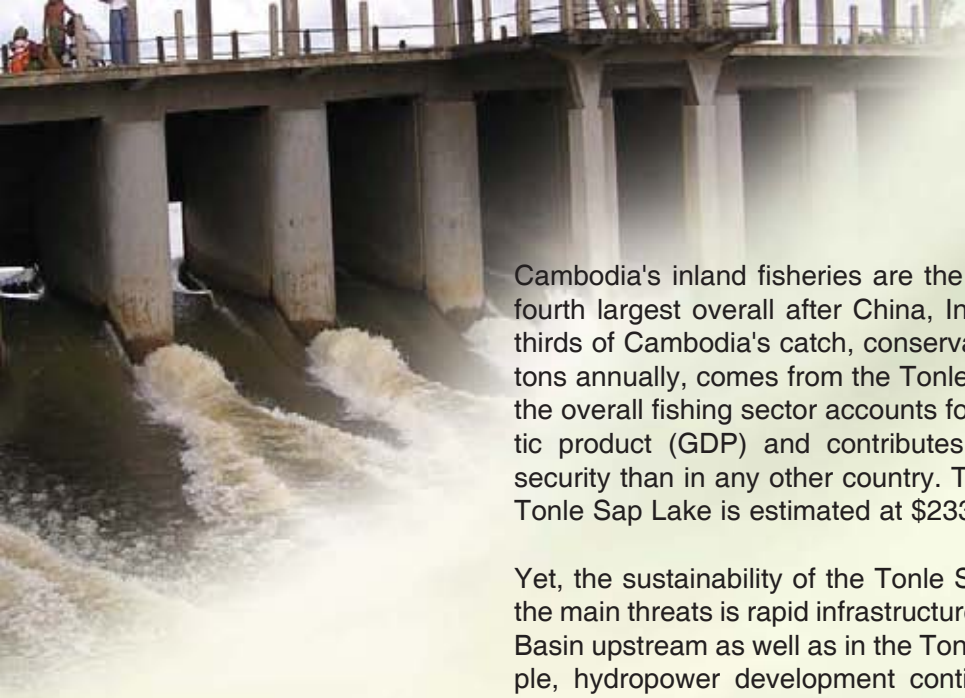
Infrastructure and Tonle Sap fisheries

How to balance infrastructure development and fisheries livelihoods?

THE CHALLENGE FACING DECISION-MAKERS IN CAMBODIA

POLICY BRIEF

Partner institutions:
• Ministry of Environment
• Ministry Of Water Resources And Meteorology



Cambodia's inland fisheries are the most intensive worldwide and the fourth largest overall after China, India, and Bangladesh. Almost two-thirds of Cambodia's catch, conservatively estimated at 400,000 metric tons annually, comes from the Tonle Sap watershed. In terms of value, the overall fishing sector accounts for 10 to 12 percent of gross domestic product (GDP) and contributes more to income, jobs and food security than in any other country. The value of the fish catch from the Tonle Sap Lake is estimated at $233 million a year.

Yet, the sustainability of the Tonle Sap fisheries is in question. One of the main threats is rapid infrastructure development in the Mekong River Basin upstream as well as in the Tonle Sap catchment basin. For example, hydropower development continues to be a high priority in the Mekong region in general, with numerous new projects under construction or proposed for development in the near future. Irrigation and flood mitigation, especially in the Lower Basin, are also the focus of significant investments.

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Built structures[1] such as dams, irrigation schemes, and roads all have numerous economic benefits. However, their impact on water flows, which in turn affects seasonally-submerged habitats and fish-migration routes, may also lead to negative hydrological, environmental and social side effects. A major challenge for decision-makers is to understand the trade-offs associated with infrastructure development and find ways to minimize adverse impacts on the sustainability of Tonle Sap fisheries while maximizing social and economic benefits.

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The Cambodian government's Rectangular Strategy, focusing on growth, employment, equity and efficiency, highlights the importance of developing infrastructure and enhancing the agriculture sector, including sustainable access to fisheries for the poor. Under the plan for 2006 to 2010, support is being provided to Commune Councils to undertake rural infrastructure projects such as rehabilitating roads and building small bridges and culverts, wells, sanitation structures, schools, water gates and small irrigation systems.

"It is time now that resources begin to be properly directed and effectively used to maximize benefits for the disadvantaged and the deprived, to lift them into the mainstream," Samdech Prime Minister Hun Sen said in his foreword to the five-year plan. The Prime Minister has also highlighted the Tonle Sap's crucial role as an important fish habitat. "We must try our best to preserve and sustain the national

[1] Built structures consist of a variety of man-made structures that contribute to changing the hydrology of a natural system. They can: (i) oppose water outflow (e.g. dams, weirs, irrigation schemes, dykes); (ii) prevent water inflow (e.g. embankments, polders, levees); (iii) change water inflow or outflow (e.g. roads, canals, large scale fishing gears); (iv) degrade water quality (e.g. factories, sewers).

fishery resources for our younger generations to come," he said during the National Fish Day ceremony in 2006.

Cambodia's policy priorities for growth and infrastructure development are clear, as are priorities for the protection of the aquatic environment and sustainable rural livelihoods. Balancing these priorities involves conscious trade-offs, and there is an urgent need for information that can document these trade-offs as the country's economy rapidly progresses.

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THE STUDY

This document summarizes some of the major findings and recommendations of a study on the influence of built structures on the fisheries of the Tonle Sap[2]. The research, funded by the Government of Finland through the Asian Development Bank, was carried out between May 2006 and March 2007 by the WorldFish Center with partners. The Cambodian National Mekong Committee was the Executing Agency of the study. Research partners included the Inland Fisheries Research and Development Institute and the Tonle Sap Biosphere Reserve Secretariat in Cambodia and a consortium of Finnish scientists.

The multidisciplinary study analysed the influence of these structures as well as the potential influence of planned water development projects upstream in the Mekong River system. The study considered influences on hydrology, fish, the environment, and ultimately on people around the Tonle Sap.

The study, based on a number of future water development scenarios[3], aims to provide guidance for decision-makers as to how to minimize adverse impacts on the sustainability of Tonle Sap fisheries while maximizing the benefits of infrastructure development. While the study's findings and recommendations are directed in particular at decision-makers, they are also relevant to scientists and development professionals working with government agencies, research institutions, donors and non-governmental organisations, and the public more broadly.

[2] A more complete summary of findings and recommendations is provided in a companion synthesis report, "Influence of Built Structure on Tonle Sap Fisheries", available from the Cambodian National Mekong Committee, and online at www.worldfishcenter.org, along with the full set of scientific reports on which the policy brief is based.

[3] To assess the potential hydrological impact of new water development infrastructure in the future, the study examined three scenarios based on different levels of future development on the Mekong River mainstream: a "baseline scenario" representing the actual situation in 2000; an "intensive basin development scenario", representing a combined water-storage capacity of 55 cubic kilometers, including seven more hydro-electric dams built across the mainstream in the Upper Mekong by 2025; and an "extreme basin development scenario", assuming an additional seven dams on the mainstream in Lao PDR, Cambodia, and Thailand, and additional dams on Mekong tributaries, boosting the total storage capacity to 140 cubic kilometers. The study also considered one scenario for the Tonle Sap watershed, assuming limited development of dams on the seven lake tributaries, with a combined storage capacity of 5.5 cubic kilometers.

WHAT ARE THE CURRENT AND POSSIBLE FUTURE INFLUENCES OF BUILT STRUCTURES ON THE FISHERIES OF THE TONLE SAP?

At the level of the Mekong Basin, the most significant built structure type evaluated was large-scale dams and associated reservoirs.

The construction of dams upstream in the Upper Mekong Basin, as well on tributaries of the Tonle Sap, promises numerous benefits. Dams produce reservoirs used for irrigation, and hydroelectric power that can create opportunities for new economic activities. Yet, these benefits come at a significant cost.

By using hydrological modeling, the study showed that upstream damming in "intensive" and "extreme" development scenarios could reduce inflows to the lake by ten to twenty-five percent in dry years. The annual flood could also be delayed for up to a month and end up as soon as two weeks earlier than normal. The height of the floodwaters, and the surface area covered, would also significantly decline.

Upstream damming could reduce inflows to the lake by ten to twenty-five percent in dry years. The annual flood could also be delayed for up to a month and end as soon as two weeks earlier than normal.

Dams would have a major impact on fisheries. First, they could disrupt migration patterns and routes. Eighty-seven percent of Mekong River Basin fish species for which information is available are migratory. For these species, the physical presence of dams would block normal migration routes leading to a drop in fish stocks and catches. Sixteen percent of these migratory fish species are also known to be sensitive to hydrological triggers; thus delays to the onset of the flood or changes to water level are likely to disrupt fish migration patterns. Because these migratory species make up a dominant part of Cambodia's annual fish harvest, these changes caused by damming could seriously impact Cambodia's fisheries. The loss of even a small percentage of this fishery represents tens of thousands of tons and millions of dollars worth of fish.

Second, upstream damming would also threaten fisheries by adversely affecting water quality. Drops in the amount of oxygen in the water and changes in drift patterns could have a negative impact on fish eggs, larvae, and juveniles. More importantly, upstream damming would trap massive amounts of sediment, which is expected to reduce the overall water productivity and subsequent fish productivity. At the same time, sediment trapping would also have a negative impact on soil fertility resulting in a drop in rice production or an increase in production costs due to heightened use of fertilizers.

Reservoirs created by damming do not compensate for the loss of fisheries downstream.

While the reservoirs created by damming are sometimes presented as a way to create new fisheries upstream, a review of literature worldwide shows that this typically would not compensate for the loss of fisheries downstream. In the Mekong, only 9 species are known to breed in reservoirs.

Finally, according to hydrological modeling, upstream damming would increase discharge in the dry season, which would then expand the surface area of the lake by between 300 and 900 square kilometers. These rising water levels would result in the Tonle Sap flooded forest being permanently inundated in the dry season, and ultimately in its dying. This would correspond to the destruction of a crucial breeding and feeding habitat for numerous fish species. More generally, with 296 fish species, the Tonle Sap Lake is the third richest lake in the world in terms of fish diversity; it has almost a third of all species and half of all families recorded in the Mekong Basin, which makes it a very significant biodiversity hotspot to be protected.

At the level of the Tonle Sap Basin, the study also assessed localized influences of specific types of built structures.

Rising dry-season water levels could result in the loss of the Tonle Sap flooded forest

The first case study examined the influence of road development in floodplains. The socioeconomic advantages of road construction are numerous. Roads provide better access to public services and markets, allowing increased trade in fish and other products, and reduce dependent on fisheries by increasing alternative livelihood options. The low velocity of water flows on the floodplains means that roads do not significantly impact the rise and fall of floodwaters. However, the location and design of roads is key in determining their impact on fish habitat and migration. The scientific literature points to habitat fragmentation as a frequent negative impact of road construction on fisheries.

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In addition to technical and engineering measures, negative impacts of built structures should be addressed through management and operational measures. The road management committee in the case study area, for example, prohibits culverts on the road from being blocked by fishing gears, a commendable practice that should be encouraged elsewhere in the country.

The second case study examined the influence of irrigation schemes. Hydrological structures including small-scale reservoirs in the Tonle Sap floodplain so far have had a limited impact on water flows and water quality due to the smaller overall volume of water they are able to trap. However, the cumulative effect of these reservoirs might be significant if their number continues to increase. A case study on the Stung Chinit reservoir showed that irrigation schemes can offer a range of opportunities for economic development to some villages that directly benefit from the irrigation. The Stung Chinit reservoir has created a relatively productive fishing ground, allowing for livelihood diversification, although the local fishermen interviewed are concerned that the reduced connection to downstream areas could eventually erode reservoir production, and hence such positive impacts on fisheries could be short-lived. On the other hand, villages downstream seem to have already suffered a reduction of fish in the river and the rice fields, and are also concerned that releasing the reservoir's water could cause flash flooding.

Tonle Sap irrigation schemes so far have had a limited impact on water flows and water quality. However, the cumulative effect of these reservoirs could become significant.

The third case study examined the influence of fishing lot fences as large scale structures. Bamboo fences and nylon nets attached to the fences are unique to the Tonle Sap Lake and its floodplain; their total length currently amounts to 409 kilometers. Experiments conducted for this study have shown that these fishing fences do not significantly reduce the speed of water flows. On the other hand, the fences have a clear impact on fish movement, even more so when nylon nets are attached. A better understanding of the fish stock and ecology, including migration corridors, is essential to determine the optimal length and design of large-scale fishing fences to ensure a sustainable level of harvest.

The livelihood influence of built structures is closely linked to the way they are operated and managed.

The livelihood influence of built structures is closely linked to the way they are operated and managed. This is especially evident in the case of fishing structures, which can be used under two management regimes (fishing lots and community fisheries). How different these two systems are in terms of actual impacts on fisheries resources is unclear. What is clear is that both management systems suffer from a prevalence of highly destructive fishing practices such as electro-fishing, damming and pumping of water out of streams. The case study illustrates that there are trade-offs between productivity, equity and possibly sustainability. These trade-offs need to be better understood when management options are selected for particular fishing grounds.

WHAT ARE THE IMPLICATIONS FOR PLANNING BUILT STRUCTURES?

The impact of built structures is heavily influenced by institutional decision-making. Therefore, sound planning is needed to ensure the maximization of advantages and minimization of disadvantages from infrastructure development.

Environmental Impact Assessments have not systematically addressed socioeconomic issues, lack a comprehensive mechanism for stakeholder consultation and have failed to address the cumulative impact of large-scale infrastructure projects.

Environmental Impact Assessments (EIAs) are an important step in the process of developing new structures. The study showed that EIAs for Tonle Sap infrastructure projects have so far been limited in terms of both technical content and processes. They tend to focus on the geographic area of the project, which provides at best a partial estimate of their impact, and on the short-term biological and physical changes to water flows and fisheries. Furthermore, they do not systematically address socioeconomic issues and lack a comprehensive mechanism for the consultation of stakeholders such as local communities, provincial authorities, and non-governmental organizations. Finally, EIAs have failed to quantify or even address the cumulative impact of large-scale infrastructure projects, which involves more than just adding up their individual impacts.

Broader precautions in development planning are needed at the international, national, and sub-national levels. Plans should encompass linkages between hydrology, fisheries, livelihoods, and environmental concerns. While such integration might not always be feasible at the local level due to resource constraints, higher-level assessments of built structures should integrate the impact on the entire Tonle Sap ecosystem. The whole range of positive and negative impacts of infrastructure developments need to be identified to clarify the range of options available to stakeholders and to support decision-making. One way to facilitate constructive debate, initiate difficult trade-offs, build stakeholder consensus, and maintain transparency is to include public consultation throughout the infrastructure development process. Closer communication is also needed between various stakeholders, including the various ministries responsible for irrigation and road building.

Negative impacts of built structures do not depend solely on technical and engineering factors; they also depend significantly on the way structures are managed and operated. All the case studies clearly showed that management and social issues associated with built structures, such as access to benefits, use rights and regulations, and operations, can be perceived at the local level as more crucial than the technical design of the structure itself. Finally, infrastructure investments should be planned so that poor households can best take advantage of new livelihood opportunities. Such planning could include extension activities, complementary investments in education, micro-finance, and community development by both the government and non-governmental organizations.

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Currently, projects such as dam building may yield the majority of their benefits to upstream regions or national economies, while downstream communities are forced to bear most of the costs. Likewise, the benefits of roads, irrigation schemes, and fishing lots tend to go more to wealthier groups. With sound planning, the benefits of future infrastructure development can be shared more equitably.

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RECOMMENDED ACTION POINTS FOR PLANNING INFRASTRUCTURE PROJECTS THAT AFFECT TONLE SAP FISHERIES

Based on the lessons learned from the basin-wide scenario evaluation as well as local case studies, the following recommendations were developed. They aim to help decision-makers maximize the benefits of infrastructure development, while minimizing its adverse effects. These action points are divided into two sections: those relevant to national and to sub-national decision-making.

NATIONAL-LEVEL DECISION-MAKERS

The following recommendations are for national decision-makers, including policymakers in the 10 ministries that are members of the Cambodian National Mekong Committee, as well as lawmakers in the National Assembly and Senate commissions that oversee infrastructure development. They are also targeted at domestic and foreign investors in the private sector and at international donors.

Recommendation 1

When planning infrastructure development, avoid irreversible changes to water flows, especially those affecting seasonal flooding or breaking the natural "connectivity" between various water bodies around the Tonle Sap.

Recommendation 2

In assessing plans for dams and other water developments upstream on the Mekong mainstream, highlight the significant impacts on flooding in the Tonle Sap Lake.

Recommendation 3

In addition to considering the seasonal impact on water flows, planning of upstream water developments should specifically take into account possible ecological consequences of the changes in flooding, including loss of flooded forests, reduced inflows of sediments, lower oxygen levels, and changes in the drift of fish larvae and juvenile fish.

Recommendation 4

The livelihood benefits of floodplains should be properly evaluated and integrated into basin-wide water development planning, with particular focus on the impact of dams on fisheries.

Recommendation 5
Adopt regional guidelines such as the Strategic Environmental Framework for the Greater Mekong Sub-region (GMS), which promote strategic environmental assessments addressing the cumulative impacts of multiple development projects.

Recommendation 6
Give special attention to infrastructure developments within the Tonle Sap Basin, because these have direct impacts on fisheries, and because they can magnify the influence of upstream changes in water flows.

Recommendation 7
Improve the Environmental Impact Assessment process, particularly the coverage of fisheries, coupled with capacity-building for EIA practitioners.

Recommendation 8
Impact assessments and regional negotiations over water allocation should take into account the unique importance of the Tonle Sap Lake for fisheries productivity and fish diversity not only in Cambodia but throughout the Mekong system.

Recommendation 9
When assessing the impact of infrastructure development on Tonle Sap fisheries, focus on species that are economically important and that depend on hydrological triggers for migration. In particular, prioritize trey sleuk russey (*Paralaubuca typus*), trey chhkok and trey sraka kdam (two species from the Cyclocheilichthys genus) and trey pra (species from the Pangasius genus) as indicator species.

Recommendation 10
In designing fisheries management strategies and conducting impact assessments, consider three ecological groups of fishes rather than the traditional two. This highlights the importance of species which rely on tributaries as dry season refuges.

SUB-NATIONAL DECISION-MAKERS

The following recommendations are aimed at decision-makers at the sub-national level, including provincial administrators and officials in the provincial departments of the 10 ministries that are members of the Cambodian National Mekong Committee, as well as district administrators, Commune Councils, community fishery committees, domestic and foreign investors in the private sector, and international donors and non-governmental organizations.

ROADS

Recommendation 11
Explicitly take water flows and fish-migration routes into account when planning and building roads in floodplains, using culverts and bridges to avoid blocking complex networks of channels. Also ensure that planning addresses how these structures will be managed and maintained.

Recommendation 12
Coordinate road development among ministries and also with local institutions, particularly Commune Councils, to ensure proper planning and maintenance.

Recommendation 13
Ensure that road planning takes into account the poorest groups by clarifying who will benefit and how. Provide alternative livelihood support services targeting poorer families to help them accumulate household assets, such as education, cattle and savings.

IRRIGATION

Recommendation 14
Assess the ecological impacts of dams and reservoirs at the planning stage. Determine the pros and cons in the long run so that informed decisions can be made and mitigation measures taken.

Recommendation 15
Analyze the social and economic costs and benefits of irrigation projects for different social groups at the planning stage. Make complementary investments to make sure poorer households can take advantage of new opportunities.

Recommendation 16
Provide training to Commune Councils to build effective communication channels between local officials, engineers and villagers. Support the establishment of water-user committees to promote equitable distribution of water and avoid conflicts over operating and maintaining the system.

FISHING LOTS

Recommendation 17
Promote future studies on how large-scale fishing fences affect the movement of fish and longer-term fish recruitment, and appropriate mitigation measures.

Recommendation 18
Decisions on where and how large-scale lot systems are implemented should take into account economic, social, and ecological trade-offs as compared to other management options such as community fisheries.

Recommendation 19
When fishing lots are released and access opened to local communities, there are apportunities for relatively wealthier households to capture more of the benefits. Pay specific attention to institutional mechanisms to ensure equity and manage conflicts.

OVERALL RECOMMENDATIONS FOR LOCAL INFRASTRUCTURE PLANNING

Recommendation 20
Ensure that negative impacts of built structures are addressed through the management and operational aspects of projects in addition to technical and engineering measures.

Recommendation 21
Improve management of fisheries around built structures adapted to the newly created social dynamics and fishing environment, through better enforcement of regulations and coordination of stakeholders, including community fisheries, government agencies, donors, and non-governmental organizations.

Recommendation 22
Hold systematic consultations between national and local stakeholders throughout the project development and help local people articulate their needs and concerns. Evaluate and publicly debate the social, economic and ecological trade-offs arising from different development scenarios before deciding on a specific option.

Recommendation 23
Link infrastructure planning to the decentralized institutions for rural development and natural resource management (commune, district, and provincial councils).

Recommendation 24
Analyze how the costs and benefits of a project affect different social groups, taking the role of local institutions and differences in household assets into account. Considering the importance of poverty alleviation in Cambodia's development agenda, make special provisions to involve the poorest groups in project planning.

Recommendation 25
Complement infrastructure projects with investments in basic education, training and technical support.





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