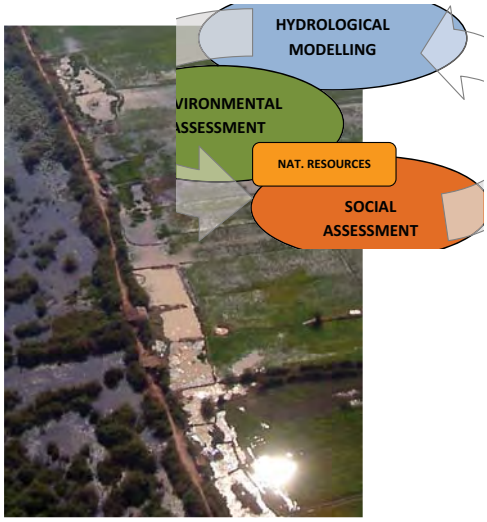
Mekong River Commission

Hydrological, Environmental and Socio-Economic Modelling Tools for the Lower Mekong Basin Impact Assessment



Water Utilisation Programme

WUP-FIN Phase 2

Methdological and thematic briefs

Finnish Environment Institute
Environmental Impact Assessment Centre of Finland Ltd
Helsinki University of Technology

Hydrological, Environmental and Socio-Economic Modelling Tools
for the Lower Mekong Basin Impact Assessment (WUP-FIN)

Methodological and thematic briefs

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Preface

This document presents a set of methodological and thematic briefs that summarise the main outputs of so-called WUP-FIN Project that operated as a complementary component to the Mekong River Commission's Water Utilization Programme in 2001-2006. The briefs provide easy-to-read summaries of the work carried out within the WUP-FIN Project. For more detailed information on the topics of the briefs, please have a look at different WUP-FIN reports, in particular WUP-FIN Final Report Part II. All project reports as well as these briefs can be downloaded at our project's web page at: www.eia.fi/wup-fin

The briefs included in this document reflect the diversity of the topics that the WUP-FIN Project has addressed in different parts of the Lower Mekong Basin. The four target areas of the WUP-FIN Project were:

A. Vientiane and Nong Khai area (Lao PDR & Thailand)
B. Nam Songkhram watershed (Thailand)
C. Tonle Sap Lake and Cambodian floodplains (Cambodia)
D. Mekong Delta (Vietnam)

These briefs aim to provide a concise summary on both methodological and thematic aspects of the WUP-FIN Project, and in particular on the challenges and possibilities that the Mekong River Basin is currently facing. Rapid development in the basin causes potentially very remarkable impacts –both positive and negative– to the people and the environment. Transparent and well-informed planning is therefore needed to ensure sustainable and balanced development of the basin's diverse resources, taking into account all its stakeholders.

We hope that the outcomes of the WUP-FIN Project facilitate this kind of planning process, and also encourage public discussion about the most feasible ways forward in the basin. Comments and remarks on these briefs and on the entire WUP-FIN Project are of course very welcome; our contact information can be found from the first page of this publication.

On behalf of the entire project team,

Juha Sarkkula

Team Leader, WUP-FIN Project
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WUP-FIN Lower Mekong Modelling Project

WUP-FIN Project is funded by the Finnish Ministry for Foreign Affairs and implemented by the Finnish Environment Institute SYKE (lead), Water Resources Laboratory of the Helsinki University of Technology TKK and Environmental Impact Assessment Centre of Finland EIA Ltd. The project is carried out as consultancy services for the Mekong River Commission Secretariat (MRCS) in close cooperation with the National Mekong Committees, line agencies and universities as well as international partners.

The project has four main target areas in Lower Mekong Basin (LMB):

A: Vientiane and Nong Khai area (Lao PDR and Thailand)

B: Nam Songkhram Watershed (Thailand)

C: Tonle Sap Lake and Cambodian floodplains (Cambodia)

D: Mekong Delta (Vietnam)

MULTI-LEVEL IMPACT ASSESSMENT FRAMEWORK

Main components of the project

Modelling

- Field measurements &observations
- Databases & GIS
- 3D EIA hydrodynamic & water quality models
- 1D & 2D hydrological models

Socio-economic and environmental analysis & impact assessment

- Field surveys
- Participatory village surveys & key-informant interviews
- Database and statistical analysis in GIS
- Literature reviews
- Policy Analysis

Capacity building and training

- Training courses at MRCS and line agencies
- Lecture series & research support at universities
- Workshops and academic conferences
- Networking and information dissemination

Main outputs:

- Improved capacity of local experts for sustainable use of developed tools
- Analytical tools, technical assistance and problem solving to help in ensuring sustainable management of the river and its floodplain resources
- Guidelines for water resources management and ecosystem protection
- Well-founded and objective information about transboundary impacts
- Facilitating dialogue and cooperation between the different actors in local, national, regional and international levels
- Experiences from the cross- and multi-disciplinarity at the project level are encouraging: water modelling project benefits from multi-disciplinary approach where focus is broadened to include also e.g. socio-economic and policy analyses.
- Very positive experience from combining consultancy work and research as well as from networking with local counterparts and international collaborators. Interaction with other actors and publishing project results also in scientific articles and conference presentations have provided useful feedback, and also made the project more transparent.

“Although having a strong belief in tailor-made solutions, we use common impact assessment framework under which different case studies are applied”

SYKE EIA Ltd.

METHODOLOGICAL BRIEFS

1 WUP-FIN Models

WUP-FIN tools consist of a large set of environmental models and their support software. The core models calculate hydrological and hydrodynamic processes. Their results are used in a number of coupled modules or separate models.

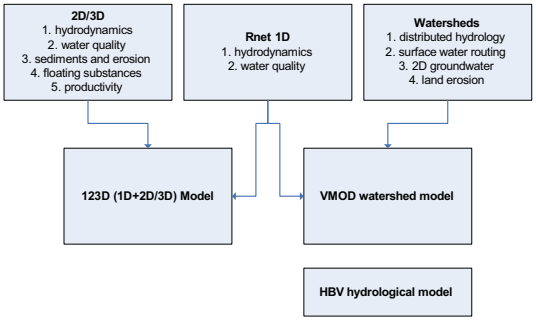
The **core models** of WUP-FIN Project are:

- EIA hydrodynamic model: River, lake, reservoir, floodplain, coastal and sea area hydrodynamics (1D/2D and 3D)
- VMod hydrological model: Watershed hydrology, erosion and water quality (0D/1D/2D) including ground water (2D)

The secondary coupled models can simulate:

1) Water quality (1D/2D/3D) including dissolved substances such as oxygen, nutrients and acidity
2) Salinity intrusion (as a density difference influenced 3D process)
3) Sediment transport, erosion and sedimentation (2D/3D)
4) Oil and chemical accidents (3D)
5) Fish larvae drift.

Iterconnections between different model components.



> **The software is non-commercial in the sense that it has no licence fee**

ISIS, SWAT, IQQM and WUP-FIN modelling tools are connected off-line. For instance SWAT results are calculated firs providing information on watershed flows into to the Mekong, ISIS calculates after that the consequent flow in the river system and finally Tonle Sap 3D model uses ISIS Tonle Sap River flows as a boundary value. Off-line coupling doesn't work in areas where there is significant interaction between the different model domains. For such cases one needs a coupled model simulating the interaction between the channel and river network and the floodplain, reservoirs or lakes. The EIA combined 1D/2D/3D model is a system where the coupled flow, sediment and water quality can be simulated. In this document it is called EIA-123D.

In the EIA-123D the 1D characteristic are simulated with the RNet river network model that solves one-dimensional river flow and water quality in a river network. The solution is based on solving simplified St.Venant equations numerically. The river system is described to the model as a river network constructed from one-dimensional rivers, and river nodes that connect individual rivers to a network. The 2D and 3D characteristics are solved by the EIA-23D model. The combined model, EIA-123D, can take its boundary values from measurements, hydrological models or basin-wide model systems such as DSF.

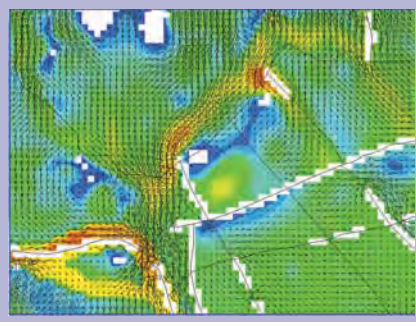
In the EIA-123D-model the connection algorithm is devised to be flexible in the sense that basically any 1D model with capability to communicate outside itself can be coupled with the floodplain model.

Combined channel/floodplain model (1D/2D/3D model)

The advantages and necessity of using a hybrid 1D/2D/3D river channel model become pronounced in the Vietnamese Delta. The Delta has an extensive river channel network and inundated area. The elements of the Delta modelling are:

- extensive river and channel network
- numerous dikes and control structures
- flooding
- saline water intrusion and regulation of saline and fresh water for aqua- and agriculture
- strong tidal effects
- erosion
- sedimentation and connected floodplain productivity
- water quality, acidification due to acid sulphate soils.

Close-up of water depths and floodplain flows from the Northern part of the area:



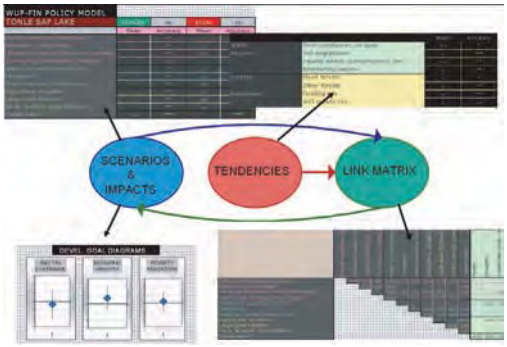
WUP-FIN Policy Models

This brief presents the principles and selected results from WUP-FIN Policy Models in two selected case study areas; Tonle Sap Area and Mekong Delta. The policy models were together with broader, basin-wide analysis the main parts of WUP-FIN Policy Analysis. The results from both policy models indicate that compromise policies are possible in both case study areas, being more balanced than the policies that target only one of the development goals.

The WUP-FIN Policy Models for the Tonle Sap and the Mekong Delta made use of probabilistic, Bayesian network approach, and were developed to facilitate learning and communication and to provide policy advice on water-related policies. The models allowed users to test systematically their ideas and insights, and to realise new, unexpected linkages between different policies. The models thus increased the understanding of the most critical management and governance issues, and assisted in learning of possibility of compromise policies.

The starting point for the policy models was the Mekong Agreement of 1995. It specifies three development goals for the Mekong Basin: economic growth, poverty reduction and environmental sustainability. These goals are also virtually identical to the concept of Integrated Water Resources Management (IWRM). The possibilities to find combinations of sector policies for achieving these, often conflicting goals within the Mekong Basin were then analyzed using WUP-FIN Policy Models.

Flow Chart of the Structure:



Results: Tonle Sap

The results from Tonle Sap Policy Model indicate that some sector policies are crucial for economic development and poverty reduction, but not all. The huge shortcomings in education and institutions are the key bottlenecks. With every scenario and sector policy, uncertainties related to their impacts remain very high and must therefore be appreciated. This is partly due to lack of data, but even more importantly due to structural uncertainties in the model. The biggest surprise was that the domestic policies appear relatively toothless to environmental problems. As the majority of the population of the Tonle Sap area live in villages and make their living from the lake or the floodplain, the environmental and social concerns are tightly interwoven.

Results: Mekong Delta

The Mekong Delta Policy Model indicate that the coordination of different sector policies can be considerably improved in order to reduce conflicts between environmental, social and economic development. The three zones of the delta appear very different, and to work out policy combinations that are successful in all zones and for all three goals is a challenge. Economic development seems to be prone to enhance polarization and poverty problems. Also economy and environment are difficult to balance, particularly in the cases of mangroves and salinization, which both are related to the expansion of aquaculture. In all zones, environmental sustainability seems to be very difficult to keep even at the present level. More stringent and explicit environmental policies would be necessary than those implemented today.

> **“Compromise policy is possible, being more balanced than any of the policies that target on one of the three goals at a time**

Main results:

- Fragile balance between environment, economy, social issues
- Causes and effects are strongly interwoven
- Identification and comprehension of linkages therefore crucial

→ Ignorance of linkages leads easily to simplistic and unbalanced policies

- Tonle Sap: alarms
  - Environmental degradation
  - Social contrasts and economic growth
  - Low local capacity to face pressures: economic changes, politics, environment
- Mekong Delta: alarms
  - Lower delta: 3 development goals in very strong conflict
  - Environmental degradation

3 Impact Assessment

This brief discusses some of the challenges occurring in cumulative impact assessment in the Mekong Basin, and then provides recommendations for regional, basin-wide impact assessment approaches. To answer the challenges of comprehensive impact assessment at the regional level, a more flexible, multilevel & interdisciplinary approach will be needed.

Water-related impact assessments in the Mekong Basin –like in any other transboundary river basin– have to tackle with the issue of scales; while the impacts of different developments are essentially felt in the local level, the impact assessment requires a regional i.e. basin-wide approach to be really meaningful.



The main challenge of impact assessments in the basin is to get sound information on the diverse development plans in different parts of the basin, and then to assess the actual cumulative impacts of these developments in a comprehensive way. There are also several smaller challenges related to this main challenge, including:

1) Challenge with data reliability

Most regional impact assessments build on macro-scale analyses, making mainly use of quantitative databases; yet many of these databases include biases and even errors, particularly when compared to actual situation at local level

2) Challenge of local level diversity

Mekong is both geographically & culturally extremely diverse, but most current impact assessment approaches fail to capture properly this complexity

3) Challenge of recognizing the orders of magnitude

At regional level impact assessments, it is critical to understand where most people live, what are their main livelihoods sources etc. – and to use this information to focus the assessment; yet this kind of understanding is often missing

To be really able to answer to the challenges described above, there is a need to move away from pre-defined, top-down impact assessment approaches towards more flexible, multi-level & interdisciplinary approaches for impact assessment. This requires a combination of regional impact assessment approaches with more local level analyses. Since neither of these approaches will work sufficiently on their own at the basin-wide scale, a common impact assessment framework is also needed; this framework has to be flexible enough to accommodate the regional differences between the case studies, and yet rigid enough so that it sets the focus to the main issues in the basin.

A successful assessment of impacts to particularly complex, crosscutting issues (such as flood pulse) requires also a shift from multidisciplinarity towards more interdisciplinary approach. This means not just having different disciplines/sectors in the same project, but also integrating knowledge and methods from different disciplines together to form new approaches and ideas for impact assessment. This, in turn, requires increased interaction between different disciplines, starting already from the definition of project approach, as well as the courage to develop entirely new kind of research methods for impact assessment.

> **More flexible, multi-level & interdisciplinary approach for impact assessment is urgently needed**

How to apply multi-level, interdisciplinary impact assessment in practice within the MRC? We propose five steps:

1) Better coordination and cooperation between different regional-level impact assessment processes within MRC
2) Combine these with already existing and planned local level analyses carried out within the countries by different institutes
3) Move impact assessment from the MRC towards the countries (NMCs, ministries, universities, NGOs)
4) Increase dialogue and interaction with other actors; with those also working on basin-wide impact assessment processes and with those familiar with local level impacts
5) Use multi-disciplinary teams at different levels to develop new, inter-disciplinary methods for cumulative impact assessment

Capacity building

4

Building of riparian capacity to apply and develop mathematical models and tools for water resources planning and management has been a priority task of the MRCS and the NMCs in the past few years. The MRCS and the countries need capable and sustainable expert teams as precondition for the maintenance and future use of the developed model system and for carrying out impact assessment work supporting the IWRM needs.

WUP-FIN project has put relatively big share of resources to work with the trainee teams from the MRCS, NMCs, national agencies and universities.

Capacity building task has proven to be more challenging and time consuming than originally expected. Time and resource limitations by both consultant and trainee teams have caused obstacles in reaching the desired level and sustainability of the training result. A more solid connection between the international teams and the riparian teams, e.g. through contract arrangements is needed to improve the efficiency of the training.

> **The general outcome of the training events has been very positive**

Further involvement of riparian Universities and Research Institutes in the modelling and impact assessment teams is seen a way to facilitate long-term capacity building in riparian countries and linking project activities better with other, national research activities. The academic institutions are expected to provide an expert resource for the national and MRCS teams and projects and for the maintenance and development of the tools.

The modelling and IA teams need to comprise of wide enough diversity of expertise (numerical modelling, IT, GIS, EIA, socio-economy) in order to be able to take care of development and maintenance of the model system, run the applications and integrated, problem solving case studies.

Main findings:

- General experience on the training has been very positive and the trainees have shown great interest to gain the skills to use the model for their every day practice
- National case study applications have benefited from being designed in close cooperation with the country teams
- Preparedness of the team members to advance in model applications is still diverse, requiring efforts in personal guidance
- Linking model training and application to academic studies and thesis work has produced promising results in long term capacity building
- Modelling and impact assessment work should be increasingly based on cooperating with multidisciplinary country teams, based on solid contracts
- It is important to keep the model software free of licence fees to allow efficient delivery of the modelling tools to the users.

THEMATIC BRIEFS

5 Flow alterations & flood pulse: future of Tonle Sap Lake?

The monsoon floods of the Mekong River are a key driver of productivity in the Tonle Sap Lake ecosystem. This 'pulsing' system with its large floodplain, rich biodiversity, and high annual sediment and nutrient fluxes from Mekong is believed to be one of the most productive freshwater ecosystems in the world. The floodplain vegetation is one of the key elements of Tonle Sap ecosystem.

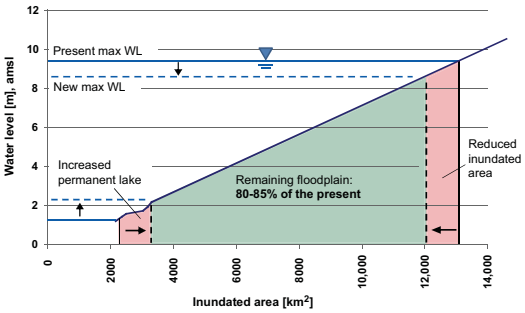
The Tonle Sap gallery forest and flood pulse research **aims** to

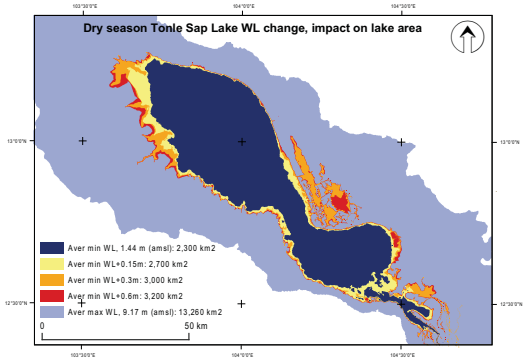
- Estimate the changes in Tonle Sap flood pulse based on the basin wide cumulative impact assessment studies
- Estimate the possible changes in flood pulse parameters
- estimate the loss of the gallery forest stripe due to possibly increased dry season water level, based on the existing studies, as a consequence of upstream development as dam and reservoir construction, and irrigation

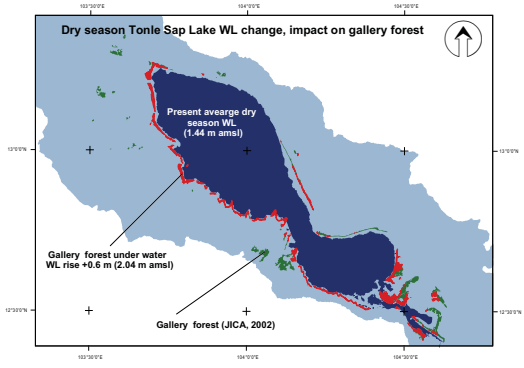
> **Large parts of the gallery forest are likely to be permanently inundated - in essence destroyed**

Main findings

- Flood pulse is the key driving force for the lake's productivity
- Mekong upstream developments will alter the flow regime downstream and impact on the flood characteristics of the Tonle Sap Lake. The predicted dry season water level rise of 0.15-0.60 m would mean permanent inundation of large areas of gallery forest stripes located in the vicinity of the lake shore
- Relatively small rises in permanent lake water level permanently inundate disproportionately large areas of floodplain, thus rendering it inaccessible to terrestrial vegetation and eroding the productivity basis of the ecosystem







Way forward:

- High quality cumulative impact assessment of planned and on-going development in the whole Mekong Basin and of the impact of climate change
- Quantification of the impacts of the predicted flood pulse changes on the ecosystem productivity of the Tonle Sap lake and floodplain
- Consequences of ecosystem productivity change for fisheries, food security and livelihoods in and around the Tonle Sap

Sediment issues

6

Sedimentation can be a curse or a blessing, depending on the viewpoint. For the natural environment, sedimentation is crucial, providing nutrients and other materials that fuel biological productivity of the ecosystem. For humans, however, sedimentation can also be problematic, potentially causing problems for transportation and maintenance of aquatic infrastructure. This is also the case in the Mekong River basin.

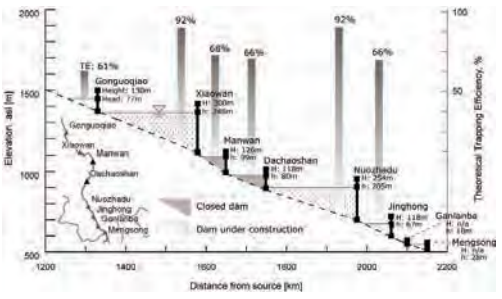
The Mekong basin yields approximately 475 km3 of water each year from a catchment area of 795,000 km2, and transports around 150×109 kg of total suspended sediment (TSS) to the South China Sea annually. More than half of the total sediment flux originates from China.

The main **aims** of the sediment related studies have been

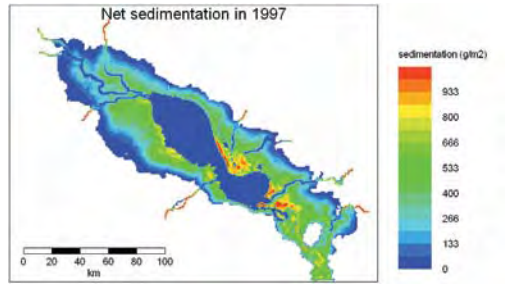
- getting an overview of the sediment issues in Mekong
- analysing the sediment trapping efficiency of the dams in Yunnan cascade
- enhance the knowledge and data of the sediment transportation related issues in hot spot areas as Vientiane – Nong Khai, Chaktomuk junction, Prek Kdam, and Tonle Sap Lake
- Tonle Sap Lake sediment studies

“Tonle Sap Lake is not filling up with sediment – however, local problems of sedimentation and erosion do exist

Theoretical trapping efficiency for Manwan is 68%, which correlates rather well with the measured trapping efficiency of 60%. The Dachaoshan Dam, closed in 2003, has a theoretical TE of 66%, while the bigger dams Xiaowan and Nuozhadu at present under construction, have trapping efficiencies as high as 92%, basically trapping all the sediment. The whole cascade of eight dams has a total theoretical trapping efficiency of 94%.



The sedimentation in the Tonle Saplake proper, i.e. dry season lake area, is very low, around 0.1-0.16 mm/year. However, even though the overall net sedimentation within the Tonle Sap Lake is not a problem, there are many local problems associated with high sedimentation and erosion rates in the area. This is the case especially in in the mouths of the major tributaries and Tonle Sap River.



Main findings

- The sediment is important part of the ecosystem functions and productivity
- The trapping efficiency of the large dams e.g. in Yunnan cascade is high and thus, the impacts of the decreased sediment flux on downstream ecosystems and bank stability should be further studied
- Tonle Sap Lake is not filling up with the sediment, although severe local sediment related problems exist in many location

Way forward:

- Basin wide sediment transport model coupled with the hydrological model
- Enhance the field monitoring, coupled with the ADCP discharge measurements
- Data and information exchange between LMB and UMB actors
- Field measurements of the sediment quality in different parts of the river, i.e. biological availability

7 Tonle Sap ecosystem productivity

The Tonle Sap Lake and floodplain ecosystem is the element of the Mekong basin where the flood pulse is the most prominent in terms of its ecological importance and livelihoods impact. The flood pulse is the driving force behind the large fish production of the ecosystem. Consequently, the Tonle Sap fisheries is of greatest importance for the food security and the livelihoods of those living on or near it, and for the food security of Cambodia as a whole. The Tonle Sap flood pulse is largely (60%) driven by the water that is pushed up into the lake by the reversed current in the Tonle Sap river during the rising Mekong River flood in June-September. The floodpulse from the mainstream brings also nutrients.

The Tonle Sap productivity research **aims** to identify a quantitative model of the ecosystem productivity of the Tonle Sap Lake and floodplain, with a particular focus on ecosystem productivity response in function of altered flow regimes in the Mekong River.

The underlying assumption is that the Tonle Sap secondary production, including fish production, is mostly based on four categories of primary products (periphyton, phytoplankton, rooted macrophytes and floating macrophytes) generated within the ecosystem rather than imported with the flood waters.

For each group, the primary production was described in function of environmental parameters, based on a review on the knowledge and data on Tonle Sap as well as similar and dissimilar ecosystems throughout the world. This was then used to formulate a quantitative approximation of the primary production by each of the four groups. Coupled with the existing 3D EIA model the productivity description allows for assessments of the impact of alterations to the environment, and in particular to the flood pulse and all its characteristics.



Hydropower development changes the natural flood pulse and the hydrograph, directly undermining the productivity of the system by reducing the inundated habitats, delaying the onset of flooding and shortening its duration (growth period for aquatic organisms), all having a negative impact on primary and fisheries productivity. It also reduces the supply of sediments and nutrients to the downstream ecosystems because of the sediment trapping in the reservoirs.

> **The flood pulse is the driving force of the productivity of the Tonle Sap**

Tentative estimates point out that under a high development scenario the productivity loss can be counted in tens of percentages of the present level. This key development issue is practically excluded from the discussion, seemingly due to the tempting financial benefits offered by hydropower development. Still, for a sustainable future in the basin, it is necessary to find the balance between acceptable level of hydropower developments and maintenance of fisheries productivity as the vital environmental and social resource in the basin.

Main findings:

The primary production of the Tonle Sap ecosystem is mostly situated inside the ecosystem. It determines the potential of the ecosystem for the production of secondary organisms, including fish, which are of critical importance to the livelihoods and food security of people living in and around the lake, and for the Cambodians in general.

The ecosystem processes of the Tonle Sap depend on the flood pulse, mostly driven by water from the Mekong River. Assessing the impact of flow changes on the flood pulse, and hence on the productivity of the Tonle Sap ecosystem is one of the major and urgent challenges in integrated water resources management for the Mekong basin.

Primary production of the Tonle Sap ecosystem can be modelled solidly, supported by reasonable amount of data collection. An assessment of the impact of flow alterations on the primary production will provide insights into the impact on the secondary production, and thereby on livelihoods and food security in the region.

Mekong Delta and socio-economic analysis

8

This brief presents the findings from the WUP-FIN socio-economic analysis in the Mekong Delta of Vietnam. The results indicate that water development in the delta has brought many benefits, but also new kind of challenges. These are related particularly to increased water demand, problems with water quality, loss of aquatic resources and increased social differentiation. To deal with these challenges, the Delta's water management would require a shift from centrally-planned structures towards multilevel management.

The objective of the socio-economic analysis was to deepen the understanding of the water-related socio-economic issues in the delta with specific focus on the WUP-FIN model application areas. The analysis was carried out with help of case studies in three different parts of the delta. The case studies consisted of village surveys, key informant interviews in different administration levels and analysis of available socio-economic statistics.

The results from the socio-economic analysis show that combination of fertile, alluvial-rich soils and agricultural modernization with construction of water structures has made the Mekong Delta an incredibly productive rice cultivation area; the rice basket of Vietnam. This progress has, however, come with a price: push for higher yields and productionist goals have lead to environmental consequences such as worsening water quality and declining biodiversity. Also the strengthening saline water intrusion is partly caused by the increased water use within the delta.



The side-effects of the delta's intensive development are closely linked to the losses of common pool resources including fishery, good water quality and alluvium. The losses in wild fishery were common in all case study areas. The reduction in aquatic productivity has been most harmful for the poorest groups of farmers, particularly for the landless who are the most dependent on the open access products. At the same time increasing water quality problems affect the daily lifes of rural people for whom surface water is the principal source for domestic uses.

One of the main challenges in the delta is that the poor's dependence on open access products is often largely ignored by the official level. The diversification of livelihoods requires thus also more pro-poor versions, of which so-called VACB-models and fish sanctuaries could serve as an example. The diversification of livelihoods is another major challenge as calls for increased flexibility of water structures built mainly for rice monoculture are rising. If and when these structures are modified, the work should not aim only for satisfying the needs of better-off farmer, but should be based on the needs of all stakeholders, with special attention paid to the most vulnerable groups.

CASE STUDY FINDINGS

AN GIANG

Benefits and costs of the flood protection system:

+ Reduced flood damages, one extra rice season and increased labour opportunities
- Reduced soil fertility and aquatic resources, increased usage of agro-chemicals → water pollution

→ Poorest farmers most vulnerable

- Transboundary impacts – flood damages in Cambodia?

LONG AN

Improvement of soil quality through heavy leaching:

→Losses of habitat and problems with acid water
→ a conflict between land and water uses?

More efficient drainage system:

→fast receding causes water shortages
→ problems for agriculture?

TIEN GIANG

Go Cong SWI control project challenged by:

1) continuing problems of fresh water shortages, especially in the most downstream areas
2) The shrimp boom
→ Alterations troublesome with structures designed solely for rice
→ Changes from brackish to freshwater and back to brackish
→ Risks: declining aquatic resources and degrading water quality

> **"The side-effects of the development are closely linked to the losses of common pool resources**

Linkages with modelling

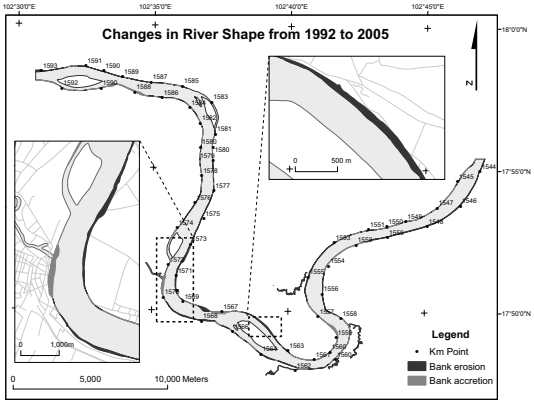
- Socio-economic analysis support modelling & impact assessment in two different ways:
  1) it helps to focus modelling better into the actual water-related problems in the modelling areas
  2) when combined with modelling results, s-e analysis facilitates impact assessment
- Socio-economic analysis thus enables modelling to better address the multidisciplinary needs of water resources management (IWRM)
  → particularly important in complex systems (= delta!)
- Participatory methods used in s-e analysis also enhance participation in the modelling project
  → recommendations for the modelling

9 Bank erosion

The changes in river channel such as bank erosion and accretion are natural processes but often human activities can have a significant impact on those changes. During the WUP-FIN project, the bank erosion issue has been studied in Vientiane – Nong Khai section of the Mekong River, identified one of the hot spot areas by LNMC and TNMC.

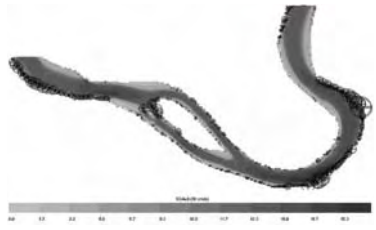
This study has focused on Vientiane - Nong Khai part of the Mekong in order to assess the problems and provide information of the bank erosion rates. The study **aims** to

- assess how much the shape of the river in Vientiane-Nong Khai section has changed over time as a result of bank erosion and accretion by using data based on hydrographical atlases from the 1960s and early 1990s and SPOT5 satellite image in 2005
- compare the EIA 3D model results of the simulated hydraulic forces related to the bank erosion, with the measured bank erosion
- present some simulation scenarios of possible human impacts on bank erosion caused by hydraulic forces
- discuss the possible causes of the changes in bank erosion rates in the study area between the two time periods



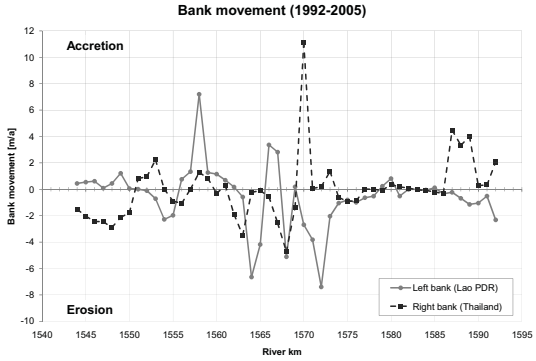
Bank erosion: River channel changes, such as bank erosion, downcut and bank accretion, are natural processes for an alluvial river. However, development like sand mining, infrastructure building on the river bank, artificial cutoff, bank revetment, construction of reservoirs and land use alterations have in many places changed the natural geomorphological dynamics of rivers.

	Annual area [ha/a]			
	1960 -1990		1990 -2005	
	Lao	Thai	Lao	Thai
Erosion	3.4	4.4	4.9	3.4
Accretion	2.0	2.0	2.5	3.3



Simulated horizontal (colours) and vertical velocities (crosses and circles). Observe that the highest vertical velocities tend to occur in the high erosion areas.

Bank erosion in the lower Mekong Basin has become a serious issue and its impacts have been significant



Main findings:

- The average annual erosion rate has dropped from 4.4 ha/a to 3.4 ha/a in the Thai side, but has increased from 3.4 ha/a to 4.9 ha/a in the Lao side.
- The bank erosion in the low Mekong River has become a serious issue and its damages have been significant
- Though the model has not yet been linked with actual river channel changes, the 3 D model has created a very promising start to couple the fluvial shear stress data with bank erodability data for calculating erosion rate estimates along the river channel
- the model has proved to be a useful and user friendly tool in simulating the impacts of man made interventions in the river channel; the simulation results show very local changes in the flow pattern when no major changes in the river cross-section are made

Climate change in Nam Songkhram

10

The effect of climate change on hydrology and flooding of the Songkhram River basin in Thailand was studied using a combination of a distributed hydrological model and a 3D flood model. The target basin, having an area of 13,138 km2, is located in North-eastern Thailand and is a part of the Mekong Basin. The climate of the area is dominated by monsoon rains that create a yearly flood pulse and cause extensive flooding specially in the Lower Songkhram River area.

The main aim of the study was to simulate the impacts of the climate change scenarios on the hydrology and flooding in the Songkhram River Basin. The results of the VMod hydrological model were used as boundary conditions for the EIA 3D model. The following parameters were simulated:

- Impact of the climate changes on discharge (results of the VMod model)
- Impact of the climate changes on flooding
  - o Flood arrival time
  - o Maximum flood extent
  - o Duration of inundation
  - o Water level in a few selected places in the floodplain
- Impact of the climate change on the reverse flow from the Mekong main stream based on the scenario results from the Mekong basin wide hydrological model (VIC)

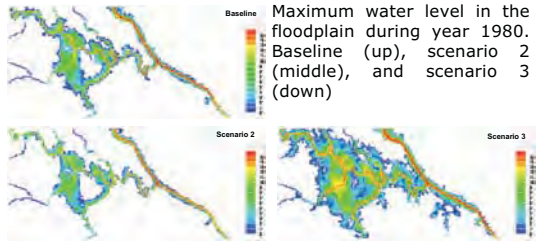
> **The water level in the floodplain is dominated by the water level in the Mekong mainstream**

The baseline condition for running the model is atmospheric carbon content that compares with the situation of 1980's (Chinvanno and Snidvongs, 2005). The atmospheric model CCAM was used to simulate climate conditions with three different levels of Atmospheric Carbon content:

- Baseline: Baseline period on 1980 – 1989 (atmospheric carbon content 360 ppm)
- Scenario 2: Atmospheric carbon content 1.5 x compared to the baseline (540 ppm)
- Scenario 3: Atmospheric carbon content 2 x compared to the baseline (720 ppm)

Table 1. The hydrological characteristics for the baseline and the two climate scenarios in Ban Tha Kok Daeng during the 1980-1989.

	Baseline scenario A Discharge m^3/s	Scenario B Change (%) from scenario A	Scenario C Change (%) from scenario A
Average precipitation	1628 mm/a	3.3 %	8.8 %
Average discharge	115	8.4 %	23.1 %
Average yearly maximum discharge	533	7.2 %	10.6 %
Average yearly minimum discharge	0.05	-31.0 %	-3.4 %
Average dry season discharge	2.3	54.7 %	-31.4 %
Average wet season discharge	226	7.9 %	23.6 %



Maximum water level in the floodplain during year 1980. Baseline (up), scenario 2 (middle), and scenario 3 (down)

> **The increase in the discharge is 2-2.5 times larger than increase in precipitation for same climate scenarios**

The Mekong water level is the main factor defining the flood behaviour in lower Songkhram River and the impact of local upstream flood control on flooding would be negligible. It is therefore crucially important to understand the impact of climate scenarios on Mekong mainstream water levels in order to be able to predict the impacts of the climate change on the flooding in the Songkhram floodplains.

Main findings:

- The water level in the floodplain is controlled by the water level in the Mekong mainstream.

→ regulation of the Nam Songkram River and its tributaries has no effect on flooding in the Nam Songkhram floodplain

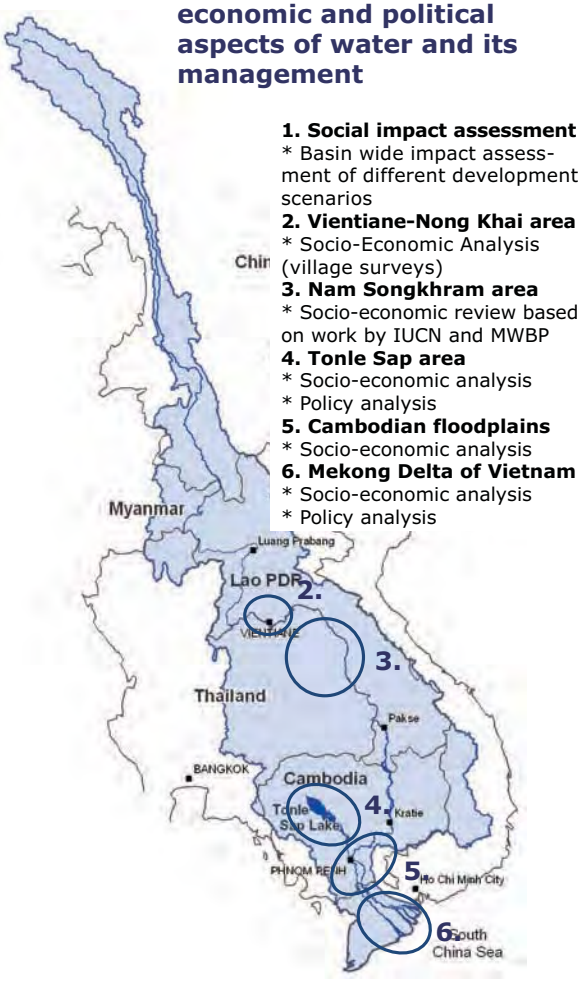
- Based on the simulations the flooded area, flood height, and flood duration, would increase in Scenario 3 but decrease in Scenario 2
- It is crucially important to understand the impact of climate scenarios on Mekong mainstream water levels in order to be able to predict the impacts of the climate change on the flooding in the Nam Songkhram floodplains
- The high productivity of the floodplains and rich fisheries in the Nam Songkhram floodplain is based on the flood pulse

Livelihood impacts

This brief provides a summary of the results achieved by WUP-FIN socio-economic and policy analysis component in assessing and analysing the livelihood-related impacts of water-related development. The findings emphasise the significance of social, political and economic aspects of water management, and highlight the need for an interdisciplinary approach that allows these issues to be properly taken into account also in water modelling projects.

The socio-economic and policy analyses carried out within the WUP-FIN increased the understanding of social, economic and political issues related to water resources and their management particularly in the local level. This increased understanding was then used to support other project components as well as to facilitate social impact assessment both locally and more broadly in basin-wide scale. As the analyses built on participatory research methods, they also allowed us to compare –and contest– our interpretations about water resources management with those of other actors and stakeholders.

"Socio-economic and policy analyses improved our understanding of social, economic and political aspects of water and its management



1. Social impact assessment
* Basin wide impact assessment of different development scenarios
2. Vientiane-Nong Khai area
* Socio-Economic Analysis (village surveys)
3. Nam Songkhram area
* Socio-economic review based on work by IUCN and MWBP
4. Tonle Sap area
* Socio-economic analysis
* Policy analysis
5. Cambodian floodplains
* Socio-economic analysis
6. Mekong Delta of Vietnam
* Socio-economic analysis
* Policy analysis

Based on our experience from the socio-economic and policy analysis work, we have concluded with eight main findings:

Findings related to methodology:

- Socio-economic and policy analyses can contribute significantly for the modelling and impact assessment, making it more focused and balanced
- Applying multiple methods for socio-economic analysis in multiple levels is needed to overcome the weaknesses of individual research methods
- Estimating the actual value of resource use and its contribution to people's well-being is challenging – and currently most probably underestimated
- Cooperation and dialogue with other actors provides clear benefits for analysis and impact assessment process

Findings related to livelihood impacts:

- Livelihoods and governance contexts are extremely diverse both within and between case study areas
- The poorest groups are deeply dependent on aquatic resources, and are therefore particularly vulnerable to the changes in river flow and availability of aquatic resources
- Already existing small-scale utilisation of Mekong's resources forms more sustainable basis for water management aiming at poverty reduction – and should be used as starting point for discussion about trade-offs
- Balanced water management requires better understanding of governance context –including access to and control over water-related resources– as well as recognition of highly political nature

Economic growth vs. Poverty reduction

12

This brief draws together selected findings related the basin-wide socio-economic development, with focus on the dilemma of poverty reduction and economic growth. We scrutinise the relation between economic growth and poverty reduction in the Mekong context, by elaborating different concepts and definitions of poverty and comparing them to the conditions in the Mekong countries.

Should the water resources policy of the Lower Mekong River basin have its priority in environmental conservation, in maximizing economic growth, or in reducing poverty as much as possible? The needs are huge in all of these aspects. Cautious scrutiny, open dialogue and compromise-building are needed, because these three inter-linked facets of development very easily collide in conditions such as those of the Mekong Basin.

> **“ The definition of poverty is far more many-sided and complicated than what is usually thought of**

In macroeconomics, the basic ground to allow poverty alleviation is economic growth; without growth, there is not more to distribute to the poor than before. Whereas this is basically right, it tells only a part of the story. In many low-income countries, the growth of the Gross National Income (GNI) means in reality widening income gap and polarization of the society.

The concept of poverty is also far more many-sided and complicated that what is usually thought of. The literature on poverty is rich –and highly inconsistent– in approaches to its analysis, alleviation, and definition. In the Mekong context, particularly challenging is to define accurately poverty, or wealth, in the communes dependent mainly on diversity of different natural resources such as fish and wetland products.



The relationship between poverty reduction and economic growth is thus very much linked with the differences between so-called modern sector and more traditional sector. An income indicator such as 1$/day applies well to people within the modern sector, but not at all to people who are living in the traditional sector. Such an indicator may give an increased income value to an absolutely impoverished individual who was before a respected and prosperous farmer not using much money, but is now living in a shantytown of a big city. How we should then develop the poverty concept to cope with the differences between traditional and modern sector? We see that the definition proposed by Amartaya Sen, Nobel Laureate of Economics of 1998, building on concept of deprivation provides a good starting point also for the Mekong Region: poverty is not only an income issue but an outcome of social deprivation.

Main findings:

- The concept of poverty is far more many-sided and complicated than what is usually considered, particularly in the communities dependent on natural resources for their livelihoods; economic growth alone is not sufficient condition for poverty reduction.
- Since the income indicators used in economics (such as $1 a day) are not able to capture this complexity properly, more elaborate alternatives should be used instead. The concept of ‘deprivation’ is perfectly suitable definition of poverty also in the Mekong Region.
- Deprivation leads typically to social exclusion and marginalization and such groups are particularly weak in finding themselves out of poverty by “self-help”, and economic growth does not trickle down to these people.
- When looking at the connections between poverty reduction and economic growth, special emphasis should be put on the differences between modern and more traditional sectors: development of modern sector should not marginalize and exclude those dependent on more traditional livelihoods.

The thematic and methodological briefs presented in this volume summarise the main methods and outputs of so-called WUP-FIN Project. More detailed information on the topics of the briefs can be found from different WUP-FIN reports, in particular from WUP-FIN Final Report Part II. The briefs included in this volume are:

METHODOLOGICAL BRIEFS

- WUP-FIN Models
- WUP-FIN Policy Models
- Impact Assessment
- Capacity building

THEMATIC BRIEFS

- Flow alterations & flood pulse: Future of Tonle Sap Lake?
- Sediment issues
- Tonle Sap ecosystem productivity
- Mekong Delta and socio-economic analysis
- Bank erosion
- Climate change in Nam Songkhram
- Livelihood impacts
- Economic growth vs. poverty reduction

WUP-FIN was a complementary project to the Mekong River Commission Water Utilization Programme (MRC/WUP). The project was funded by the Finnish Ministry for Foreign Affairs. The project had two phases: Phase 1 (2001-2004): Modelling of the Flow Regime and Water Quality of the Tonle Sap, and Phase 2 (2004-2006): Hydrological, Environmental and Socio-Economic Modelling Tools for the Lower Mekong Basin Impact Assessment. More information on the project and its publications can be found at www.eia.fi/wup-fin.