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Kampong Bay, Cambodia - the climate perspective in water-related development

by

Yem Dararath

Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia

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Contributions are most welcome - in English or in Bahasa Indonesia.

The author:

Yem Dararath, Research Manager, Natural Resources and the Environment,
Cambodian Development Resource Institute (CDRI)
dararath@cdri.forum.org.kh, dararath@online.com.kh

CRBOM
Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org
info@crbom.org

Contents

Acknowledgement

This paper builds on a case study of resource-based development opportunities in Kampong Bay River Basin, Cambodia, conducted in 2007 for Ministry of Environment under the project *'Environmental Management in the Coastal Zone (EMCZ)'* with support from Danida.

Summary

The climate vulnerability of Kampong Bay Basin is related to (i) increased rainfall irregularities (which will affect the flood risk in the entire basin, and possibly incur a drought risk that is not imminent today); (ii) increased frequency and height of storm surges in the sea (which will in turn influence the flood risk in the downstream parts of the basin); and (iii) an increased mean sea level (which will enhance the salinity intrusion).

A functional climate proofing must encompass adaptation of water management, land use, infrastructure, and production systems. Due to the diverse interactions and potential synergies, benefits can be assured by a holistic, inter-agency and multi-sector approach.

One key observation is that most viable climate proofing measures tend to be *'safe'*, as far as they serve several good purposes at the same time. They will remain feasible even if the climate does not change in the way that is presently expected.

Acronyms and abbreviations

IWRM:	Integrated water resources management
MAFF:	Ministry of Agriculture, Forestry and Fisheries (Cambodia)
MOE:	Ministry of Environment (Cambodia)
MOWRAM:	Ministry of Water Resources and Meteorology (Cambodia)

Glossary

Efficiency improvement: The over-all water efficiency is the production per unit of water. The distribution efficiency is the ration between water supplied and raw water withdrawn. Improvement of water efficiency comprises reduction of any unnecessary losses and waste (during storage, distribution or consumption). This can be achieved (for example) by appropriate operation and maintenance (and rehabilitation if required), and/or by introduction of new technology in agriculture and industry. The economic efficiency is the value generated per unit of water

IWRM (integrated water resources management) (as defined by Global Water Partnership): A process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

Saline intrusion (or salinity intrusion) in a river: Inflow of (saline) sea water in low-lying, downstream parts of a river, driven by the density surplus of the sea water relative to freshwater, and further determined by the sea water level, the river bed level and the (net) outflow of the river. Often, the saline inflow takes place in a well-defined bottom layer called a salt water wedge. Saline intrusion occurs when the densimetric Froude's number is less than one

1 Introduction

Kampong Bay river basin is in many ways typical for SE Asia. It features a highly seasonal (and somewhat erratic) rainfall; it has agriculture as a predominant livelihood; and incomes are generally low (or even extremely low). On the other hand, there is an attractive potential for agricultural development, while development of the industry and service sectors is in full swing: Reclamation for industries is taking place around the river mouth, the transport infrastructure is being upgraded, a large hydropower plant is under construction, and tourism is escalating.

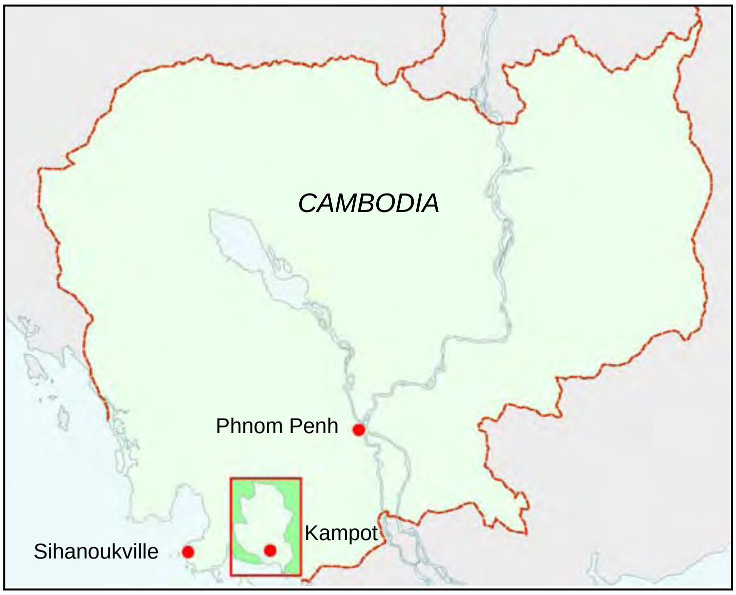
The present paper presents findings of a recent pilot study of water-related development conducted by Ministry of Environment (2007). It has been compiled as a greeting to the new Indonesian *'Center for River Basin Organizations and Management'.*

2 The Kampong Bay Basin

Population and land use

The population of Kampong Bay river basin is around 149,000 persons, or around one percent of the national population. The basin covers an area of 2,443 km2. Most of the basin - 92 percent - is located in Kampot province.

Figure x: Location map



The basin includes a large part of the 1,400 km2 Bokor National Park (with rare mammal and plant species)[1]; the 180 MW Kamchay hydropower plant with its 3 mio m3 reservoir (under construction), rapid infrastructural development; and a comprehensive physical (and economic) development of the coastal zone. The area around the river mouth is exposed to (manmade and natural) morphological changes, including dredging and reclamation.

Cultivation

Low-yield rainfed paddy cultivation is the traditional livelihood. Most of the cultivation is rainfed. The rice yield is 1.4-1.7 2 t/ha (2005 data), which is low by national as well as SE Asian standard. The combination of one crop per year, low yield, and small land holdings indicates a meagre income from paddy cultivation. Furthermore, the farmers may be under-paid for their crops.

Water uses

The main town, Kampot, is exposed to regular floods in the wet season, while in the dry season, saline intrusion threatens its water supply (and impedes irrigated agriculture in the basin).

In-stream (or non-consumptive) water uses include navigation, fisheries, tourism, and aquatic habitat preservation.

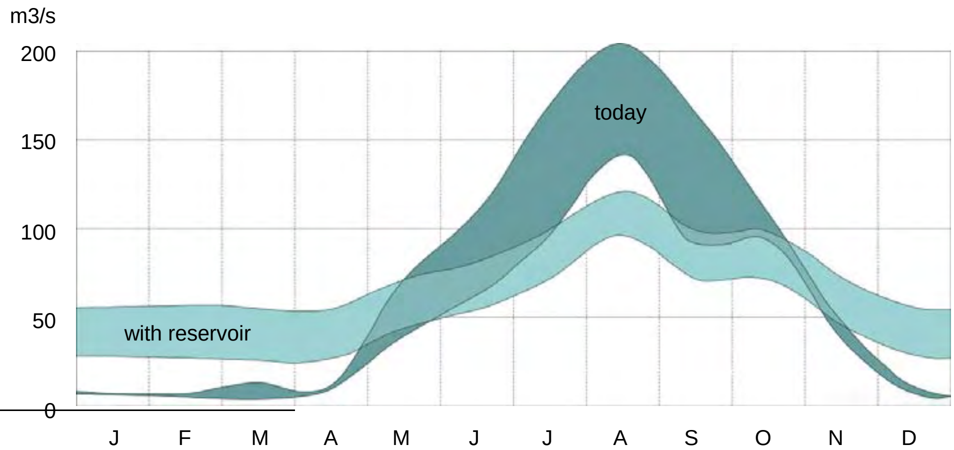
Off-stream (or consumptive) water uses include domestic supplies; consumption by industry and services; irrigated agriculture; and livestock.

Water availability

The average annual rainfall is 1,770 mm/year, with a significant variation from year to year (a factor 2), within the basin (a factor 2), and from one season to another (a factor of around 30 for monthly average rainfall).

In the near future, the water balance of the basin will change, due to the storage reservoir of the Kamchay hydropower plant (presently under construction). The changes - illustrated below - are quite visible, as it would be expected, considering the reservoir volume and the size of its catchment area (32 percent of the basin). The changes are estimated to an additional flow at Kampot town of somewhere between 17 and 41 m3/s from December to April. If so desired, the additional flow in the dry season can be used for a variety of off-stream and/or in-stream uses.

Figure x: Flow at Kampot town today and with the Kamchay reservoir



[1] The park has 29 mammal species, 9 of which are critically endangered worldwide

The intervals illustrate high and low estimates of the flow in a normal year on a monthly basis. Values are uncertain estimates based on rough assumptions about operation and active storage

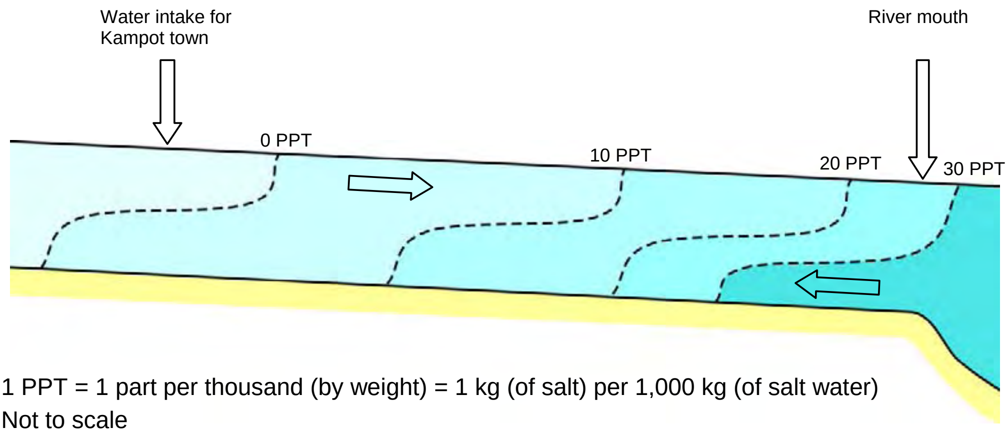
The additional evaporation from the reservoir is estimated at around 0.3-0.6 m3/s on the average. In comparison, this is somewhere around 10-20 percent of the present dry season flow at the reservoir, or some 1-2 percent of the future (augmented) flow.

Saline intrusion

Evidence of *'clear and present danger'* has been provided by Kampot Waterworks, observing that (diluted) salt water from the sea reached its intake in April-May in 2004 and 2005. The intake is located 8 km upstream of Kampot town, so a considerable part of the river must have been affected.

The salinity intrusion will increase in case of dredging, sand extraction, and if the dry season flow is reduced (for example during construction of the Kamchay dam or during filling of its reservoir). It will decrease if the dry season flow becomes higher than today (for example during routine operation of the Kamchay reservoir).

Figure x: Salinity distribution in the lower part of the river



1 PPT = 1 part per thousand (by weight) = 1 kg (of salt) per 1,000 kg (of salt water)
Not to scale

3 Climate change effects and vulnerabilities

An enhanced climate variability can comprise

(i) increased rainfall irregularities (which will affect the flood risk in the entire basin, and possibly incur a drought risk that is not imminent today);

(ii) increased frequency and height of storm surges in the sea (which will in turn influence the flood risk in the downstream parts of the basin); and

(iii) an increased mean sea level (which will increase the flood risk and the flood exposure, as well as the saline intrusion into the basin.

The climate change effects are expected to materialise as *increased exposure to existing risks,* the one exception being a new risk of drought (which, unlike many other Cambodian river basins, is not regarded as an issue today). Therefore, clear assumptions can be made about the cause-effect relationships and the potential vulnerabilities.

In comparison, the actual *magnitude of impacts* is uncertain - for example regarding rainfall irregularities or sea level rise. Also, the impacts are highly influenced by interaction between the different processes - one can enhance or reduce the effects of another.

The changes will take place on a complex background of human intervention and natural developments that are unrelated to climate change. Construction of the new reservoir is expected to visibly enhance the dry season flow and reduce the wet season flow in the lower parts of the basin, including the river mouth.

Changed land use is a part of the picture: Reclamation around the river mouth can increase the flood risk while, at the same time, reduce the saline intrusion. Siltation can generate similar effects, while sand extraction and deepening of waterways can generate opposite effects.

A related risk to watch out for is land subsidence due to groundwater utilization. While not an issue today, the ongoing industrial development around the river mouth may and may not generate a new demand of groundwater, which may, in turn, cause a land subsidence that can increase the vulnerability to floods, unless due precautions are taken.

4 Water-related development

4.1 General

The agenda for social and economic development changes with time, sometimes gradually and sometimes stepwise. In Kampong Bay river basin, the changes are rapid. The Kamchay reservoir will re-allocate a large volume of water from the wet to the dry season, whereby the water availability downstream of the reservoir will increase significantly. Another important aspect is the planned upgrading of the railway, which will support trade, manufacturing and tourism. This change is likely to interact positively with the ongoing development towards lower cross-border trade barriers. Escalating tourism, including a projected dramatic increase in tourist arrivals from East Asia, is a well-known trend.

The following development needs and opportunities seem to have a particular potential:

- Water and agriculture: Response to the national *'Joint Strategy for Agriculture and Water 2006-2010'*[2], with its opportunities for political support (and funding) for initiatives that can improve agricultural productivity and added value
- The Kamchay hydropower reservoir: Response to the new prospects for dry season cultivation, livestock breeding and (possibly) aquaculture offered by the augmented flow
- Infrastructure and trade: Response to the opportunities offered by better railway links and lowered trade barriers
- Tourism: Response to the opportunities (and challenges) offered by escalating tourism
- Flood management (and salinity control): Response to the flooding that has occurred around Kampot town in recent years, as well as flood management

[2] MAFF and MOWRAM (Feb 07): Joint Strategy for Agriculture and Water 2006-2010, prepared by Ministry of Agriculture, Forestry and Fisheries and Ministry of Water Resources and Meteorology

related to coastal land reclamation, while at the same time avoiding increased saline intrusion

- Climate change: Response to greater climatic variability, expectedly including (i) increased rainfall irregularities; (ii) increased frequency and height of storm surge in the sea; and (iii) increased mean sea level

Figure x: Flooding in Kampot Town

Photo: Sok Saing Im 16 Aug 06

4.2 Climate proofing

At the basin level of management, it may be assumed that the exposure cannot be controlled, while the vulnerability is manageable. Response to increased climate variability may include for example

- flood preparedness (and possibly also drought preparedness, even if today this is not a concern in the study area) - structural and non-structural - as well as pest preparedness);
- appropriate land use planning and land management;
- appropriate adaptation of cultivation systems and other primary production systems (livestock, aquaculture and plantations), aiming at higher efficiencies, higher resilience, and higher added value per m2 of land and m3 of water;
- a responsive (or at least harmless) operation of the Kamchay reservoir, preferably with a long-term predictability (that can allow for investment in irrigation infrastructure); and
- a routine monitoring programme. (Today, there is no monitoring of streamflow, evaporation, or groundwater abstraction).

The related, indispensable research and development will take its course at the national, regional and international level. At the river basin (or province) level of management, there is a need to disseminate technological adaptations and new technologies by appropriate bridging mechanisms.

4.3 Synergies

In general, the various development needs and opportunities are basically independent but can amplify each other if pursued in a coordinated way. For example, rural livelihoods and income generation can highly benefit from simultaneous improvements of water availability, agricultural technology, agro-processing capacity, transport infrastructure, and trade. It makes sense to expect that the combined benefits of these related developments will highly exceed the sum of individual benefits that can be achieved by one measure at a time.

Examples of relations between developments are provided in the table below.

Table x: Examples of impact amplifications and offsets

Primary effect	***Flood risk***	***Saline intrusion***
Increased (climate-related) mean sea levels	Adverse	Adverse
Increased (climate-related) storm surge levels	Adverse	Neutral or adverse
Increased peak flow, for example caused by increased climate variability, or by changed land use	Adverse	Neutral or positive
Advancing the coastline by land reclamation or due to natural processes	Adverse	Positive
Siltation in the downstream part of the river or off its mouth	Adverse	Neutral or positive
Increased channel depth in the river, for example caused by dredging or sand excavation	Positive	Adverse
Increased minimum flow, for example during routine operation of the Kamchay reservoir	Neutral	Positive
Reduced dry season flow, due to irrigation and other withdrawals, or during reservoir construction and filling	Neutral	Adverse
Land subsidence due to groundwater abstraction	Adverse	Adverse

Note: The significance of each aspect is unknown at present

4.4 Implementation aspects

Promotion of development initiatives are facilitated

- if the initiative complies with national (or regional) policies and strategies, and a clear reference can be provided;
- if the initiative is communicated to the agencies in charge of public planning and investment;
- if the justification is attractive and well described (in terms of local support, number of households to benefit, small and/or manageable negative side effects); and
- inter-sector and intra-basin implications (for example regarding water allocation and water sharing) have been sorted out in an acceptable way.

A holistic, inter-sector, IWRM-based approach to water-related development is well suited to address many of the important challenges of climate proofing.

5 Bottom line

Between them, the development scenarios represent a broad range from severe risks to attractive socio-economic opportunities; and many of the impacts can be managed or mitigated.

A functional climate proofing must encompass adaptation of water management, land use, infrastructure, and production systems. Due to the diverse interactions, benefits can be assured by a holistic, inter-agency and multi-sector approach.

One key observation is that most viable climate proofing measures tend to be *'safe',* as far as they serve several good purposes at the same time. They will remain favourable even if the climate does not change in the way that is presently expected.

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Center for River Basin Organizations and Management,
Solo, Central Java, Indonesia
www.crbom.org, info@crbom.org