DROUGHT MANAGEMENT IN THE LOWER MEKONG BASIN

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Abstract

Severe economic, social and environmental impacts of droughts in the Mekong River Basin confirmed a growing level of vulnerability of the people living in the affected area. For example, millions of farmer and low income earners were affected by the most recent drought of the year 2004, which caused considerable agricultural losses in North East Thailand and Cambodia, a significant reduction in the second rice crop in Lao PDR and critical levels of saline intrusion in the Mekong Delta. Unlike floods, which require relatively short time periods until they reach a high level of severity, droughts develop more slowly over periods of several months and within certain regional areas. Once in full gear, economic, social and environmental consequences pose a serious threat to those who rely on secure water availability and supplies, including farmers, fishermen, domestic households, and the like. Vulnerability of people is further aggravated by population growth and migration, urbanization, land use changes, government policies, water use patterns, or the diversity of income generating activities, changing cultural practices and so forth. The severe impacts on the livelihood people living in the affected areas raised high level political concerns in all the MRC Member States.

The MRC 2006-2010 Strategic Plan, which was approved by the MRC Council in principle in December 2005, suggested the establishment of a MRC Drought Management Programme as part of the MRC programme portfolio. Under the regional framework for cooperation, the MRC Secretariat in close consultation and collaboration with the MRC member countries (Cambodia, Lao PDR, Thailand and Vietnam) has formulated the Drought Management Programme. The programme then was approved by the MRC Council in December 2006. Four key issues for drought management in the Lower Mekong Basin are: (i) drought forecasting (ii) drought impact assessment (iii) drought management policy, and (iv) drought preparedness and mitigation measures.

KEYWORDS: Drought, Drought Management Programme, Mekong River Commission.

1. Introduction

Drought, by many considered to be the least understood of all major natural hazards, has also been shown to be the most costly [Wilhite, 1993] a fact that is as true in the Mekong River Basin as it is elsewhere. Because of the various ways drought is measured, an objective drought definition for the Lower Mekong Basin (LMB) has yet to be generally agreed.

Their impacts are *non-structural* – unlike other hydro-meteorological extremes such as floods and typhoons - and they tend to be much more widespread geographically. The severity of a drought is dependent not only on its duration, intensity and spatial extent, but also on the specific environmental and the economic activities carried out within it. Therefore, it is useful to discuss and agree definitions and indicators.

According to the glossary of meteorology, a drought is defined as "a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area", Glossary of Meteorology (1959). The World Meteorological Organization (WMO) defines six types of drought referring to meteorological, climatologic, atmospheric, agricultural, hydrological and water

management drought. Each type is the result of a specific situation of causes, effects and impact. In order to characterise the prevailing conditions of the Mekong, Adamson (2005) proposes the following definitions, which reduces the number of drought types to four:

1) ***Meteorological or climatologic drought***, which focuses on the degree of "dryness" in terms of some accumulated rainfall deficit.
2) ***Agricultural drought***, which expresses the precipitation shortfall primarily in terms of its impact upon crop production through insufficient soil moisture. It generally applies to rainfed agriculture, though irrigated crops can be affected when the water resources themselves become restricted or too expensive.
3) ***Hydrological drought*** refers to shortages in both surface and ground water. This can take the form of critically low river flow, drawn down reservoir storage and deeper groundwater levels which make pumped abstraction too expensive or mechanically impossible.
4) ***Socio-economic*** definitions of drought associate the supply and demand consequences for economic goods. For example, if the water shortage becomes so severe that the cooling water supply to key thermal power stations is reduced, the event would be severe. Similarly, energy outputs from hydropower schemes can be curtailed due to low stream flow and low levels of reservoir storage. There are industrial, agricultural, environmental and social consequences from any curtailment of water supply and water use during droughts.

The inter-relationships of drought types, the factors associated with each and their impacts are summarized in Figure 1:

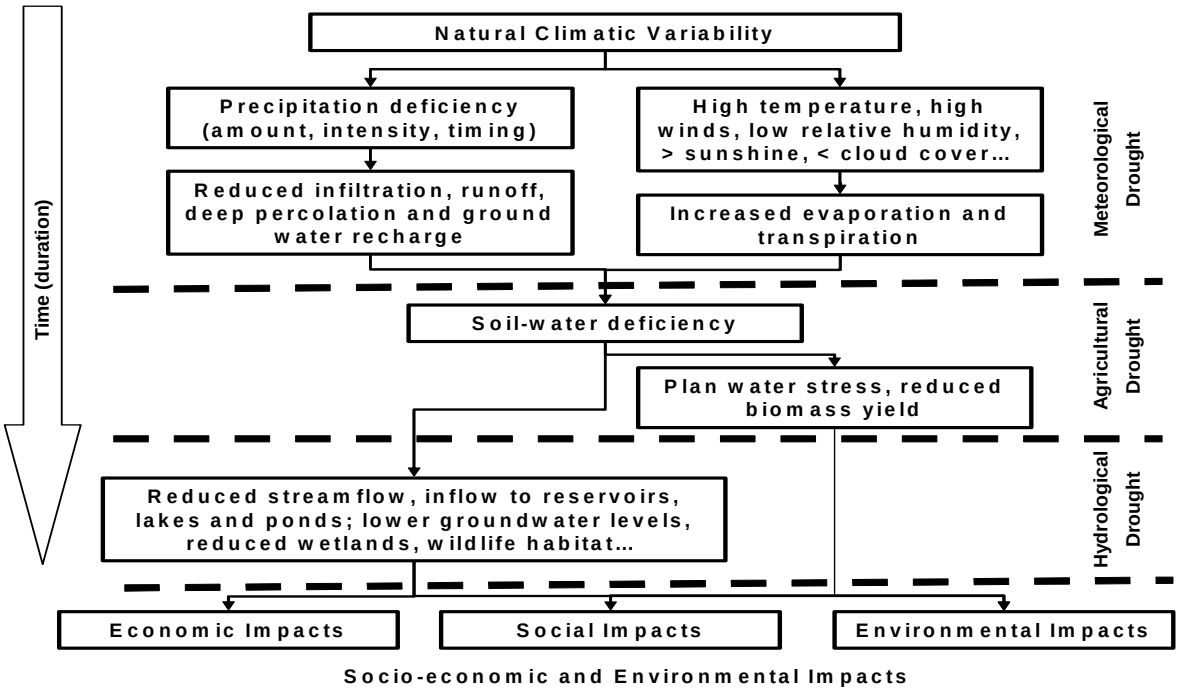


Figure 1: Drought processes, factors, relationships and impacts

2. Recent Droughts in the Lower Mekong Basin

Drought events in the Mekong region have occurred several times in the last decade in 1992, 1993, 1998, and 1999 [MRC, 2005]. The 1993 and 1999 events extended across every

region of Thailand and caused water shortages within the agriculture, industrial and domestic sectors. The 1998 drought was also severe, especially in the Mekong Delta of Cambodia and Vietnam. Flood season flows were low, with critically reduced flood plain inundation. The Tonle Sap Great Lake recorded a maximum level of only 6.85 m and a flooded area 7,000 sq.km, compared to typical seasonal maxima of 8 to 9 m and 15,000 sq km. In six provinces of the Central Highland in Vietnam stretching 400 km north from Hue, severe meteorological drought and agricultural was reported.

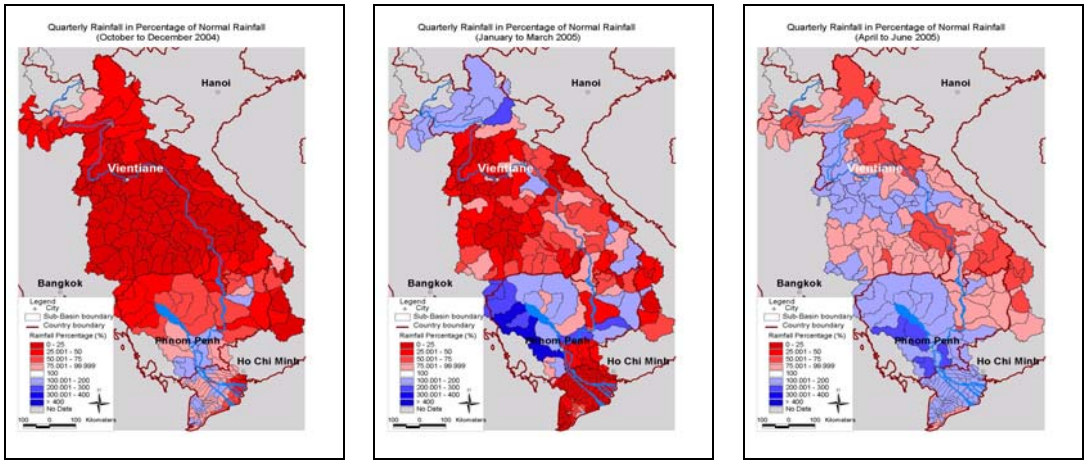
The most recent drought event began in 2003 and generally lasted into 2005 though there are some areas where lower than normal water levels and flows are being observed. Close and routine monitoring in these areas is being carried out by concerned national line agencies and the MRC Secretariat.

Some Recent Regional Drought History

The most recent regional drought episode emphasized the point the drought is not just about accumulated rainfall deficits, but also about unexpected patterns of rainfall occurrence. Regionally, total rainfall in 2004 was average, but it all occurred early in the monsoon season which ended very early in the first weeks of September (see Adamson, 2005), after which rainfall was only a fraction of normal. Analyses of the quarterly total rainfall from October 2004 to June 2005 provided the results shown in Table 1 and Figure 2. Mean regional rainfall over the LMB during the last quarter of 2004 was only +/- 47 % of normal. Among the four countries, Thailand received only 13 % of the normal amount while 29 %, 65 % and 68 % were the equivalent figures in Lao PDR, Vietnam and Cambodia, respectively.

Table 1: Quarterly rainfall in % of normal rainfall in each country from October 2004-June 2005

Rainfall	*Q4(Oct-Dec)2004*	*Q1(Jan-Mar)2005*	*Q2 (Apr-Jun)2005*	*Data sources*
LMB (mm)	106	46	495	NOAA derived rainfall
Cambodia (mm)	205	50	563	
Lao PDR (mm)	50	63	499	
Thailand (mm)	18	32	445	
Vietnam (mm)	296	19	461	
LMB (%)	47	82	97	Normal rain is estimated from spatial rainfall distribution using raingauge stations over the LMB (1985-2000)
Cambodia (%)	68	140	126	
Lao PDR (%)	29	88	82	
Thailand (%)	13	56	95	
Vietnam (%)	65	41	95	



(a) (b) (c)

Figure 2: Quarterly rainfall as percentage of normal over the LMB sub-basins from Oct 2004 to Jun 2005.

This early end to the 2004 wet season in the LMB, meant that the residual soil moisture was soon critically depleted causing huge losses to crops planted towards the end of the wet season that depend on this residual soil moisture for ripening during the drier months.

Problem Analysis

The main findings, based on the national baseline study reports on drought are presented in the form of a *Problem Tree* (Table 2).

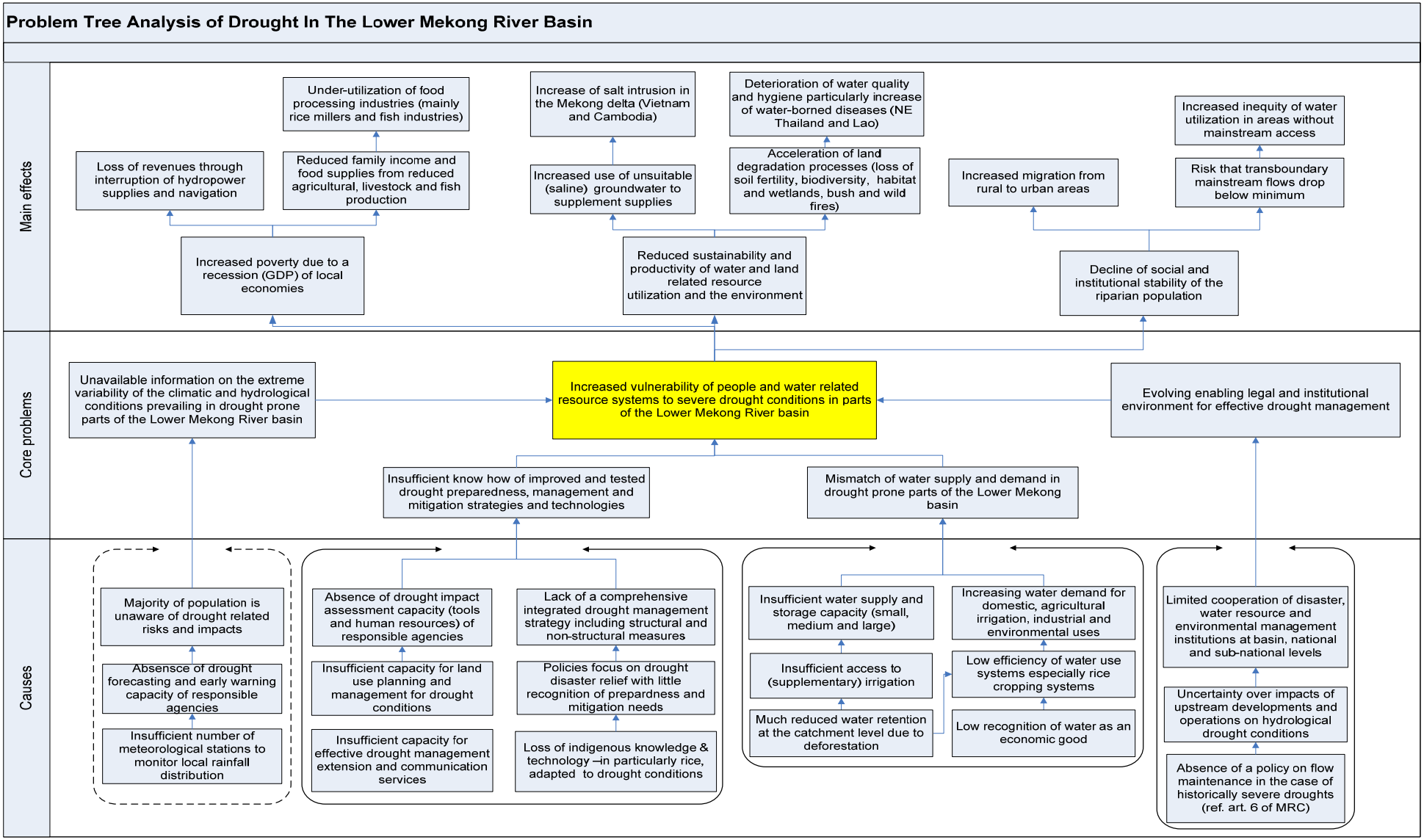
The identification of the core problem combining the effort of national studies and consultation, and the input of international experience resulted in the following proposed overall problem statement **'Core problem: Increased vulnerability of people and water related resource systems to severe drought conditions in parts of the Lower Mekong River basin'.**

Notably, the key aspect of the statement is not on the very occurrence of a drought in the basin, but on the *vulnerability of people and water related resource system to drought stresses*. The complexity of drivers behind drought and the vulnerability of people and systems imply a range of associated problems that need to be accounted for as they add meaning and clarity and support the core problem statement. Three associated problem statements were developed and are summarised as follows:

Problem 1: Insufficient availability of detailed information on the extreme variability of climatic and hydrological conditions in drought prone parts of the Lower Mekong River basin.

This problem is concerned with the information needs of the people directly affected by drought and those who work within agencies in charge of drought management. The majority of people are unaware of the risks and possible impact of droughts. Decisions to prepare for or to mitigate drought impact currently lack the required information reference and basis. A sufficiently detailed drought information system as a functional forecasting and early warning system is currently not available to the agencies in neither of the MRC member states. The problem refers to the following inabilities and causes:

Table 2: Problem Tree Analysis



- To adequately measure the distribution of local rainfall and stream flows,
- To make predictions of the regional macro climatically driven rainfall patterns and probabilities;
- To make predictions of the seasonal and intra-seasonal flow regime of the mainstream and possible major tributaries of the Mekong river;
- To make predictions of the soil water depletion of major land use types and soils in the affected areas; and
- To disseminate information to those who need it as a reference for informed decision talking at multiple levels.

Problem 2: Insufficient know-how of improved and tested drought preparedness, management and mitigation strategies.

The second problem affects the vulnerability of people and water-related systems in many ways: It refers to the loss of indigenous knowledge identified as a major problem in Cambodia, where the history of conflicts and migration has created an environment in which a large portion of indigenous technologies and techniques have disappeared. For example, about thirty years ago Cambodian farmers used some 2,000 different rice varieties, all of which were adapted to the specific biotic and abiotic stresses of the prevailing ecologies such as floating, deep water, lowland and upland.

The problem also refers to the current policy focus on short-term drought. Associated with this is the absence of a comprehensive and integrated longer-term drought management strategy comprising both the structural and non-structural measures and know-how. Other aspects to take into account include the absence of drought impact assessment capacity (tools and human resources) of responsible agencies, and insufficient land use planning capacity for implementation and testing of improved strategies and know-how. Finally, a contributing factor to vulnerability is the relatively poor capacity to communicate and provide extension services to the people living in drought affected areas.

Problem 3: Mismatch of water supply and demand in drought prone parts of the Lower Mekong basin.

The mismatch between water supply and demand is the most critical problem for the vulnerability of people and resource systems to drought. If supplies from streams, groundwater and storage are in serious decline, this affects the entire local economy in terms of irrigation, drinking water supply, power and industrial output. For example:

- Insufficient storage capacity is the most pressing problem in the drought hot spots in northeast Thailand and in Cambodia.
- A frequently mentioned cause for reduced water availability at the catchment level is the vast disappearance of forest cover (deforestation) mainly caused by *slash and burn* practices or bush and wild fires. The situation is particularly severe in the Central Highlands of Viet Nam.

According to water managers participating in the consultation meetings, water still is regarded as a free good in many drought-prone areas and economic tools and incentive systems, which could trigger a more careful use of water, are not yet being seriously considered.

Problem 4: An evolving enabling legal and institutional environment for effective drought management.

Despite considerable progress in the field of emergency response at the international and nation levels of the MRC member states[1], this problem refers to the somewhat unfinished legal and institutional enabling environment for effective drought management at the basin, sub-basin, national and sub-national levels.

Firstly, Article 6 of the Mekong Agreement makes an explicit exception of the maintenance of flow procedures *in the case of historically severe droughts and floods*. The implication of this exception is that the MRC member states have no common policy on the flow management in such a case. It also implies that the term *historically serve drought* requires clarification.

Second, there is a considerable level of uncertainty with regards to possible impact of upstream developments and operation in the Upper Mekong on the drought conditions elsewhere in the Basin.

Thirdly, there is only limited cooperation on integrated disaster, water resource, and environmental management institutions at the basin, national and sub-national levels.

Based on the analysis of problems and main causes, the analysis identifies three main areas, which are assumed as being affected by the core problem:

- Increased poverty due to the resulting decline of local economic conditions.
- Reduced sustainability and productivity of water and land related resource utilization and the environment.
- Decline of social and institutional stability of the affected riparian populations.

Poverty and vulnerability inevitably go hand in hand. The poor are usually more susceptible to disease, are generally more exposed to natural hazards such as a droughts and floods, and are less likely to have the resources to recover from material and economic loss.

As long as agriculture and other water consumptive sectors contribute a large portion to the GDP of the MRC member states, drought will have a negative socio-economic impact on vulnerable people and affected water related systems. More people are likely to fall below the poverty line. The immediate effects are reduced family incomes and food supplies from declining agricultural, livestock and fish production. Since commercial farming and food processing industries (rice millers and fish industries) are part of the chain, their facilities are also likely to be under-utilized.

Another important and related immediate economic effect of the drought vulnerability of water supply systems includes a loss of revenues from interruptions or reductions of hydropower supplies and navigation.

The second effect of increased vulnerability to drought is a loss of sustainability and productivity of the water and land related resources and the environment. These losses are manifested through an acceleration of land degradation processes such as loss of soil fertility, biodiversity, habitat and wetlands, etc. Another major concern is the deterioration of water quality and hygiene in drought prone areas.

Increased utilization of unsuitable groundwater can be identified as a drought coping strategy of people in order to ensure their survival despite the known consequences for the quality and quantity of produce. In areas where the groundwater is saline, drought implies an increase of soil salinity and a loss of productivity and fertility.

[1] Refer to the ASEAN agreement on disaster management and emergency response (Vientiane, July 2005; the Hyogo Framework (a global platform for disaster risk reduction efforts during the next decade); etc.

Saline intrusion is a major adverse effect of drought - especially under advanced hydrological drought conditions in the Mekong Delta. The national drought study reports that drought is a threat to extremely vulnerable soils of the acid sulphate type in the Mekong Delta. Their subsoil contains acids which if present in the top layers would cause significant damage to fertility. As long moisture is maintained in the top layer this is not a serious threat. However, as soon as water is depleted from the top layer by evaporation the direction of water movement in the sub-soil changes upwards brining along the acids, which result in a rapid soil acidification and degradation process.

The third main effect of the core problem is a decline of social and institutional stability of the riparian population namely those who interface with the water resource of the drought prone area and beyond. An example from northeast Thailand may illustrate the dimension: The northeast region is home of many people who, in search of employment, migrate to urban centres and coastal areas. During the dry season they frequently return and engage in irrigated rice production and other enterprises in order to supplement their limited incomes. Under drought conditions many people will stay away from the affected provinces and try to survive where they are. Others may leave the northeast region in the hope of finding employment, income and food elsewhere, often with little or no success.

3. Management of Drought in the Lower Mekong Basin

Drought forecasting and early warning

Drought forecasting and early warning contributes to reducing the negative impacts of droughts within a relatively short period of time.

A suitable procedure for hydrological dry season flow forecasting has already been developed within the MRC which may be application as a basis for a systematic forecasting system. In August 2005, the MRC finalized a study on drought forecasting and management (Adamson, 2005) which presented a scientific basis for a statistically-based forecasting methodology for hydrological drought onset, specifically for critically deficient dry season flows on the mainstream. This innovative methodology is based on *seasonal flow pattern recognition*. The methodology takes statistical measures of the flood season hydrograph and links them with the magnitude and pattern of flows in the following dry season, starting in December of each year. The parameters of the current flood season hydrograph are evaluated in November and matched with the nearest historical set. The corresponding subsequent historical dry season is then used as the forecasting model. The method permits forecasts of hydrological drought with *lead times* of up to six months.

Drought impact assessment

Drought is a complex phenomenon, and its impacts result from numerous and widely varying causes. Drought impact assessment is therefore correspondingly complex requiring integrated assessment of the economic, social and environmental impacts of the vulnerable people and the water-related resource systems.

The Integrated Basin Flow Management (IBFM) flow assessment framework being put in place by the MRCS is already providing a useful starting point for drought (i.e. low flow) impact assessments. Social impact assessments are also complex involving consideration of such factors as population growth, migration trends, urbanization, changes in land use, government policies, water use trends, diversity of economic activities, cultural compositions and so forth.

Identification and classification of droughts is also complex and is done elsewhere through the application of drought indicators which integrate a variety of physical, environmental, and climatic variables to produce useful numerical drought *indices*. Development of appropriate drought indices acceptable for application by all Member Countries in the Mekong Basin are required to facilitate regional collaboration and harmonization in mitigating the negative impacts of drought.

Drought preparedness and mitigation planning

Preparedness and mitigation are two planning processes of emergency management as illustrated in Figure 3.

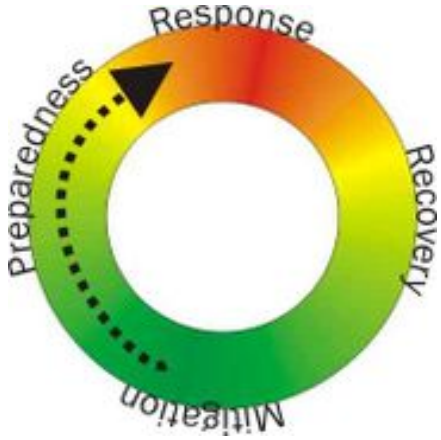


Figure 3: Four phases of emergency management cycle

In preparedness planning, response and recovery actions available for implementation in the event of droughts are developed and rehearsed.

Mitigation planning deals with longer-term efforts to prevent the occurrence of drought from developing into a fully fledged situation, or to reduce the effects of drought when they occur. Mitigation measures can be structural and non-structural and they are usually the most cost-effective method for reducing the negative impact of droughts.

Notably there is now a clear understanding that a mismatch in water supply and demand requires a shift from a reactive to a proactive approach. An important strategic area therefore is to augment water supplies and at the same time as reducing demand by:

- Increasing storage and control capacities for both surface and groundwater;
- Improving access to irrigation facilities mainly in the form of medium to small-scale systems (such as supplementary irrigation based on water harvesting, conjunctive use of groundwater, soil water conservation);
- Improved water reuse either through groundwater recharge in combination with pumping or through the uses of treated waters; and
- Managing flow releases from hydropower dams, as well as inter and intra basin water transfer of water from water surplus to water deficiency areas.

Drought management policy environment

The problem analysis identified the need for improved drought cooperation and policy alignment:

- Uncertainty over impacts of upstream developments and operations on hydrological drought conditions; and
- Limited cooperation of emergency response, water resource and environmental management institutions at basin, national and sub-national levels;

4. Drought Programme Development

The MRC 2006-2010 Strategic Plan, which was approved by the MRC Council in December 2005, suggested the establishment of a MRC Drought Management Programme (DMP) as part of the MRC programme portfolio.

Through the DMP formulation process it became clear that a coordinated effort of drought planning and management is needed at the regional level, promoting inter-governmental and inter-agency cooperation based on the integrated water resource management principles. These guiding principles, in conjunction with the fundamentals of the MRC Strategic Plan 2006-2010, resulted in the formulation of the overall *Strategic Framework for the Drought Management Programme*.

Two strategic pillars were identified and agreed as critical for its success:

1. The MRC Strategic Plan's Integrated Water Resource Management approach, which is now a broadly agreed, and
2. The Integrated Basin Flow Management activities. IBFM represents an objective, scientific, multi-disciplinary framework for assessing changes in flow to which can be linked the assessments of the impacts of drought and drought management strategies on the Mekong River basin's related economic, social and environmental beneficial uses.

The development objective combines the focus on vulnerability with the given role of the MRC to support cooperation for the sustainable development of the Mekong River Basin in accordance with the overall five-year goal of the MRC agreed in the Strategic Plan.

Development Objective: More effective use of the Mekong's water and related resources to reduce vulnerability of people and water-related resource systems to severe drought conditions.

Immediate Objective: To establish effective drought awareness, preparedness, planning and management mechanisms in the Lower Mekong River basin supported by the best available tools and know how, and facilitating and supporting the implementation of high priority national and regional programmes and multi-purpose projects.

A programme is supported by a results statement under each component, which summarizes the expected outputs of a both structural and non-structural nature such as:

- infrastructure to improve hydro-meteorological stations,
- computer-based data collection and processing systems,
- drought impact assessment tools, and
- proposed policy, strategic and technical options to prepare, manage and overcome drought impacts.

Drought Forecasting: To improve the availability and quality of drought related data and forecasting information referring to the variable meteorological, hydrological, agricultural and socio-economic drought conditions in parts of the Lower Mekong River Basin.

Drought Impact Assessment: To improve generation, transfer and uptake of know-how of improved and tested drought management and mitigation strategies, which follow thorough technical and economic analyses of the underlying causes of drought impact and vulnerability and benchmarked against a suite of drought status, impact and response indicators.

Drought Management Policy: Implementation of an effective DMP can only be done if the institutional and management environment is sufficiently enabling - both internally and externally. This component will therefore contribute to the evolvement of such an enabling management and policy environment as a framework for improved cooperation within the Programme and beyond, reaching out to other MRC programmes, NMCs, partner organizations and the public as whole.

Drought Preparedness and Mitigation Measures: To close the gap between water supply and demand in drought prone parts of the Lower Mekong Basin through planning and promoting implementation of appropriate structural and non-structural measures to mitigate the negative impacts of drought. It would be fully aligned with and support the IWRM-based Basin Development Plan.

5. Conclusion

This paper has set out the rational for establishing the Drought Management Programme within the MRC, given the catalyst of the severe regional drought conditions that prevailed during 2004 and 2005 and which resulted in significant socio-economic losses in all four countries.

The potential to take forward the exploratory drought forecasting procedures that have already been developed has been demonstrated here. The regional hydrometeorological database is adequate has also been indicated while the long established regional data exchange and international cooperation provides an excellent opportunity to develop a truly international programme.

Multi national river monitoring programmes that could be extended to cover drought are already in place such as the Mekong Hydrological Cycle Observing System. The prospects and potential for linking drought and flood forecasting research are self evident , while drought management programme of the LMB could liaise beneficially with the ongoing Flood Management and Mitigation Programme with regard to the development of dissemination and communication systems between the MRC Secretariat, drought and flood ‘stakeholders’, relevant national and regional organizations including the mass media in order` to deliver reliable data/information and ‘awareness’ to all such stakeholders.

In short there is much institutional expertise in place and considerable work in progress to improve drought management in the LMB. Three key emerging aspects of regional drought management and mitigation are:

(i) development of a regional drought forecasting and early warning method;
(ii) drought impact assessment and monitoring;
(iii) drought management policy formulation; and
(iv) identification of regionally appropriate preparedness and mitigation measures.

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