Intra-basin use shall be subject to notification to the Joint Committee.
    b. Inter-Basin diversion shall be subject to prior consultation which aims at arriving at an agreement by the Joint Committee.
2. 2. During the dry season:
    a. Intra-basin use shall be subject to prior consultation which aims at arriving at an agreement by the Joint Committee.
    b. Any inter-basin diversion project shall be agreed upon by the Joint Committee through a specific agreement for each project prior to any proposed diversion. However, should there be a surplus quantity of water available in excess of the proposed uses of all parties in any dry season, verified and unanimously confirmed as such by the Joint Committee, an inter-basin diversion of the surplus could be made subject to prior consultation (Article 5, MRC Agreement in 1995).

The Article 5 forms the strong bases for Cambodia to protect the Tone Sap Lake. However, it is argued that the Article 5 can be translated into three different ways: First, the Mekong can be dammed and diverted; second, the average flows can be maintained; and third, that maintaining average flows in the Mekong during the rainy season is a healthy optimum. The question is how to protect the Tonle Sap using this article given it vague meaning and confused terms (Ojendal, 2000; Sithirith, 2007). Article 6 also raises two concrete points in maintaining flows in the mainstream:

a. Of not less than the acceptable minimum monthly natural flow during each month of the dry season;
b. To enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season (Article 6, MRC Agreement in 1995).

Under the MRC Agreement, at country level, the Cambodian National Mekong Committee (CNMC) is of national arm of MRC to coordinate the national agencies to involve in water management. The CNMC has 10 ministries as a member, and it is chaired by the Minister of Water Resources and Meteology (MOWRAM). The CNMC externally maintains a direct linkage with the MRC and nationally, the CNMC is tasked to assist and advise the government in all matters relating to water policy and strategy as well as management and development of the water and natural resource of the Mekong River Basin.

At the national level, to implement the RGC's priority policies in the Sixth Legislature of the National Assembly, the Cambodia National Mekong Committee (CNMC) will continue to fully cooperate with other Mekong Member Countries under the Mekong River Commission (MRC) framework to ensure the prosperous and sustainable development of the Mekong River Basin, implement more effectively the Agreement on Cooperation for the Sustainable Development of the Mekong River Basin, and ensure mutually beneficial cooperation towards the optimal and sustainable development of the Mekong River Basin. The integrated water resources management (IWRM) requires a water-food-energy nexus, a gender-sensitive perspective, the mainstreaming of climate change and the alignment of regional and national efforts in development planning and implementation, the protection against extreme floods and droughts, as well as the preservation of key environmental assets and livelihood of vulnerable communities necessary to achieving the relevant Sustainable Development Goals committed by the MRC Member Countries, especially Goal 6, "Ensure availability and sustainable management of water and sanitation for all".

To implement the committed prioritized policies, the CNMC will continue to cooperate with Mekong Member Countries to optimize development opportunities and address challenges through a basin-wide, integrated, and inclusive multi-disciplinary process, notably through the implementation of the Basin Development Strategy (BDS) in continuing to implement all the MRC Procedures for Water Utilization to support the sustainable, reasonable, and equitable use of the Mekong water and related resources;

strengthening the MRC basin-wide monitoring networks and forecasting systems for floods and droughts, as well as data and information management systems; continuing to improve the dissemination, uptake, and use of the MRC products by relevant line agencies and organizations; as well as identifying opportunities for further cooperation with Dialogue Partners, Development Partners and other concrete cooperation mechanisms such as ASEAN, Mekong-Lancang Cooperation, and Greater Mekong Sub-region.

5.1.2. The Greater Mekong Sub-region (GMS)

In 1992, the Asian Development Bank (ADB) initiated the Greater Mekong Sub-region (GMS). It comprises of Cambodia, the People's Republic of China (specifically Yunnan Province and Guangxi Zhuang Autonomous Region), Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. It is bound together by the Mekong River, covering 2.6 million square kilometers and a combined population of around 326 million. It was established to promote regional cooperation, economic and infrastructure development, cross-border trade and economically productive uses of untapped natural resources. Unlike MRC, the GMS included China and Myanmar.[51]

Japan was the key driver of the GMS: the country's economic strength was at a peak and it was searching for opportunities to invest Japanese capital in countries along the Mekong River. Japan's position in the governance and financing of the ADB ensured a powerful role for it at a time when China was still a limited geo-economic power. Furthermore, because the GMS tapped the resources and capacity of the private sector to invest in infrastructure development, it acted to promote a public-private partnership for investment along the Mekong.[52] Through this public-private partnership of the GMS, the ADB has been able to leverage the non-hegemonic states to challenge the hydro-hegemons in transboundary river governance in the region.[53]

Under the GMS framework, ADB as a third party inspires the hydro-hegemonic and the non-hegemonic states in the Mekong to work together. ADB has also utilized both a non-water and water resources approach to development. The non-water resource approach focused on agriculture, energy, environment, human resource development, information and communication technology, tourism, transportation, trade facilitation, urban development, and other multisector and border economic zones to create impacts in the Mekong region. The ADB has implemented more than 100 cooperative projects in infrastructure, energy, telecommunications, trade, tourism, and the environment.[54] From 1992 to 2013, the ADB "mobilized 16.6 billion USD in investment projects and 330.8 million USD in technical assistance," with 6 billion USD coming directly from the ADB.[55] Between 2014 and 2018, the GMS was planning to implement 93 priority investment and technical assistance projects. By the end of 2019, some 52 of the original 93 projects have already secured financing estimated at US$26 billion, 85% of the original estimated total cost. Moreover, about a third of investment projects have commenced implementation and two projects, both in the transport sector, have been completed.[56]

In their water resource approach, ADB facilitated the riparian states in the planning of the hydropower dam development that was agreed upon by all Mekong River countries under the GMS framework. In the early 1990s, the ADB/GMS funded two major preliminary technical and economic feasibility studies for hydropower projects in the region. The first study, undertaken in 1994, provided an initial inventory of potential hydropower projects in the Mekong region. The second study, begun in 1998, specifically focused on the feasibility of hydropower projects in the Sekong, Sesan, and Nam Thoeun River Basins (SKSSNT).[57] The SKSSNT study was completed in two phases and analyzed a total of 37 potential hydropower sites in the three basins. The 11 highest-ranked projects were then selected, from which six dams were selected for further study: the Sesan 3 and Thoung Kontum in Vietnam, the Lower Srepok 2 and Sesan 4 in Cambodia, and the Xe Kaman 3 and Nam Kong 1 in Lao PDR.[58]

5.1.3. Lancang-Mekong Cooperation

China has been rising as a regional and global power, particularly in the Pacific and the Mekong regions.[59] China began to change its view of its neighboring countries in the Mekong, from political enemies to potential trade partners and sources of natural resources and investment. In line with this, China adjusted its approaches and strategies with its neighbors from confrontation to cooperation.

In 1992, China chose to join the Greater Mekong Sub-region (GMS), initiated by the Asian Development Bank (ADB), aiming at employing the GMS to first boosting the development in the least developed region of Yunnan Province in the South-western China, and second, to link the Yunnan Province to the Mekong Region through the Mekong River for cross-border trades and economic development. In this context, China views the Mekong as a gateway or 'land-link' connecting mainland China, particularly Yunnan province, with maritime Southeast Asian countries for trade and economic development.[60] In 1993, under the ADB/GMS initiative, waterway transportation on the Upper Mekong River was identified as a high priority

---

[51] Hirsch, 'The Shifting Regional Geopolitics of Mekong Dam', pp. 63-74; ADB, The GMS Beyond Borders: Regional Cooperation Strategies and Program 2004-2008 (Manila: ADB 2004), pp.84; ADB, The Greater Mekong Subregion Economic Cooperation Program. GMS Assistance Plan (2001-2003), (Manila: ADB 2000), pp.65

[52] ADB, Greater Mekong Sub-region Economic Cooperation Program: Overview of the Regional Investment Framework 2022 (Manila: ADB 2018), pp. 29.

[53] Hirsch, 'The Shifting Regional Geopolitics of Mekong Dam', pp. 63-74.

[54] Han, 'China, an Upstream Hegemon', pp. 30-55.

[55] ADB, Viet Nam: Energy Sector Assessment, Strategy and Road Map, (Mandaluyong City, Manila: ADB 2015), pp.1-52.

[56] ADB, Greater Mekong Subregion Mid-Term Review and Revised Regional Investment Framework Implementation Plan 2020, available at https://www.adb.org/documents/gms-midterm-review-revised-rif-ip-2020?6018C8AD-3C25-9F43-9004-74E94BD09237_kis_cup_C6FA3ED5_6D17_47D1_B6E2_F4B02CC905E0, accessed on 05 January 2020.

[57] Halcrow and Partners, Sekong, Se San and Nam Theun River Basins Hydropower Development Study: Final Report (Manila: Asian Development Bank 1999).

[58] ADB, Final Report: TA6367 Sesan, SrePok, and Sekong River Basins Development Study in Kingdom of Cambodia, Lao People's Democratic Republic, and Socialist Republic of Vietnam, (Manila: ADB 2010b), pp.67; Hori, 'The Mekong', pp. 424; Ojendal; Mathur and Sithirith, Environmental Governance in the Lower Mekong, pp.1-72.

[59] Hong Liu and Guanie Lim, 'The Political Economy of a Rising China in Southeast Asia: Malaysia's Response to the Belt and Road Initiative', Journal of Contemporary China28(116), (2019), pp.216-231, https://doi.org/10.1080/10670564.2018.1511393; Olivier Hensengert, 'Regionalism, Identity, and Hydropower Dams: The Chinese-Built Lower Sesan 2. Dam in Cambodia', Journal of Current Chinese Affairs, 46(3), (2017), pp. 85-118. https://nbn-resolving.org/urn:nbn:de:gbv:18-4-11097.

[60] Grundy-Warr Carl, 'B/ordering nature and biophysical geopolitics: A response to Hirsch,' Political Geography, 58, (2016), pp. 131-135; Thomas Ptak, Considering Multiple Chinas in the Shifting Regional Geographics of MekongRiver Dams,' Political Geography, 58, (2016), pp.1-3. Doi: 10.1016/j.polgeo.2016.09.007.

transport sector for the GMS. China then took the initiative to lead the other three upstream Mekong countries (Myanmar, Laos, and Thailand) in moving the ADB/GMS initiative forward.[61] On April 20, 2000; China signed an agreement with Thailand, Laos, and Myanmar in Tachileik, Myanmar, to establish the Quadrangle Economic Cooperation (QEC) to develop navigation along the upstream Mekong River for the promotion of cross-border trade and to facilitate the export of Chinese goods to other Mekong countries.[62]

In 2013, China initiated the new initiative known as "the the Belt and Road Initiative (BRI)". The BRI provides further instrumental supports to back up internationally operating Chinese players such as SOEs, private firms, and less well-capitalized Chinese entrepreneurs overseas.[63] The goal of this BRI is to "enhance regional connectivity and embrace a brighter future."[64] The BRI comprises the creation of new infrastructure investments in more than 150 sovereign nations throughout Asia, Europe, Latin America, the Middle East, and Africa. The BRI shows the territorial hegemony of China, which links China to the rest of the world by investing huge financial resources and building massive infrastructure, but which is also displacing large numbers of people and damaging the environment.[65]

On 23 March 2016, China found the Lancang-Mekong cooperation (LMC) together with five other Mekong countries in Hainan Province of China, aiming at bolstering the economic and social development of the Sub-regional countries, enhancing the wellbeing of their people, narrowing the development gap among regional countries and supporting ASEAN Community building[66]. China has effectively utilized its changed policies and institutions to build a 'new regional order', weaving specific countries into a Sino-centric 'community of shared destiny'.[67] Furthermore, *the Lancang-Mekong Cooperation thereby creates a new cooperation framework t*hrough which China is able to increase investment in the region to develop regional infrastructure and improve the regional connectivity network. But the enhanced political relations would result in a Chinese dominant and highly asymmetric relationship with the Mekong riparian countries, as there is very little cooperation built into the cross-border water allocation, dam-building, or environmental protections. The signing of the Cooperation Framework also allows China a new diplomatic tool to temper downstream complaints concerning Chinese construction of large-scale dams on the mainstream Mekong and a formal mechanism to take action with its downstream neighbors in addressing such issues.[68] In sum, China has brought to the Mekong region a financial hegemony, through infrastructure development such as the BRI, as well as through diplomacy, culture, state and private sector investments, human and institutional resources, security and geopolitics. The foreign exchange reserves, trade packages, foreign direct investments, and political alliances all act to alter the leverage of power between the hydro-hegemon states, such as China and Vietnam, and the non-hegemon, such as Cambodia, in the Mekong and the 3S Regions[69]. As such, the new regional relationship with China allows Cambodia and Laos to reduce their dependency on Vietnam, but increases China's influence in the region.[70]

In Laos, China has invested significantly in dam building, with 32% of China's foreign direct investment (FDI) going into hydropower projects. As of 2014, China has built 14 hydropower projects in Laos—six in operation and eight under construction—most of which under a build-operate-transfer (BOT) model. Under a BOT contract, the riparian government grants a concession to a Chinese Company to finance, build and operate a hydropower project for a period of 40-44 years to generate a return and will return the project to the that government after the concession period ended.[71] China is Vietnam's largest trading partner, with energy trade accounting for about 20% of bilateral trade between China and Vietnam[72]. Chinese dam-builders and financiers have built four dams in Vietnam in addition to several others planned or under construction, although Vietnam's hydropower sector is already well-developed[73]. However, the extent of Chinese dam-building in the Mekong and its severe real and potential downstream impacts have caused Vietnam great concern.[74] In the Mekong region as a whole, China has built more than 50 large-scale dams (over 50 MW): Myanmar (30), Laos (14), Cambodia (7), Vietnam (3).Thailand has several Chinese dam projects, but none over 50 MW.[75] The Chinese dam-building industry in Cambodia is an instrument for economic growth and development, but Vietnam they are seen as potentially undermining national growth, development, and security.[76]

5.2. National Water Governance

At the national level, MoWRAM is responsible for water resources management and a led agency in water governance. As Mekong River provides water resources to Cambodia, water governance in general refers to the Mekong water governance, and thus, Cambodian National Mekong Committee (CNMC) is structured under MOWRAM to coordinate lined ministries to involve in water governance, including MOWARAM, MoE, MAFF, MRD, MIME, MPWT and few other ministries.

---

[61] ADB, The Greater Mekong Subregion Economic Cooperation Program. GMS Assistance Plan (2001-2003), (Manila: ADB 2000), pp.48.
[62] ADB, The GMS Beyond Borders: Regional Cooperation Strategies and Program 2004-2008 (Manila: ADB 2004), pp.84.
[63] Liu and Lim, 'The Political Economy of a Rising China in Southeast Asia', pp.216-231;
[64] Ibid.
[65] Apichai Sunchindah, Water Diplomacy in the Lancang-Mekong River Basin: Prospects and Challenges. Paper presented at the Workshop on the Growing Integration of Greater Mekong Sub-regional ASEAN States in Asian Region (Yangon: ASEAN 2005); The Nation, Water Diplomacy by China Offers Drought Relief, March 18th, 2016, The Nation, Asia News Network, accessed on 17 May 2017,www.nationmultimedia.com/news/national/aec/30281969.
[66] Biba, 'From securitization moves to positive outcomes', pp. 420-439; Han, 'China, an Upstream Hegemon', pp. 30-55; Liebman, 'Trickle-down hegemony? pp. 281-304.
[67] Olivier Hensengerth, 'Where is the power? Transnational networks, authority and the dispute over the Xayaburi Dam on the Lower Mekong Mainstream', Water International, 40 (5-6), (2015), pp. 911-928, http://dx.doi.org/10.1080/02508060.2015.1088334.
[68] Hirsch, ' The Shifting Regional Geopolitics of Mekong Dam', pp.63-74.
[69] Nathanial Matthews & Stew Motta, 'Chinese State-Owned Enterprise Investment in Mekong Hydropower: Political and Economic Drivers and Their Implications across the Water, Energy, Food Nexus', Water, 7 (11), (2015), pp. 6269-6284.
[70] Hensengerth, ' Where is the power?' PP. 911-928.
[71] Danielle Tan, China in Laos: Is there cause for worry? (Singapore: Institute of Southeast Asian Studies, 2014), pp.1-16.
[72] Carl Middleton, Cambodia's Hydropower Development and China's Involvement (Phnom Penh: Rivers Coalition in Cambodia 2008), pp. 1-60.
[73] Vannesa Lamb & Nga Dao, Perceptions and practices of investment: China's hydropower investments in Vietnam and Myanmar, Journal Canadian Journal of Development Studies / Revue canadienne d'études du développement, 38(3), (2017), pp. 395-413.
[74] Frauke Urban; Giuseppina Siciliano and Johan Nordensvard, ' China's dam-builders: their role in transboundary river management in South-East Asia. International Journal of Water Resources Development, 34 (5), (2018), pp. 747-770.
[75] Matthews & Motta, 'Chinese State-Owned Enterprise Investment in Mekong Hydropower', pp. 6269-6284.
[76] Urban; Siciliano and Nordensvard, ' China's dam-builders', pp. 747-770.

The current Royal Government of Cambodia (RGC)'s 'Rectangular Strategy' has promoted large-scale water management through: (i) Enhancement of the agricultural sector, and (ii) Further rehabilitation and construction of the physical infrastructure.[77] Five strategic areas have been prioritized in order to achieve these priorities: (1) Water resources management, and the development and implementation of irrigation systems, (2) flood and drought management, (3) promoting the law regarding water provision and sustainability, and (4) water resources management and meteorological information. Management of water resources in Cambodia has long been centralized by the government and dominated by large-scale irrigation systems. About 2525 irrigation schemes were developed across major provinces in Cambodia[78]. These schemes are categorized into large-scale, medium-scale and small-scale schemes. Large-scale irrigation schemes can be broken down into three further categories based on the land area being irrigated. The first group of large-scale irrigation schemes irrigates more than 10,000 ha, and there are nine of these countrywide. The second group of large-scale schemes includes those which irrigate a land area of between 5000 and 10,000 ha, and there are 22 such schemes in Cambodia. Those schemes in the third group can irrigate between 2000 and 5000 ha, and there are 65 of these. The rest of the schemes fall within the medium- and small-scales. The medium-scale schemes can be broken down into two types: (i) those covering between 1000 and 2000 ha, and (ii) those covering just 500 to 1000 ha. The small-scale irrigation schemes range in size between 500 and 100 ha. Of the irrigation schemes, 1574 do not function at all; 802 schemes function partly and only 149 schemes function well[79].

However, the governance of water in Cambodia has been challenged by weak coordination and overlapping roles of ministries related to water management and it is more concerned with economic growth than the environment, and its governance. Despite the integrated water resource management approach taken, insufficient cooperation takes place among the different ministries and even between different departments within a given ministry. Moreover, even though the MoWRAM is in overall charge of water management and conservation issues, intra-ministerial coordination is weak, meaning there is room for improvement in terms of its management capacity. Data related to water collected by individual ministries should be passed to and be accessible through the MoWRAM, with a master dataset openly available to all the ministries.

Water management in Cambodia is dominated by large-scale irrigation systems characterized by the use of a top-down and sectoral approach, requiring a high technical capacity, high costs and state-driven interventions. Such projects seldom involve public participation in the consultation, decision-making and design processes. As a consequence, many large-scale irrigation schemes do not operate in the dry season due to a shortage of water, while many small-scale irrigation systems, such as those suitable for small farmers, have not been built. Hence, the efficient use and governance of water resources continue to be a challenge to Cambodian farmers.

5.3. Local Level Water Governance

RGC has promoted the participation of local communities in water governance to enhance the effectiveness of water management across the country. Cambodia has adopted a Participatory Water Management and Development (PWMD) approach to the planning, development and management of water resources. Policy and instructional frameworks were developed to support the decentralized water management through which the government is developing responsibility for all water management activities, including the regulation of water access, the collection of fees and monitoring.[80]

The government of Cambodia had developed the Water Law in 2005. Article 19 of the Water Law states that "All farmers using water from the irrigation system or part thereof may form a Farmers' Water User Community (FWUC)."[81] The sub-decree on FWUC gives guidance on how the FWUCs should be organized. The FWUCs have to be registered in the Farmers Water User Community registry held by the provincial or municipal directorate of the MOWRAM. After having been registered, an FWUC is fully entitled to carry out activities in accordance with its statutes and is formally recognized.

FWUCs are established to serve the interests of farmers who have farming land and use water to irrigate their rice fields. They are part of a strategy designed to bring farmers together on the issues of sharing water and building the social capital needed to use water in a sustainable manner. The idea is that in this way the FWUCs help build collective action and solidarity. Out of 2525 irrigation schemes, only 230 (6.3%) schemes across the country have an FWUC in place, and of those 230, only four (2%) can be considered to be functioning well, though another 84 (36%) have the potential to do so. The majority (62%) were found to be non-functioning.[82] Between 2014 and 2018, about 109 FWUCs involving 13,899 farmer households were planned to be established, covering 31,948 ha in the wet season and 17,587 ha in the dry season. The RGC will establish 7 FWUCs annually between 2019 and 2023, increasing from 551 FWUCs in 2019 to 579 FWUCs in 2023.

[77] Royal Government of Cambodia. Rectangular Strategies Phase III; The Council for Development of Cambodia: Phnom Penh, Cambodia, 2013.
[78] MOWRAM, 2017. Cambodian Information System on Irrigation Schemes (CISIS) Database (May 2017). .
[79] Center for Agriculture Development Study (CEDAC). Inventory of Irrigation Schemes and Famer Water User Communities in Cambodia; CEDAC and Water Program; Center for Agriculture Development Study: Phnom Penh, Cambodia, 2009.
[80] Nang, P.; Khiev, D.; Hirsch, P.; Whitehead, I. Improving the Governance of Water Resources in Cambodia: A Stakeholder Analysis–Understanding Stakeholders' Roles, Perceptions and Constraints for Effective Irrigation and Catchment Management and Development; Working Paper Series No. 54; Cambodia Development Research Institute: Phnom Penh, Cambodia, 2011.
[81] Ministry of Water Resources and Meteorology (MOWRAM). Sub-Decree on the Establishment and Dissolving of FWUC; Ministry of Water Resources and Meteorology: Phnom Penh, Cambodia, 2015.
[82] Ibid. Center for Agriculture Development Study (CEDAC), 2009.

6. Policy Roadmap of MOWRAM

Water resources sector play important roles in supporting RGC in achieving the Rectangular Strategies 2019-2023, the NSDP 2019-2023, and water policy, contributing to poverty reduction. Water resources sector development and management reduces natural disaster and risks, and ensure water supply for rice farming and crop product, which contribute to national policies on food security and rice exports, and rural and urban domestic water uses. In implementing the roles and responsibilities outlined in the legal frameworks by the RGC, MOWRAM mobilizes and utilizes funds and its resources to addressing the national needs of water resources for country's development:

1. Rehabilitating the irrigation schemes to provide sufficient water for rice farming, daily domestic water uses for human, animals and tourism.
2. Constructing the dykes for flooding control and salt intrusion to protect the agricultural land, public properties and national public infrastructures

6.1. Water Sector Strategic Development Plan 2019-2023

MOWRAM has developed the water sector strategic development plan 2019-2023 to illustrate the goals, objectives and activities on water resources governance. This strategic plan is guided by four basic principles: (1) The legal mandates and the functions of MOWRAM; (2) Water Policy; (3) Water Management and the Development of Irrigation System; (4) Rectangular Strategies 2019-2023.

The Water Sector Strategic Development Plan 2019-2023 covers five areas: (1) Repairing and rehabilitating; (2) building; (3) maintaining the irrigation schemes and the flooded release, (4) Flooded monitoring Infrastructures; (5) Meteorology and hydrology status. The main purposes of the strategic plan include:

1. Increase the irrigated area of rice farming of 30,000 ha annually from existing 1,802,359 ha in 2018 to 2 million ha in 2023 for both wet and dry season rice farming and 500 ha of other crops annually for the farmer to cultivate 2-3 crops a year to increase incomes and crease jobs for rural farmers
2. Implement the national water policy in Cambodia through maintenance, rehabilitation, and construction of irrigation schemes, flood and salty water control dyke systems, flood releasing system and hydropower;
3. Draft the sub-decree and standard provisions related in order to implement the water law in Cambodia;
4. Continue to establish the Farmer Water User Communities (FWUCs) to reduce the burden on national budget for repairing and maintaining, and ensure the sustainability of irrigation schemes;
5. Intervene in the drought event both in the wet and dry season to pump water to save the rice farming for farmers;
6. Implement the gender strategic plan in water and meteorology;
7. Manage the River Banks from erosion and landslides
8. Manage the hydrological data in order to support the research and monitoring of the surface and ground water, the hydrological changes, impacts on wetlands which are important for agriculture.
9. Understand the climate change and its impacts.
10. Conduct the regular weather forecast and provide an early warning system before the disaster happened.
11. Establish the River Basin Management Committee and develop the River Basin Management Plan for the River Basins that have established the River Basin Management Committee already through at least one time meeting a year.
12. Implement the strategies for water and agriculture.

6.1.1. Goals

In order to implement the Water Sector Strategic Development Plan 2019-2023 as well as the NSDP (2019-2023), the RS-Phase IV, and achieving the long term vision in water sector, MOWRAM has a goal to:

- Manage, develop and conserve water resources effectively, equitably, and sustainably in order to ensure the ecological balance and reduce the natural disasters such as floods and drought on human lives and public properties. More specifically, the strategic plan aims at increase irrigation efficiency through building additional new irrigation schemes in the area where there are high water resources potential and implement the irrigation management:
  1. irrigation through storing and collecting water;
  2. Flood alleviation to reduce flood impacts on crops and properties of local communities;
  3. Protection through building the flood control system and dykes to protect life, properties, and infrastructures from floods.
- Modernization of the irrigation system—improvement and rehabilitation through integrating modern technology and ideas into the irrigation system in response to the socio-economic development of the country, the increased mechanization of agriculture, the global warming, the increased aged population, the decreased labor forces in rural communities, and to ensure that the irrigation system can be utilized in the long run and in a sustainable manner.

6.1.2. Strategies

To realize these goals, MOWRAM has laid out five strategies:

- Administration management improvement and human resources development.
- Water resources management and development including irrigation hegemony implementation effectively and equitably.
- Water resources and meteorology information management.
- Flood and drought management and meteorology information management.
- Water sustainability and conservation.

Table 15. Strategies and road map of water sector development 2019-2023.

Strategies	5-Years Road Map, 2019-2023
1. Administration management improvement and human resources development.	1. Strengthening administrative processes and the capacity of MOWRAM officials, at the central and sub-national levels for both males and females in order to implement and manage the works effectively and efficiently.
2. Water resources management and development including irrigation hegemony implementation effectively and equitably.	2.1 Water resources in Cambodia have been managed and developed effectively and equitably, benefiting to local people. 2.2 Implementation of irrigation management
3. Flood and drought management	3. Reduce the impacts of water, particularly floods and droughts on the livelihoods, public and state properties
4. Water resources and meteorology information management.	4. Water resources in Cambodia have been well developed and managed responsibly and creatively based on the available data and information.
5. Water sustainability and conservation.	5. Water law has been created to manage and develop water resources effectively and equitably.

6.1.3. Road Maps of Water Sector Strategic Development Plan

Below are detailed roadmaps and activities by five main areas:

a. Administration management improvement and human resources development

MOWRAM has planned to build the capacity of staff both national and sub-national levels:

- Number of training conducted annually between 2019 and 2023 is 30 trainings.
- Number of MOWRAM staff received training annually between 2019 and 2023 is 250 staff.

b. Water resources management and development

The current irrigated paddy area is 1,802,359 ha. MOWRAM has planned to increase the annual irrigated paddy area by 30,000 ha, from 1,832,359 ha in 2019 to 1,952,359 ha; the annual irrigated crop area by 500 ha, from 4,913ha in 2019 to 6,913ha in 2023.

MOWRAM has planned to establish 7 FWUCs annually between 2019 and 2023, increasing from 551 FWUCs in 2019 to 579 FWUCs in 2023. MOWARAM has encouraged investments from international donors and the private sector to support the management of irrigation schemes with farmers' and development partners' participation and has developed the plan to generate income through irrigated agriculture and continual investments in the water sector for agricultural productivity.

Table 16. Irrigation Development Plan 2019-2023.

Projects	Unit	2018 Baseline	2019 estimated	2020 Projected	2021 Projected	2022 Projected	2023 Projected
1. Irrigation capacity on rice paddy field	Ha	1,802,359					
+Outcome in each year	Ha		30,000	30,000	30,000	30,000	30,000
+Subsequent total	Ha		1,832,359	1,862,359	1,892,359	1,922,359	1,952,359
2. Irrigation capacity on minor crop	Ha	4413					
+Outcome in each year	Ha		500	500	500	500	500
+Subsequent total	Ha		4913	5413	5913	6413	6913
3. FWUC created	Ha	544					
+Outcome in each year	Ha		7	7	7	7	7
+Subsequent total	Ha		551	558	565	572	579

Source: *MOWRAM, Water Strategic Development Plan, 2019-2023*

c. Flood and drought management

- The MOWRAM has planned to protect sustain and expand protection over agricultural areas, public property, and national physical infrastructure over 139,156 ha during the period of 2019-2023:
- MOWRAM has a plan also to rescue rice paddy during drought and water shortages of over 90,000 ha annually between 2019 and 2023.
- In 2018, the total pumping stations were 31 stations, and the RGC has planned to build annually 5 pumping stations, increasing from 36 pumping stations in 2019 to 56 Stations in 2023.
- MOWRAM has planned to repair the pumping stations machines. Annually, 9 pumping stations will be repaired between 2019 and 2023. Annually 18 pumping machines will be repaired between 2019 and 2023 (Table 16).

Table 17. Flood and Drought management Plan 2019-2023.

Action Plan	Unit	2018 Baseline	2019 estimated	2020 Projected	2021 Projected	2022 Projected	2023 Projected
1. Flood prevention and alleviation	ha	139,156	Sustain and expand protection over agricultural area, public property and national physical infrastructure				
2. Sea water protection and alleviation	ha	21,043	Sustain and expand protection over agricultural area and all kind of crops				
3. Rescued rice paddy during the drought and water shortage	ha	93,287	90,000	90,000	90,000	90,000	90,000
4. Set up pumping stations	Place	31					
+Outcome in each year	Place	5	5	5	5	5	5
+Subsequent total	Place		36	41	46	51	56
5. Repaired Pumping Station	Place	9	9	9	9	9	9
6. Repaired pumping machine	Place	18	18	18	18	18	18
Source: MOWRAM, Water Strategic Development Plan, 2019-2023							

d. Water resources and meteorology information management.

In 2018, there were 44 hydrological stations across the country. MOWRAM has planned to:

- Build annually 17 stations between 2019 and 2023, increasing from 61 stations in 2019 to 129 stations in 2023.
- Annually 12 hydrological stations will be repaired between 2019 and 2023.
- Install hydrological stations, from 20 stations in 2019 to 24 stations in 2023.
- Set up meteorology—5 every years, increasing 70 meteorology in 2019 to 90 in 2023 (Table 17).

Table 18. Water resources and meteorology development 2019-2023.

Project	2018 Baseline	2019 estimated	2020 Projected	2021 Projected	2022 Projected	2023 Projected
1. Set up hydrological stations	44					
+ Outcomes in each year		17	17	17	17	17
+Subsequent total		61	78	95	112	129
2. Repaired hydrology station in each year		12	12	12	12	12
3. Install hydrological station water	19					
+Outcome in each year		1	1	1	1	1
+Subsequent total		20	21	22	23	24
4. Set up meteorology	65					
+Outcome each year		5	5	5	5	5
+Subsequent total		70	75	80	85	90
5. Prepared meteorological station in each year		12	12	12	12	12

Source: *MOWRAM, Water Strategic Development Plan, 2019-2023*

e. Water sustainability and conservation

MOWRAM will carry out the following activities:

- Strengthening and encouraging the enforcement of Water Resources Management Law and other related provisions to monitor and prevent all rehabilitation and construction projects which might have adverse impact on water resources and eco-systems.
- Maintaining water discharge and minimum water level in river, and lake for sustainable ecological systems and waterway transport.
- Prohibiting and taking urgent action to prevent the invasion of land filling or excavation or the invasion of water in rivers, lakes, ponds, and canals as well as regular inundated or coastal areas without any permission which in turn impacts water resources, eco-system and environment.
- Strengthening river basin and natural lake conservation which could store water to help reduce flood and maintain ecosystems.
- Preparing a sub-decree to define the geographical map of irrigation systems, and the reservoir to avoid possible invasion in irrigation system area.
- Focusing on efforts to prioritize the preservation of river basins and caves.

6.1.4. Budget

To implement successfully the Water Sector Strategic Development Plan (WSSDP) 2019-2023, MOWRAM needs a budget of USD 3,142,802,000. The RGC allocates USD471,790,000 from the National Budget to MOWRAM to implement the WSSP 2019-2023. MOWRAM needs additional USD2,671,014,000 from development partners in order for them to fully implement the WSSP 2019-2023. However, DPs have committed only USD2,414,860,000 to finance the implementation of the WSSP 2019-2023. MOWRAM needs to find additional funds of USD256,154,000 from other DPs.

Table 19. Budgets for Implementing the WSSDP 2019-2023.

Strategies	National Budget (USD)	Development Aids and DPs (USD)		Total Budget (USD)
		Contracted/Signed	Exploring	
1. Administration management improvement and human resources development.	47,793,000	32,620,000	1,338,000	80,751,000
2. Water resources management and development including irrigation hegemony implementation effectively and equitably.	371,277,000	2,022,995,000	46,466,000	244,073,8000
3. Flood and drought management	41,566,000	339,745,000	173,960,000	555,271,000
4. Water resources and meteorology information management.	7,240,000	500,000	7,960,000	15,700,000
5. Water sustainability and conservation.	4,914,000	19,000,000	26,430,000	50,344,000
Total	471,790,000	2,414,860,000	256,154,000	3,142,805,000

Source: *MOWRAM, Water Strategic Development Plan, 2019-2023*

6.2. National Irrigation and Water Resources Management Investment Program 2019-2033

MOWRAM is also making all efforts to secure effective and sustainable development through water managements and investment for agriculture and for other development. Cambodia has a total of 2,500 irrigation schemes countrywide that could irrigate 2.32 million ha, of which 1926 irrigation schemes are having the potentials for rehabilitation, of which 65% are located in the Mekong floodplains, 35% in the Tonle Sap floodplains. Most of the irrigation schemes in Tonle Sap floodplains do not have secured water sources and cannot provide a year round water for irrigation. They are effective to irrigate 2-3 crops a year. The maintenance of these schemes is one of key issue in the governance of irrigation schemes.

In Cambodia, the total irrigated land covers 1.5 million ha, of which one million ha is for the wet season rice and 0.5 million ha for the dry season rice. Since 2000, RGC has heavily invested in rehabilitating the irrigation schemes with a total budget of USD 1.3 billion, 80% of this fund came from the Development Partners (DPs) and 20% from a national budget. These investments cover 467,000 ha of irrigated land–327,000 ha of the wet season rice and 140,000ha of dry season rice. The effectiveness of the investments in irrigation schemes has not been assessed entirely.

However, the irrigation investment up until 2019 has been focused on the main irrigation canals, but not on the comprehensive irrigation system. The technical quality of the construction and irrigation system remain weak and lack of national standards in terms of quality. The operation and management of the system remain weak. The establishment of FWUC has been undertaken in many irrigation schemes, but faced legal limitations. Capacities of staff of MOWRAM in irrigation, hydrology, and water management are limited. There are about 1,250 staff, about half are based in 25 Provincial Departments of Water Resources and Meteorology (PDOWRAMs). The annual national budgets for MOWRAM is USD 35 million for rehabilitating the irrigation schemes, USD 15 million for the operation and management of the irrigation schemes and USD 0.5 million for the establishment of FWUCs. The annual budget allocation to MOWRAM has been small and limited in addressing the management, rehabilitation and construction of the irrigation schemes. Seeing the needs of improving water management and irrigation development for agriculture, MOWRAM has developed the National Irrigation and Water Resources Management Investment Program (NIWRMIP) 2019-2033.

The Road Map for the irrigation development and investment has been established to support MOWRAM in modernizing the water resources management and irrigation development in Cambodia. The Road Map and Investment Program are developed based on the flexible strategies in responding to the needs in the changing contexts of the program implementation. The Visions and Goals of the Road Map and Investment Program are established to support the construction of irrigation schemes with highly adaptive capacity, resilience and high returns, which could be adapted to the changing markets and climate change and finally create trust and attract foreign investors to invest in Cambodia. Six specific objectives of the Road Map and the Investment Program:

1. To high quality irrigation schemes which functions comprehensively.

2. To establish self-sustained FWUCs which contribute the fees for the uses of the irrigation schemes at least 95%.
3. To establish the National Water Information Center that contains the water resources database for the entire country and water analysis infrastructure including technical training center.
4. To establish the National Weather Forecast and Flood Center which will function comprehensively to provide a national flood warning to public.
5. To develop the hydrological and meteorological monitoring system which will be completely functioned; and
6. To develop the sub-river basin managements, which define the water allocation procedures for 5-10 sub-river basins around Tonle Sap Lake.

The Road Map and the Investment Program for Irrigation Development 2019-2023 focus on four main areas:

1. Secure water supply
2. Fully functional irrigation schemes
3. Sustainable Operation and management of irrigation schemes
4. Profitable irrigated agriculture

Table 20. The Road map and investment program area 2019-2023.

Areas	MOWRAM Strategic Plan 2019-2023	Investment Program 2019-2023
1. Secure Water Supply	• Strengthening hydro-met network; water balance assessments, drought and flood forecasting and addressing climate change	• Automatic hydro-met monitoring network covering 80% of the country. • Water analytical analysis, covering 32 river basin. • National –wide climate and flood forecasting system in place.
2. Complete fully functional irrigation schemes	• 30,000ha of rice per year to reach 2 million ha of irrigation command area by 2023. • Prioritize pumping interventions to support dry season cropping	• Additional 705,000ha command area and 1,375,000ha of irrigated area. • All existing medium & large pumping schemes in Mekong Delta (above 60% conditions) fully functional.
3. Sustainable Operation and Management (O&M)	• Support FWUCs to establish sustainable O&M to reduce pressure on state expenditure	• Approximately 250 self-sufficient FWUCs.
4. Enabling Environment	• Sub-decree to support Water Law • Strengthening MOWRAM/PDOWRAM planning and budgeting system. • Gender mainstreaming • Training of up to 250 MOWRAM staff	• Endorsed Sub-decree • Minimum 10 Senior hydrologist • Minimum 10 operational PDOWRAM • Quality service provider industry established to support sustainable irrigation and water resources management

Outputs:

The Road Map and Investment Program has planned to produce the following key outputs:

a. Secure water supply

1. The networks of hydrological and meteorological monitoring stations will be established throughout the country.
   These include:
   - 90 hydrological stations,
   - 51 meteorology stations,
   - 99 auto-water quality control stations and
   - 410 ground water control stations across the country
2. The River Basin Management Plans of 25 River Basins will be developed, equipped early warning system and auto-record of data system.
3. The Water Resource Center will be established with Flood Focus Center in MOWRAM

b. Fully functional irrigation schemes

1. Rehabilitation of existing 466 irrigation schemes and 4 newly built irrigation schemes.
2. Setting up the Maintenance System of the irrigation schemes.
3. Establishing the guidelines of integrated water management.

c. Sustainable Operation and management

1. Support to PDOWRAMs and FWUCs to establish the system to manage and operate system, including the self-financial management system, conflict resolution system and responses to external pressures.
2. Rehabilitation of small and medium-scale irrigation schemes for 3 years periods in order to support FUWCs after the large-scheme construction completed.

d. Profitable irrigated agriculture

Establish the guideline for integrated water resources management based on the NRM Policy, the planning tools and networks of hydrological and meteorological monitoring system, water analysis infrastructure and the M&E system set up from the design of the plan, the construction of irrigation schemes, and the operation and management.

To achieve these targets, prioritization of investment in irrigation systems by focusing on linkages with agricultural production areas together with regular maintenance and reinforced management of these systems. Maintaining the efforts to promote a vibrant rural development with additional investment in rural roads, small-scale irrigation systems, expansion of electricity supply coverage and access to clean water, sanitation upgrading, and improving people's livelihood through the "One Village-One Product Movement" and "New Village Movement".

Budget

The IIPWM (2019-2033) takes 15 years to implement the full program. The IIPWM will cost USD 2.64 billion. It will rely on loans and grants from DPs. ADB, WB, and European Banks have expressed in providing loans to finance this investment. MOWRAM has approached other DPs to explore funding support for this investment program.

6.3. Challenges and Opportunities

The policy road maps of MOWRAM on water development and management is developed based on water policy and legal framework with a total cost of USD 2.64 billion over 10 years period. It is a heavy investment program of MOWRAM to rehabilitate the irrigation system across Cambodia. The investment program has limited inputs from other concerned ministries and relevant stakeholders, particularly MAFF, MRD, MoE, MIME and provincial government.

The governance of water has been challenged by weak coordination and overlapping roles of ministries related to water management and it is more concerned with economic growth than the environment, and its governance. Despite the integrated water resource management approach taken, insufficient cooperation takes place among the different ministries and even between different departments within a given ministry. Moreover, even though the MoWRAM is in overall charge of water management and conservation issues, intra-ministerial coordination is weak, meaning there is room for improvement in terms of its management capacity. Data related to water collected by individual ministries should be passed to and be accessible through the MoWRAM, with a master dataset openly available to all the ministries

The MOWRAM's Investment Program (2019-2033) aims at rehabilitating 2525 irrigation schemes. These schemes mostly are large-scale. Many large-scale irrigation schemes have been rehabilitated, but suffered from dysfunctional due to lack of water during the dry seasons. A common cause of operational problems in irrigation schemes is the way they are designed and/or constructed. Most schemes were not designed to cope in a context of increasing water scarcity in the dry season and with double-cropping becoming more common; most schemes were originally designed and built to provide wet-season supplementary irrigation only. As a result, these schemes do not retain enough water during the wet season for use later in the dry season. Flawed designs in relation to hydrological and geographical realities have also contributed to several existing schemes falling into disrepair, with failure already built into the design and/or occurring during construction. A more investment in rehabilitating the remaining large-scale irrigation schemes would add more concerns in term of effectiveness and efficiency of the investment.

There is a lack of participation of civil societies and NGOs in the designing and development of irrigation schemes. The construction and building of irrigation schemes do not respond to the needs of local communities. As they are small holders, many farmers benefit poorly from large-scale irrigation schemes, and instead they keep relying on rainfalls for their rice farming.

Climate change has altered water regimes in the irrigation canals. Many built irrigation schemes suffer from lack of waters. For these reasons, farmers do not depend on water from the irrigation canal to irrigate their rice. Instead, they continue to use rainfalls to water their small farmers. In some provinces, farmers migrates to cities and oversea for non-farm jobs and they left their rice fields uncultivated.

At present, investment in large-scale irrigation schemes in the Cambodian water sector depends heavily on international donors such as the World Bank, the Asian Development Bank (ADB), the IMF and various UN agencies. Bilateral donors such as the European Union, France (through the AFD), Italy, Japan (through JICA) and Australia, South Korea (through KOICA), Kuwait, Qatar, China and India also make significant contributions to the water management sector in Cambodia. This donor funding is often used to build "hard" infrastructure such as physical irrigation works, and to conduct extension programs. Furthermore, under the new MOWRAM's investment program (2019-2033), Cambodia has limited financial resources. It will rely more on development partners and bilateral donors such as ADB, World Bank, European Investment Bank (EIB), AFD, China, Korea, Japan, etc. The degree of coordination between donors in irrigation investment in Cambodia remain critical. MOWRAM is meddling between donors who has soft and less conditions for the loans.

7. Conclusion and Recommendations

7.1. Conclusion

Cambodia has abundant water resources due to its geographies and the existence of 39 river basin systems. These rich natural resources are essential assets for the country. However, Cambodia has experienced too-much water in the wet season and too little water in the dry season. Floods and droughts have undermined the development of Cambodia. Thus, improved water management is key to the development of Cambodia in the long run.

The increased developments of infrastructures, irrigations, and hydropower powers in the Mekong region by riparian states including China, Thailand, Vietnam, and Laos have affected the Mekong River System and have altered the hydrological regimes of the Mekong River. These developments have further affected the flows and the volumes of water in Cambodia, particularly in Tonle Sap Lake. These developments have been driven by national interests, power relations, the geography of riparian states, and upstream and downstream politics. Furthermore, the rise of China has transformed the Mekong region into more regional cooperation frameworks such as MRC, GMS, and LMC. The US has concerned about the rise of China in the Mekong Region and scaled up its programs.

Climate change has further complicated the hydrological regimes of the Mekong River and also in Cambodia. It has made the flooding caused by hydropower operations more server and destructive. The drought will be served downstream by hydropower operation and climate change. Both floods and droughts have caused the destruction of agricultural produces and also damaged the roads, infrastructures, livelihoods, and environment. Cambodia has limited institutional capacities and resources, both finance and human, to address the climate change impacts.

RGC is aware of these developments and the threats to the country as a downstream state in the Mekong, and so, has developed the policy, strategies, and priorities to cope with these changes and to sustain economic growth and sustainable development through improving water management and to graduate to a middle-income country in 2030. The improved water management would reduce the impacts of flooding and droughts on the economy, agriculture, and development of infrastructure. Agriculture has been identified as the key economic engine of the country and is worth investing.

Water management has been centered on the governance of irrigation developments and river basin management. The irrigation scheme is built to take water from the river basin to irrigate agricultural lands around the river basins. However, water governance in Cambodia remains centralized and MOWRAM drives the agenda. Other ministries have also vest interests in water and thus, have been mandated to manage the water for the developments of the sector, e.g MAFF, and MIME for energy development. Coordination between concerned ministries is not strong and is dominated by MOWRAM.

Nonetheless, in improving water management, Cambodia would need to build some infrastructure. Cambodia would need to build water supply systems such as rural water wells to supply water to the rural population to reach 100% in 2025. Cambodia will rehabilitate existing 466 irrigation schemes and 4 newly built irrigation schemes between 2019 and 2033. Furthermore, the RGC has commissioned over 400 MW of utility-scale solar energy, representing 15% of our energy mix, to supply solar power to the national grid. This is a new commitment to future energy development in Cambodia. This does not mean that Cambodia will not build hydropower dams in the Mekong Region, not in the mainstream river.

7.2. Recommendations

Based on the results of the study, it recommends the following:

1. The ICT in river basin management is still at the infant stage. Thus, mainstreaming the ICT into river basin water management is key to future water governance in Cambodia. The Korean Government has supported the ICT in Cambodia and should continue to provide these supports in river basin water governance.
2. Water governance is key to the development of Cambodia. At the national level, strong coordination between key ministries is needed, particularly between MAFF, MOWRAM, MRD, and MoE. At the regional level, Cambodia would need to strengthen its water diplomacy in regional cooperation in order to ensure that Cambodian interests are well addressed and reduced impacts on Cambodia.
3. Water governance has been centered on irrigation management. Since 2000, USD1.30 billion has been invested in irrigation development, 80% funded by donors. Its effectiveness has not been assessed and thus, donors should support the RGC to assess its funding in irrigation development before they further provide funding to support the Irrigation Investment Program 2019-2033.
4. The Korean Government may find interested in funding the irrigation projects in the Irrigation Investment Program 2019-2033 of MOWRAM.
5. Water governance in Cambodia has been centralized and its impacts have been localized, in which, local communities have been affected by changing hydrological regimes in the Mekong River. Concerted efforts should be promoted to encourage local communities' participation in transboundary water governance.

List of figures

List of tables

Reference

ADB. 2021. Surface Water Resources Assessment of the Tonle Sap and Mekong Delta River Basin Groups: Improving Climate Resilience, Productivity, and Sustainability. ADB Brief, No. 171. March 2021. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.adb.org/sites/default/files/publication/689106/adb-brief-171-surface-water-resouces-rbgs-cambodia.pdf.

ADB.2020. Greater Mekong Subregion Mid-Term Review and Revised Regional Investment Framework Implementation Plan 2020, available at https://www.adb.org/documents/gms-midterm-review-revised-rif-ip-2020?6018C8AD-3C25-9F43-9004-74E94BD09237_kis_cup_C6FA3ED5_6D17_47D1_B6E2_F4B02CC905E0, accessed on 05 January 2020.

ADB. 2018. *Greater Mekong Sub-region Economic Cooperation Program: Overview of the Regional Investment Framework 2022*. Manila: ADB 2018, pp. 29.

ADB. 2015. *Viet Nam: Energy Sector Assessment, Strategy and Road Map.* Mandaluyong City, Manila: ADB 2015, pp.1-52.

ADB (Asian Development Bank). 2010. *Strategy and Action Plan for the Greater Mekong Subregion Southern Economic Corridor.* Manila: ADB.

ADB.2010a. *Final Report: TA6367 Sesan, SrePok, and Sekong River Basins Development Study in Kingdom of Cambodia, Lao People's Democratic Republic, and Socialist Republic of Vietnam*. Manila: ADB 2010, pp.67

ADB. 2005. *Tonle Sap and its fisheries: Future solutions now*. The Tonle Sap Initiative; Asian Development Bank, Manila, Philippines.

ADB. 2004. *The GMS Beyond Borders: Regional Cooperation Strategies and Program 2004-2008*. Manila: ADB 2004, pp.84.

ADB. 2000. *The Greater Mekong Subregion Economic Cooperation Program. GMS Assistance Plan (2001-2003).* Manila: ADB 2000, pp.65.

Arief A. Yusuf, Herminia A. Francisco. 2009. Mapping Analysis. *Climate Change Vulnerability Mapping for Southeast Asia*. EEPSEA. 2009. Accessed 5 May 2015. http://www.eepsea.org/pub/tr/12324196651Mapping_Report.pdf.

Anthony, Jude. Greater Mekong Subregion (GMS) market coordination. Asian Development Bank. Accessed 5 September 2022. https://www.iea.org/reports/southeast-asia-energy-outlook-2013.

Baird, I. 2016. Non-government Organizations, Villagers, Political Culture and the Lower Sesan 2 Dam in Northeastern Cambodia. *Critical Asian Studies,* 48(2), (2016), pp. 257-277.

Baran, E.; Samadee, S.; Shwu Jiau, T. and Thanh Cong, T. 2013. *Fish And Fisheries in the Sekong, Sesan and Srepok Basins (3s Rivers, Mekong Watershed), with Special Reference to the Sesan River.* Project report: Challenge Program on Water & Food Mekong project MK3 "Optimizing the management of a cascade of reservoirs at the catchment level". ICEM: Hanoi, Vietnam.

Biba, S. 2016. From securitization moves to positive outcomes: The case of the spring 2010 Mekong crisis. https://doi.org/10.1177/0967010616657795.

Cambodia Constructors Association. 2019. 150 MW Coal-Fired Power Plant in Sihanoukville Nearing Completion. 19 March 2019. https://www.construction-property.com/read-news-1709/ Accessed 30 July 2022.

Cambodia Constructors Association. 2019. *Government to construct $160 million hydro-power plant in Pursat province*, 13 February 2019. https://www.construction-property.com/read-news-1646/.

Cambodia National Mekong Committee. 2003. *National Sector Review 2003: Hydropower*. MIME, June 2003.

Center for Agriculture Development Study (CEDAC). *Inventory of Irrigation Schemes and Famer Water User Communities in Cambodia*; CEDAC and Water Program; Center for Agriculture Development Study: Phnom Penh, Cambodia, 2009.

Chu Ta-Wei. 2017. Riparians versus the State in Southeast Asia. *Asian Survey, 57(6):*1086–1109. doi:10.1525/as.2017.57.6.1086.

Constable, D. (2015). *Atlas of the 3S Basins*. Bangkok: IUCN.

Construction Property. 2018. Hydro Power Lower Sesan II dam inaugurated. 17 December 2018. https://www.construction-property.com/read-news-1549/ Accessed 28 June 2022.

Council for Development of Cambodia. 2022. Cost of Doing Business: Utility Cost. Accessed 30 August 2022. http://www.cambodiainvestment.gov.kh/investment-enviroment/cost-of-doing-business/utility-cost.html.

Danielle Tan, 2014. *China in Laos: Is there cause for worry?* Singapore: Institute of Southeast Asian Studies, 2014), pp.1-16.

Department of Climate Change. 2018. *Cambodia Climate Change Strategic Plan (2014-2023).* http://www.camclimate.org.kh/en/policies/ncsd-news/445-445.html Accessed 30 June 2018.

Electricity Authority of Cambodia. 2018. Salient Features of Power Development in Kingdom of Cambodia. Consolidated Report for the year 2018. https://eac.gov.kh/uploads/salient_feature/english/salient_feature_2018_en.pdf Accessed 21 April 2022.

Electricity Authority of Cambodia. 2016. Report on power sector for the year 2014. http://eac.gov.kh/wp-content/uploads/2015/07/report-2014en.pdf.

Frauke Urban; Giuseppina Siciliano and Johan Nordensvard, ' China's dam-builders: their role in transboundary river management in South-East Asia. *International Journal of Water Resources Development*, 34 (5), (2018), pp. 747-770.

FAO. 2022. FAO Database. Available online: http://www.fao.org/nr/water/aquastat/data/query/results.html (accessed on 16 July 2022).

German Watch. 2016. Briefing Paper Global Climate Risk Index 2016: Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2014 and 1995 to 2014. https://germanwatch.org/sites/germanwatch.org/files/publication/13503.pdf Accessed 20 July 2022.

George Radosevich & Douglas Olson. 1999. *Existing and Emerging Basin Arrangements in Asia: Mekong River Commission Case Study, (*Washington, DC: World Bank, 1999), available at http://siteresources.worldbank.org/INTWRD/918599-1112615943168/20431963/MekgongRiverComCaseStudy.pdf, Accessed on 12 September 2022.

Grundy-Warr Carl. 2016. 'B/ordering nature and biophysical geopolitics: A response to Hirsch,' *Political Geography*, 58, (2016), pp. 131-135;

Halcrow and Partners. 1999. *Sekong, Se San and Nam Theun River Basins Hydropower Development Study: Final Report*. Manila: Asian Development Bank 1999.

Han, H. 2017. China, an Upstream Hegemon: A Destabilizer for the Governance of the Mekong River? *Pacific Focus*, 32 (1), 30–55.

Hiroshi Hori. 2000. *The Mekong: Environment and Development* (Tokyo: United Nations University Press 2000), pp. 424; Joakim Ojendal, 'Sharing the Good: Mode of Managing Water Resources in the Lower Mekong River Basin' (PhD Diss., Goteborg University 2000).

Hirsch, P. 2016. The Shifting Regional Geopolitics of Mekong Dam. Political Geography, 63-74.

Hong Liu and Guanie Lim. 2019. The Political Economy of a Rising China in Southeast Asia: Malaysia's Response to the Belt and Road Initiative. *Journal of Contemporary China, 28(116), (2019), pp.216-231,* https://doi.org/10.1080/10670564.2018.1511393;

IPCC. 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Lamb, V & Dao, N. 2017. Perceptions and practices of investment: China's hydropower investments in Vietnam and Myanmar, Journal Canadian Journal of Development Studies / Revue canadienne d'études du développement, 38(3), (2017), pp. 395-413.

Letter from MIME to Royal Group, dated 04 March 2022, informing about the decision of RGC to not build the Sambo and Stung Treng Dam.

Lieng Vuthy. 2013. Cambodia country report in Kimura, S. (ed.) "Analysis on energy saving potential in East Asia, ERIA research project report 2012-19", pp.99-113. ERIA. Accessed 5 September 2022. www.eria.org/RPR_FY2012_No.19_chapter_4.pdf.

Matthews, N. & Motta, S.2015. 'Chinese State-Owned Enterprise Investment in Mekong Hydropower: Political and Economic Drivers and Their Implications across the Water, Energy, Food Nexus', *Water*, 7 (11), (2015), pp. 6269-6284.

May Kunmakara, 2017. Toshba to build power plant. *Khmer Times*, 28 February 2017.

Middleton, C. 2008. *Cambodia's Hydropower Development and China's Involvement*. Phnom Penh: Rivers Coalition in Cambodia 2008), pp. 1-60.

Ministry of Environment (MoE). *Vulnerability Adaptation Report*; Ministry of Environment: Phnom Penh, Cambodia, 2016. Available online: https://ppcrcambodia.files.wordpress.com/2013/02/vulnerability-adaptation-report_moe-comments_20130121.pdf.

Ministry of Mines and Energy (MIME) Letter dated 04 March 2022 to Okha Kith Meng, Director of China (Cambodia) Rich Investment Co., Ltd., about the feasibility studies of the Sambo and Strung Treng Dams.

Ministry of Mines and Energy. 2013. "National policy, strategy and action plan on energy efficiency in Cambodia." Accessed 13 October 2015. https://data.opendevelopmentcambodia.net/laws_record/national-policy-strategy-and-action-plan-on-energy-efficiency-in-cambodia.

Ministry of Planning (MoP). 2020. Population Census 2020. NIS, Cambodia.

Ministry of Public Work and Transport (MPWT). 1998. ANUKRET (Sub-decree) on the Organization and Functioning of the Ministry of Public Works and Transport. Available online: file:///C:/Users/Sithirith%20Mak/Downloads/3559b32d-ca6a-4a18-b361-d40fc1fb782a%20(2).pdf. Accessed on 25 July 2022.

Ministry of Water Resources and Meteorology (MOWRAM). 2015. *Sub-Decree on the Establishment and Dissolving of FWUC*; Ministry of Water Resources and Meteorology: Phnom Penh, Cambodia, 2015.

MOWRAM & JICA. 2019. Guideline for Establishing and Operating River Basin Management Committee (RBMC). The Project for River Basin Water Resources Utilization (RBWRU).

MOWRAM. 2017. Cambodian Information System on Irrigation Schemes (CISIS) Database (May 2017).

MOWRAM. 2007. Water Law. Kingdom of Cambodia.

MOWRAM. 2005. Water Policy. Kingdom of Cambodia.

Nang, P.; Khiev, D.; Hirsch, P.; Whitehead, I. *Improving the Governance of Water Resources in Cambodia: A Stakeholder Analysis—Understanding Stakeholders' Roles, Perceptions and Constraints for Effective Irrigation and Catchment Management and Development*; Working Paper Series No. 54; Cambodia Development Research Institute: Phnom Penh, Cambodia, 2011.

Ojendal, J.; Mathur, V. & and Sithirith, M. 2002. *Environmental Governance in the Lower Mekong*, pp.1-72.

Olivier Hensengert. 2017. Regionalism, Identity, and Hydropower Dams: The Chinese-Built Lower Sesan 2. Dam in Cambodia. *Journal of Current Chinese Affairs*, *46*(3), (2017), pp.85-118. https://nbn-resolving.org/urn:nbn:de:gbv:18-4-11097.

Piman, T.; Cochrane, T.A.; Arias, M.E.; Green, A.; Dat, N.D. 2013. Assessment of Flow Changes from Hydropower Development and Operations in Sekong, Sesan, and Srepok Rivers of the Mekong Basin. *J. Water Resour. Plan. Manag*. 2013, *139,* 723–732.

Ptak, T. 2016. Considering Multiple Chinas in the Shifting Regional Geography of Mekong River Dams. *Political Geography*, 58, (2016), pp.1-3. Doi: 10.1016/j.polgeo.2016.09.007.

Royal Government of Cambodia (RGC). 2021. National Statement by H.E SAY Samal, Minister of Environment, at the United Nations Climate Change Conference COP 26/ CMP 16/CMA 3 Glasgow, UK, November 2021.

RGC. 2019. *Cambodia: National Report on Istanbul Program of Action 2011-2020*. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.un.org/ldc5/sites/www.un.org.ldc5/files/cambodia_ldcs_country_national_report_on_istanbul_program_of_action_2019_9nov2019_1.pdf.

Royal Government of Cambodia (RGC). 2019. *Rectangular Strategy (RS) Phase IV*. The Council for Development of Cambodia: Phnom Penh, Cambodia.

Royal Government of Cambodia (RGC). 2019. *National Strategic Development Plan (NSDP) 2019-2023*. Phnom Penh, Cambodia.

Royal Government of Cambodia (RGC).1999. *Sub-decree on the organization and functioning of the ministry of industry, mines and energy*. Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://portal.mrcmekong.org/assets/v1/documents/Cambodian-Law/Sub-decree-on-Organization-and-Functions-of-MIME-(1999).pdf.

Royal Government of Cambodia (RGC). 2019. *Cambodia Sustainable Development Goals (CSDGs) Framework 2016-2030*. Phnom Penh, Cambodia.

Royal Government of Cambodia. 2013. *Rectangular Strategies Phase III*. The Council for Development of Cambodia: Phnom Penh, Cambodia, 2013.

Sithirith, M. 2016. Dams and State Security: Damming the 3S Rivers as a Threat to Cambodian State Security. *Asia Pacific Viewpoint* 57(1), 60–75.

Sithirith, M. 2015. *Transboundary Cooperation between Cambodia and Vietnam: Integrated Water Resources Management in the Mekong Delta*; Consultancy Report; Cambodia National Mekong Committee: Phnom Penh, Cambodia, 2015; p. 56.

Sunchindah, A. 2005. *Water Diplomacy in the Lancang-Mekong River Basin: Prospects and Challenges.* Paper presented at the Workshop on the Growing Integration of Greater Mekong Sub-regional ASEAN States in Asian Region (Yangon: ASEAN 2005);

The Cambodia Herald.2020. Hun Sen says all villages to have electricity by 2020. 20 February 2013. Accessed 25 August 2022. www.thecambodiaherald.com/cambodia/hun-sen-says-all-villages-to-have-electricity-by-2020-3449.

The Nation. 2016. *Water Diplomacy by China Offers Drought Relief, March 18th, 2016,* The Nation, Asia News Network. www.nationmultimedia.com/news/national/aec/30281969.

World Bank. 2018. *Cambodia beyond connections*. Energy access diagnostic report. Washington DC. http://documents.worldbank.org/curated/en/141011521693254478/Cambodia-Beyond-connections-energy-access-diagnostic-report-based-on-the-multi-tier-framework.

Ziv, G., Baran, E., Nam, S., Rodríguez-Iturbe, I., & Levin, S. A. 2012. Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences*, *109* (15), 5609-5614.

Authors

Mak Sithirith, Sok Sao and Sanjiv De Silva.

Citation

This publication should be cited as: Sithirith M, Sao S and Silva SD. 2024. Legal and institutional Analysis of Water Resource Management and Development in Cambodia. Penang, Malaysia: WorldFish. Technical Report.

Acknowledgments

Funding support for this study was provided through CGIAR Initiative on Asian Mega-Deltas. This work was carried out with support from the CGIAR Asian Mega-Deltas (AMD) and Aquatic Foods (RAqFs) Initiatives. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund: *www.cgiar.org/funders*.

Design and production

Chua Seong Lee, Thavamaler Ramanathan and Sabrina Chong, WorldFish.

Photo credits

Front cover, Sean Vichet/WorldFish.

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. *www.cgiar.org*

To learn more about this Initiative, please visit *https://www.cgiar.org/initiative/asian-mega-deltas/*.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit *www.cgiar.org/cgiar-portfolio*

WorldFish

IWMI International Water Management Institute

CGIAR INITIATIVE ON Aquatic Foods

CGIAR INITIATIVE ON Asian Mega-Deltas