ADB

Technical Assistance

TAR: CAM 37576

Technical Assistance to the Kingdom of Cambodia for the Study of the Influence of Built Structures on the Fisheries of the Tonle Sap (Financed by the Government of Finland)

October 2005

Asian Development Bank

CURRENCY EQUIVALENTS
(as of 12 September 2005)

Currency Unit	–	riel (KR)
KR1.00	=	$0.00024
$1.00	=	KR4,163

ABBREVIATIONS

ADB	–	Asian Development Bank
CNMC	–	Cambodia National Mekong Committee
EIA	–	environmental impact assessment
IEE	–	initial environmental examination
IFREDI	–	Inland Fisheries Research and Development Institute
MRC	–	Mekong River Commission
TA	–	technical assistance
TSBR	–	Tonle Sap Biosphere Reserve
WUP-FIN	–	Water Utilization Program-Finland

TECHNICAL ASSISTANCE CLASSIFICATION

Targeting Classification	–	General intervention
Sector	–	Agriculture and natural resources
Subsectors	–	Environment and biodiversity, fishery, water resource management
Themes	–	Sustainable economic growth, environmental sustainability
Subthemes	–	Developing rural areas, natural resources conservation, environmental policy and legislation

NOTE

In this report, "$" refers to US dollars.

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I. INTRODUCTION

1. Built structures[1] such as dams, weirs, and flood control works bring social and economic benefits. But they can also alter water quantity, quality, and timing; modify flooding patterns; induce loss of habitat; affect fishery resources by blocking fish migration and access to spawning areas; and ultimately impact communities that depend on natural, especially aquatic, resources. On 29–31 August 2005, a Fact-Finding Mission of the Asian Development Bank (ADB) visited Cambodia to formulate this technical assistance (TA), in line with the program of actions formalized in the poverty partnership agreement between the Government and ADB and in ADB's Tonle Sap Basin[2] Strategy.[3] The design and monitoring framework is in Appendix 1.[4]

II. ISSUES

2. The Tonle Sap ecosystem is the permanent core area of the Tonle Sap and its floodplains, which lie within boundaries formed by the upper flood lines. It includes the Tonle Sap River, its branches, and floodplains. The Tonle Sap ecosystem is (i) the main source of animal protein for much of the population of Cambodia because of the fishery resources of the Tonle Sap, (ii) a direct and irreplaceable source of livelihood for more than 1 million people living on and around the Tonle Sap, (iii) a seasonal breeding and nursery ground and forage area for fish that migrate to the Mekong River, and (iv) an environmental hot spot of global significance. The Tonle Sap basin covers 85,000 square kilometers (km^2), of which 80,000 km^2 lie in Cambodia. It extends over 44% of Cambodia's land area and is home to 32% of Cambodia's population, or about 3.6 million people (1998 figure). It is a reservoir from which water drains in the dry season to control salinity and conserve mangrove in the Mekong delta.

3. The fishery resources of the Tonle Sap rank first in the world for their productivity[5] and fourth for their total catch[6] despite the small size of the country. The Tonle Sap ecosystem contributes 60% of this boon with the most productive floodplains worldwide.[7] The floodplains' contribution to income, employment, and food security is higher than in any other country. With the rising demand for high-value freshwater fish in Thailand and Viet Nam, their fishery resources are becoming a significant source of foreign exchange. The natural productivity of the Tonle Sap's floodplains will decline if the flood pulse, the temporarily submerged habitats, and the migration routes of the Tonle Sap are not given attention. In relation to this, the influence of built structures needs to be better assessed at the ecological and socioeconomic levels. The TA will complement the suite of loan and TA projects that ADB promotes under the Tonle Sap

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[1] These can be classified as structures that (i) oppose water outflow, e.g., dams, weirs, irrigation schemes, levees, and embankments; (ii) prevent water inflow, e.g., roads, flood control works, polders, colmatage canal systems, dykes, reclaimed urban and industrial areas, railways, wharves, and quays; (iii) alter water inflow or outflow, e.g., drainage canals, diversion structures, agricultural works such as rice field dikes, bank modifications such as the Chaktomuk peninsula extension and, in the case of the Tonle Sap, fishing gears that are set on a massive scale, alter hydrological flows and obstruct fish movements; and (iv) degrade water quality, e.g., plants with aqueous effluents, mining and mineral processing facilities, petroleum storage facilities, sewerage systems, and dredgers.

[2] The Tonle Sap basin is, strictly speaking, a subbasin of the Mekong River basin. However, in conformity with international practice for a system of this magnitude, the term Tonle Sap basin is used in this report. The catchments of the individual tributaries that flow directly into its lake are referred to as subbasins.

[3] ADB. 2005. *The Tonle Sap Basin Strategy*. Manila.

[4] The TA first appeared in *ADB Business Opportunities* (internet edition) on 4 April 2005.

[5] The catch per fisher amounts to 20 kilograms (kg) per person per year (compared with 4.5 kg/person/year in Bangladesh and 0.5 kg/person/year in India). The natural productivity of the Tonle Sap's floodplains ranges from 130 kg to 230 kg per hectare per year, which is a world record.

[6] Research suggests that production ranges from 290,000 tons to 430,000 tons per year.

[7] High biodiversity qualified the ecosystem as a biosphere reserve in 1997.

Initiative.[8] The TA's findings and recommendations are intended to find expression in the Tonle Sap Initiative. They can also inform ADB's recent work on cumulative impact assessment.

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

4. The impact of the TA will be sound management and conservation of natural resources and biodiversity in the Tonle Sap basin. Its outcome will be improved awareness of the influence of built structures on the lake's hydrology. Six accomplishments will achieve the TA's outcome: (i) a database of built structures will be created, (ii) the impact of built structures on hydrodynamics and water quality will be modeled, (iii) the influence of built structures on the environment will be assessed, (iv) the influence of built structures on fishery resources will be assessed, (v) the influence of built structures on livelihood will be assessed, and (vi) policy makers and decision makers will be informed. The principal deliverable from the TA will be guidelines recommending approaches, methods, and processes so that the design, number, and operation of built structures can maximize economic returns from investments in infrastructure development without impacting environmental sustainability or the communities that depend on the Tonle Sap.

B. Methodology and Key Activities

5. The methodology of the TA will combine fish bioecology, socioeconomics, livelihood analysis, hydrodynamic modeling, environmental impact assessment, and database construction and management. The results will be synthesized and combined into clear-cut policy briefs in the English and Khmer languages targeting policy makers and decision makers. The TA will be embedded within the Tonle Sap Biosphere Reserve (TSBR) Secretariat in the Cambodia National Mekong Committee[9] (CNMC) to ensure the best possible uptake of lessons learned. Collaboration with its key members, as well as the Inland Fisheries Research and Development Institute (IFREDI), is also intrinsic to the methodology. Activities will also rely on and create synergies with other operating outputs of the Tonle Sap Initiative, the Mekong River Commission (MRC), and the Food and Agriculture Organization of the United Nations. The TA's multidisciplinary approach will lean on surveys in four study sites.

1. Creating a Database of Built Structures

6. Built structures are, by default, any human construction. But not every built structure that influences the free flow of water and aquatic organisms deserves consideration. This output will assess built structures of concern. Key activities will include (i) conducting a scoping study on built structures, aimed at defining built structures of relevance for cataloguing, specifying the built structures of concern, and defining the limits of the study; (ii) gathering existing information on built structures of concern in the Tonle Sap basin—the existing data includes orthophotomaps prepared under the ADB-assisted Tonle Sap Environmental Management

[8] The Tonle Sap Initiative is a partnership of organizations and people working to meet the poverty-environment challenge of the Tonle Sap. Details are at http://www.adb.org/Projects/Tonle_Sap/.

[9] CNMC's mandate is to assist and advise the Government in all matters related to the formulation of water policy, strategy, management, preservation, investigation, planning, restoration, and the development of the water and other natural resources of the Mekong River basin within Cambodia. CNMC is chaired by the Minister of Water Resources and Meteorology.

Project,[10] MRC data on projected infrastructure development, and information from the World Bank-assisted Land Management and Administration Project; (iii) ground-truthing built structures of concern in selected locations; and (iv) producing a database of the characteristics of built structures of concern.[11]

2. Modeling the Impact of Built Structures on Hydrodynamics and Water Quality

7. Given the large variability of natural conditions and processes, it is difficult to measure directly the impacts of all built structures of concern. This output will apply mathematical modeling as the only feasible option. Mathematical modeling is now common for environmental management and the 3D hydrodynamic and water quality model developed for the Tonle Sap basin under the Water Utilization Program-Finland (WUP-FIN)[12] Phase I (2001–2003) will be used.[13] The model's resolution of 1 kilometer can give an overall picture of medium to large impacts, but a more detailed study will be needed for local impacts and to bridge the gap between hydrology, hydrodynamics, water quality, and fish habitat. Key activities will include (i) integrating large-scale built structures, at the basin level, into the Tonle Sap hydrodynamic and water quality model;[14] (ii) integrating small-scale built structures, if possible at the basin level, into the Tonle Sap hydrodynamic and water quality model;[15] (iii) assessing the impact of major fishing gears[16] on hydrodynamics, integrating major fishing gears in the Tonle Sap hydrodynamic and water quality model, and quantifying their impact on fish migration; and (iv) conducting quantitative analysis of hydrodynamic and water quality differences with and without built structures.[17]

3. Assessing the Influence of Built Structures on the Environment

8. This output will assess the side-effects of built structures of concern on the environment. It will streamline information at two levels to assess possible cumulative impacts. Key activities will include (i) reviewing the documented short-term and long-term influence of built structures in tropical floodplains worldwide, from environmental and social safeguard perspectives; (ii) synthesizing the findings and recommendations from environmental impact assessments (EIAs) and initial environmental examinations (IEEs) conducted for development projects in the Tonle Sap basin, from environmental and social safeguard perspectives; and (iii) identifying gaps in the approaches, methods, and processes followed by EIAs and IEEs in the Tonle Sap basin.

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[10] ADB. 2002. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Cambodia for the Tonle Sap Environmental Management Project.* Manila.

[11] The database will be used to model the impact of built structures on hydrodynamics and water quality and assess their influence on the environment, fishery resources, and livelihood.

[12] WUP-FIN is a flexible consortium centering on the Finnish Environment Institute, the Environmental Impact Assessment Center of Finland, and the Helsinki University of Technology.

[13] WUP-FIN Phase I (2001–2003) and Phase II (2004–2006) complement the Water Utilization Program of the Mekong River Commission (MRC). Phase I created means to understand physical, chemical, and biological processes in the Tonle Sap. Phase II aims to expand the experience to other subbasins in the Greater Mekong Subregion. It focuses on integrating hydrodynamic and socioeconomic data, tools, and results into MRC's decision support framework, training associated staff members of MRC and the national Mekong committees, estimating environmental and socioeconomic impacts of development projects, and devising ways to mitigate harmful effects.

[14] Large-scale structures include dams, roads, weirs, and flood control works.

[15] Small-scale structures impacts have to be parameterized in the model's 1-kilometer grid scale.

[16] There are over 200 types of gear in use on the Tonle Sap. Large-scale gear includes barrage traps, *dai* (bagnets), and arrow-shaped traps.

[17] The impacts will be calculated for dry, wet, and average flood cycles and the results cast into a form that can be easily used to assess the influence of built structures on fishery resources and disseminate lessons learned.

4. Assessing the Influence of Built Structures on Fishery Resources

9. This output will assess the influence of built structures on fishery resources based on a comparative approach (i.e., built versus pristine sites). It will be based on identification of the main guilds of fish species that have similar responses to hydrological and environmental modifications.[18] Given the time constraint (half a biological cycle), field studies will rely primarily on traditional ecological knowledge gathered in selected study sites in coordination with output 5. The information gathered will be combined with output 2 and integrated into the BayFish Tonle Sap model developed by the WorldFish Center and IFREDI[19] to assess the response of fish to changes driven by built structures and weigh the influence of these structures vis-à-vis other independent parameters. Key activities will include (i) surveying local knowledge of the influence of built structures on fish production and species ecology in four study sites; (ii) combining fish ecology data and the changes in hydrology and water quality predicted by the Tonle Sap hydrodynamic and water quality model, with emphasis on large-scale fishing gears; (iii) integrating output 2 into the BayFish Tonle Sap model and forecasting the impacts of hydrological changes on fishery resources; and (iv) quantifying, based on available information, the influence of built structures on fishery resources.

5. Assessing the Influence of Built Structures on Livelihood

10. Building on outputs 3 and 4, output 5 will conduct a livelihood analysis focusing on communities that depend most on aquatic resources. This output will consider first-order impacts, namely (i) changes in resource access by different social groups; (ii) diet (including seasonal variation); and (iii) income, and, if feasible, second-order impacts such as conflict over fishery resources.[20] Key activities will include (i) reviewing the main consequences of built structures on the livelihood of fish-dependent communities in tropical floodplains worldwide; (ii) conducting participatory rural appraisal, distributing open-ended questionnaires, and conducting key-informant interviews[21] in four study sites directly affected by built structures and in one pristine study site; (iii) assessing the possible influence of built structures on the livelihood of Tonle Sap communities; and (iv) probing the availability of alternative livelihood to assess the extent to which the loss of one source of income or food can be replaced given the local ecological and economic context.

6. Informing Policy Makers and Decision Makers

11. Building on outputs 1, 2, 3, 4, and 5, output 6 will synthesize all lessons learned and make them accessible to a large audience. Key activities will include (i) preparing policy briefs; (ii) preparing guidelines on the design, number, and operation of built structures; and (iii) disseminating the policy briefs and guidelines.[22]

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[18] This analysis is made possible by tools recently developed by FishBase at the WorldFish Center.

[19] This is a model of fish production developed under ADB. 2002. *Technical Assistance to the Kingdom of Cambodia for Capacity Building of the Inland Fisheries Research and Development Institute*. Manila (TA 4025–CAM).

[20] Conflict has escalated in recent years as more compete over a limited resource. Its forms have been protests, arrests, petitions, confiscation of fishing gear, injuries, and killings of fisherfolk and fisheries officers. All are widely reported in the media. They occurred because of (i) different interpretations of the boundaries of fishing lots, community lots, and public access areas; (ii) conversion of the flooded forest for other uses (e.g., rice cultivation) by the villagers; (iii) illegal fishing operations by lot operators and villagers; and (iv) competing uses of water for fishing and irrigation.

[21] Informants will include fisheries authorities, nongovernment organizations, and fishing lot owners. The participatory rural appraisals and open-ended questionnaires will target the villagers, particularly fishers, living in the study sites. The analyses will incorporate the perceptions that informants have of built structures.

[22] Early during TA implementation, the resource specialists will formulate a dissemination policy, a dissemination plan, a dissemination strategy, and dissemination tactics. Advice on linking research to practice is provided at http://www.adb.org/Projects/Tonle_Sap/.

C. Cost and Financing

12. The cost of the TA is estimated at $900,000 equivalent, comprising foreign exchange of $585,000 and local currency equivalent of $315,000. The Government has requested financing on a grant basis of $765,000 equivalent to finance the entire foreign exchange cost and local currency cost of $180,000 equivalent. The Government will finance the remaining local currency cost of $135,000 equivalent. The TA will be financed by the Government of Finland and administered by ADB. The cost estimates and financing plan are in Appendix 2.

D. Implementation Arrangements

13. CNMC, through its TSBR Secretariat, will act as Executing Agency. The TA is expected to begin in March 2006 and to be completed by end-December 2006. The WorldFish Center will be selected directly to implement the TA. With its experience, capacity, and commitment, it is the most qualified and competent agency to provide the required services. The Mekong region is one of the Center's priority regions and Cambodia is one of its priority countries. The Center has a regional office in Cambodia and has collaboration arrangements with IFREDI. It has a good track record in implementing several operating outputs of the Tonle Sap Initiative. The WorldFish Center will subcontract resource specialist services to WUP-FIN as required.

14. TA implementation will require (i) 34 person-months of international resource specialists, mainly in the fields of fish bioecology, socioeconomics, and hydrological modeling, and (ii) 39 person-months of short-term domestic resource specialists, mainly in the same fields. The methodology, key activities, and terms of reference for the TA are specific and clearly identified. Hence, ADB's procedures for simplified technical proposals will be used as the basis for contract negotiation with the WorldFish Center. The resource specialists will be engaged in accordance with ADB's *Guidelines on the Use of Consultants*. The fisheries bioecologist will act as team leader and coordinate, supervise, and monitor their activities. Equipment will be procured in accordance with ADB's *Guidelines for Procurement*. The staffing schedule is shown in Appendix 3. Terms of reference are in Appendix 4.

15. The resource specialists will operate from the regional office of the WorldFish Center in Phnom Penh. At the WorldFish Center, a project coordination office headed by a WorldFish Center representative and including experts in natural resources, socioeconomics, and policy development will be established to advise on TA implementation and coordinate with the TSBR Secretariat and ADB. The TSBR Secretariat will give the WorldFish Center and ADB access to relevant data and information. At ADB, a project officer with suitable expertise will be assigned to administer the TA and monitor its progress.

IV. THE PRESIDENT'S DECISION

16. The President, acting under the authority delegated by the Board, has approved ADB administering technical assistance not exceeding the equivalent of $765,000 to the Government of Cambodia to be financed on a grant basis by the Government of Finland for the Study of the Influence of Built Structures on the Fisheries of the Tonle Sap, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets/Indicators	Data Sources/Reporting Mechanisms	Assumptions and Risks
Impact Sound management and conservation of natural resources and biodiversity in the Tonle Sap basin	• Development of built structures in the Tonle Sap ecosystem is better driven, coordinated, and streamlined.	• Policy statements • Project design summaries • Research program publications • Funding for further research • Government statistics	**Risk** • The cumulative impact of built structures in the Mekong River basin could disrupt the Tonle Sap ecosystem.
Outcome Improved awareness of the influence of built structures on the lake's hydrology	• Guidelines on the number, design, and operation of built structures are formulated to maximize economic returns from investments in infrastructure development without impacting environmental sustainability or the communities that depend on the Tonle Sap.	• Technical assistance (TA) design and monitoring framework • Final report of the resource specialists • TA completion questionnaire filled out by the Cambodia National Mekong Committee (CNMC) • TA completion report prepared by the Asian Development Bank (ADB)	**Assumptions** • CNMC and its key members understand clearly what the impact of the TA is expected to be. • CNMC and its members, with support from the aid community, apply the guidelines on the number, design, and operation of built structures.
Outputs 1. A database of built structures is created. 2. The impact of built structures on hydrodynamics and water quality is modeled. 3. The influence of built structure on the environment is assessed. 4. The influence of built structures on fishery resources is assessed. 5. The influence of built structures on livelihood is assessed. 6. Policy makers and decision makers are informed.	• Built structures are mapped. • Case studies are conducted in four study sites. • Findings and recommendations are synthesized. • Guidelines on the number, design, and operation of built structures are formulated and disseminated.	• TA design and monitoring framework • TA reports and review missions • Brief monthly progress notes • Tripartite meetings • Research program publications	**Assumptions** • CNMC and other national partners understand clearly the purpose of the TA and how it is to be achieved. • TA outputs are publicized and disseminated, and lend themselves to follow-up analysis and action, including status reports and recommendations for management purposes.
Activities with Milestones (for details of activities and their milestones, see the indicative staffing schedule and the terms of reference) 1. Creating a database of built structures 1.1 A scoping study on built structures, aimed at defining built structures of relevance for cataloguing, and defining the limits of the study			**Inputs** • ADB • Government • Cofinancing • Local communities

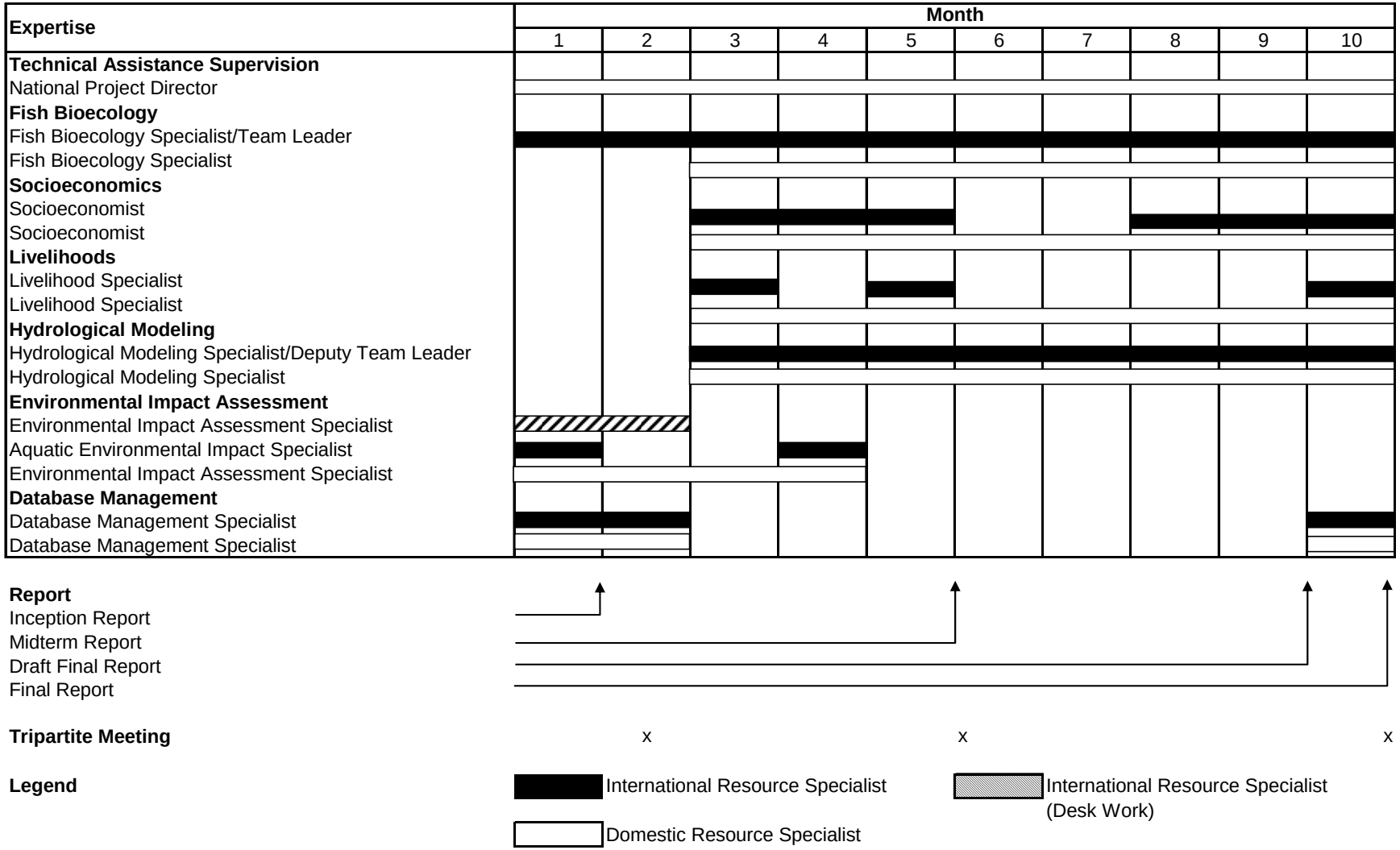
1.2 A repository of information (maps and reports) on built structures of concern in the Tonle Sap basin 1.3 Ground validation in selected locations, of built structures of concern 1.4 A database of the characteristics of built structures of concern 2. Modeling the impact of built structures on hydrodynamics and water quality 2.1 An updated Tonle Sap hydrodynamic and water quality model integrating large-scale built structures at the basin level 2.2 An updated Tonle Sap hydrodynamic and water quality model integrating small-scale built structures, if possible at the basin level 2.3 An assessment of the impact of fishing gears on hydrodynamics and fish migration 2.4 A quantitative analysis of hydrodynamic and water quality differences with and without built structures 3. Assessing the influence of built structures on the environment 3.1 A review of the documented short-term and long-term influence of built structures in tropical floodplains worldwide, from environmental and social safeguard perspectives 3.2 A synthesis of the findings and recommendations from environmental impact assessments (EIAs) and initial environmental examinations (IEEs) conducted for development projects in the Tonle Sap basin, from environmental and social safeguard perspectives 3.3 Identification of gaps in the approaches, methods, and processes followed by EIAs and IEEs in the Tonle Sap basin 4. Assessing the influence of built structures on fishery resources 4.1 A survey of the influence of built structures on fish production and species ecology in four study sites 4.2 Integration of fish ecology data and the changes in hydrology and water quality predicted by the Tonle Sap hydrodynamic and water quality model 4.3 Integration of the combined data into the BayFish Tonle Sap model to weigh the influence of built structures and that of other independent environmental and fishery parameters 5. Assessing the influence of built structures on livelihood 5.1 A review of the main consequences of built structures on the livelihood of fish-dependent communities in tropical floodplains worldwide 5.2 Participatory rural appraisals, open-ended questionnaires, and key-informant interviews in four study sites 5.3 Assessment of the possible influence of built structures on the livelihood of Tonle Sap communities 5.4 A probe of the availability of alternative livelihood 6. Informing policy makers and decision makers 6.1 A synthesis of lessons learned culminating in policy briefs 6.2 A set of guidelines on the design, number, and operation of built structures 6.4 A dissemination policy, a dissemination plan, a dissemination strategy, and dissemination tactics to inform policy makers and decision makers	• Technology • Consultants

COST ESTIMATES AND FINANCING PLAN
($'000)

Item	Foreign Exchange	Local Currency	Total Cost
A. Government of Finland[a]			
1. Resource Specialists			
a. Remuneration and Per Diem			
i. International Resource Specialists	425.0	0.0	425.0
ii. Short-Term Domestic Resource Specialists	0.0	39.0	39.0
iii. Per Diem	68.0	0.0	68.0
b. International and Local Travel	14.0	4.0	18.0
c. Reports and Communications	3.0	7.0	10.0
2. Equipment[b]	10.0	20.0	30.0
3. Training/Workshops	0.0	15.0	15.0
4. Surveys/Fieldwork	0.0	65.0	65.0
5. Miscellaneous Administration and Support Costs	5.0	10.0	15.0
6. Contingencies	60.0	20.0	80.0
Subtotal (A)	**585.0**	**180.0**	**765.0**
B. Government of Cambodia Financing[c]			
1. Office Accommodation and Transport	0.0	45.0	45.0
2. Remuneration and Per Diem of Counterpart Staff	0.0	45.0	45.0
3. Others	0.0	45.0	45.0
Subtotal (B)	**0.0**	**135.0**	**135.0**
Total	**585.0**	**315.0**	**900.0**

[a] Administered by the Asian Development Bank.
[b] Includes provision for office equipment and consumables (computers, printers, scanners, photocopiers, file cabinets, map cases, and bookshelves).
[c] In kind.
Source: Asian Development Bank estimates.

INDICATIVE STAFFING SCHEDULE



Source: ADB staff estimates.

TERMS OF REFERENCE FOR RESOURCE SPECIALISTS

A. Introduction

1. The Executing Agency for the technical assistance (TA) will be the Cambodia National Mekong Committee (CNMC), through its Tonle Sap Biosphere Reserve (TSBR) Secretariat. The Implementing Agency will be the WorldFish Center, which will be appointed by direct selection to deliver 34 person-months of international resource specialist services.[1] Domestic resource specialists will be engaged to provide 39 person-months of specialized services. All resource specialists will be familiar with the particular circumstances of the Tonle Sap basin. They will endeavor to transfer skills to staff of CNMC to ensure that higher capabilities exist in CNMC by the time inputs from the TA are completed. Because the TA will complement the suite of loan and TA projects that the Asian Development Bank (ADB) promotes under the Tonle Sap Initiative, all resource specialists will make themselves familiar with related projects.[2]

B. International Resource Specialists

2. **Fish Biocologist/Team Leader** (10 person-months). The specialist will (i) gather information about the influence of built structures on fish production and dominant species through field samplings and interviews (semi-open questionnaires; at least 20 key informants) in four selected study sites characterized by different built structures; (ii) compare the results in one test site; (iii) combine fish ecology data and the changes in hydrology and water quality predicted by the Tonle Sap hydrodynamic and water quality model to determine fish response to built structures; (iv) integrate the combined data into the BayFish Tonle Sap model, to weigh the influence of built structures and that of other independent environmental and fishery parameters; (v) oversee the preparation of the policy briefs prepared by the international resource specialists; (vi) synthesize recommendations from each resource specialist and prepare detailed guidelines, recommending approaches, methods, and processes so that the design, number, and operation of built structures can maximize economic returns from investments in infrastructure development without impacting environmental sustainability or the communities that depend on the Tonle Sap; (vii) assume responsibility for meeting reporting requirements on schedule and for planning and holding national and provincial workshops;[3] (viii) submit monthly progress notes to ADB, CNMC, and the national project director.

3. **Socioeconomist** (6 person-months). The specialist will (i) review the main consequences of built structures on the livelihood of fish-dependent communities in tropical floodplains worldwide; (ii) in close consultation with the livelihood specialists, collect socioeconomic information through participatory rural appraisal, open-ended questionnaires, and key-informant interviews in the four study sites, with a specific focus on food supply and diet, income and wealth distribution, changes in activity patterns and resource access, and conflicts; (iii) analyze the information gathered, with special attention to fishery resources and livelihood, and assess current and possible future influence on livelihood while probing the availability of alternative occupations; (iv) integrate the information gathered with that generated

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[1] The choice of international resource specialists should be based on technical, management, and cross-cultural skills. It should include (i) extensive reference checks of effectiveness in previous assignments, and (ii) indicated willingness to undertake cross-cultural orientation. The selection process should include CNMC.

[2] See, for instance, ADB. 2003. *Technical Assistance to the Kingdom of Cambodia for Establishment of the Tonle Sap Basin Management Organization*. Manila (TA 4212–CAM); ADB. 2004. *Technical Assistance to the Kingdom of Cambodia for Establishment of the Tonle Sap Basin Management Organization II*. Manila (TA 4427–CAM).

[3] The timing, location, agenda, and scale of the workshops will be flexible. The workshops may be planned and held to test hypotheses or elicit feedback on findings and recommendations.

by other outputs, particularly from modeling work; (v) cooperate with the livelihood specialists and the domestic socioeconomist to prepare a policy brief on the social consequences of built structures; (vi) together with the livelihood specialists and the domestic socioeconomist, make recommendations to the team leader on the design, number, and operation of built structures; and (vii) submit monthly progress notes to the team leader.

4. **Livelihood Specialist** (3 person-months). The specialist will (i) in close consultation with the socioeconomists and the domestic livelihood specialist, collect livelihood information through participatory rural appraisal, open-ended questionnaires, and key-informant interviews in the four study sites with a specific focus on local people's viewpoints on and perception of built structures and the interconnections between hydrology, built structures, environment, fisheries, and livelihood; (ii) investigate local people's recommendations for best practices for built structures; (iii) analyze the information gathered and compare and synthesize it with that generated by other outputs and related existing information from the study sites; (iv) cooperate with the socioeconomists and the domestic livelihood specialist in preparing a policy brief on the social consequences of built structures; (v) together with the socioeconomists and the domestic livelihood specialist, make recommendations to the team leader on the design, number, and operation of built structures; and (vi) submit monthly progress notes to the team leader.

5. **Hydrological Modeling Specialist/Deputy Team Leader** (8 person-months). The specialist will (i) integrate the large-scale close and remote built structures into the Water Utilization Program-Finland (WUP-FIN) Tonle Sap hydrodynamic and water quality model; (ii) integrate the relevant small-scale built structures into the WUP-FIN Tonle Sap hydrodynamic and water quality model; (iii) integrate fishing gears into the WUP-FIN Tonle Sap hydrodynamic and water quality model and quantify impacts on hydrodynamics; (iv) analyze quantitatively the hydrodynamic and water quality differences with or without built structures over example flood cycles (dry, wet, and average flood cycles); (v) produce maps of the differences and illustrative animations of the effects; (vi) prepare a policy brief on the impact of built structures on hydrodynamics and water quality; (vii) help the team leader synthesize recommendations from each resource specialist and prepare detailed guidelines on the design, number, and operation of built structures; (viii) act as deputy team leader with particular responsibility for the timely delivery of all activities related to the WUP-FIN Tonle Sap hydrodynamic and water quality model; and (ix) submit monthly progress notes to the team leader.

6. **Environmental Impact Assessment Specialist** (2 person-months). The specialist will conduct a desk study to (i) review the literature on the influence of built structures in tropical floodplains worldwide, taking into account their scale, size, and mode of operation; (ii) synthesize the environmental impact assessments (EIAs) and initial environmental examinations (IEEs) of development projects undertaken in the Tonle Sap basin and, based on a sample survey of ongoing and completed projects, carry out a broad but critical analysis of their strengths and limitations from the environmental and social safeguard perspectives; (iii) make recommendations to the team leader on the design, number, and operation of built structures; and (iv) submit monthly progress notes to the team leader.

7. **Aquatic Environmental Impact Specialist** (2 person-months). The specialist will (i) review the main consequences of built structures on the livelihood of fish-dependent communities in tropical floodplains worldwide; (ii) synthesize the EIAs and IEEs of projects undertaken in the Tonle Sap basin and, based on a sample survey of ongoing and completed projects, carry out a critical analysis of their strengths and limitations, focusing on aquatic resources; (iii) drawing from this knowledge, complete key gaps through additional literature review and informal interviews with stakeholders, using participatory rural appraisal, open-

ended questionnaires, and key-informant interviews in the four study sites, with a focus on modes of operation that can minimize impacts; (iv) cooperate with the domestic environmental impact assessment specialist in preparing a policy brief on the influence of built structures on aquatic resources; and (v) submit monthly progress notes to the team leader.

8. **Database Management Specialist** (3 person-months). The specialist will (i) conduct a scoping study aimed at identifying built structures of concern and the limits of the study, (ii) gather existing information on built structures in the Tonle Sap basin using the orthophotomaps prepared under the ADB-assisted Tonle Sap Environmental Management Project,[4] Mekong River Commission data on projected infrastructure development, and information from the World Bank-assisted Land Management and Administration Project, among others; (iii) ground-truth built structures identified in selected locations; (iv) check and organize all data into a database, including metadata, to be incorporated in the TSBR Environmental Information Database and also made available on CD-ROM; (v) train staff of CNMC to staff to enable them to use and build on the database; (vi) develop approaches for sustainable operation of the database, e.g., protocols for regular update, procedures for technical upgrade and maintenance, and associated budget requirements, with a view to incorporating them in CNMC's annual budget;[5] and (vii) submit monthly progress notes to the leader leader.

C. Domestic Resource Specialists

9. **Fish Bioecologist** (8 person-months). The specialist will help (i) gather information on the impact of built structures on fish production and dominant species through field sampling and interviews; (ii) combine fish ecology data and the changes in hydrology and water quality predicted in the WUP-FIN Tonle Sap hydrodynamic and water quality model; and (iii) integrate fish ecology data into the BayFish Tonle Sap model.

10. **Socioeconomist** (8 person-months). The specialist will help (i) collect socioeconomic information with a specific focus on food supply and diet, income and wealth distribution, changes in activity patterns and resource access, and conflicts, using participatory rural appraisal, open-ended questionnaires, and key-informant interviews; (ii) review and compare existing socioeconomic information from the area in cooperation with the international socioeconomist and the livelihood specialists; and (iii) integrate the information gathered with that generated by other outputs, particularly with modeling.

11. **Livelihood Specialist** (8 person-months). The specialist will help (i) collect livelihood information with a specific focus on local people's viewpoints on and perception of the influence of built structures, using participatory rural appraisal, open-ended questionnaires, and key-informant interviews; (ii) investigate local people's recommendations for best practices for built structures; and (iii) review and compare existing socioeconomic information from the area in cooperation with the international livelihood specialist and the socioeconomists.

12. **Hydrological Modeling Specialist** (8 person-months). The specialist will (i) help transfer skills to run the Tonle Sap hydrodynamic and water quality model independently; (ii) conduct data input, model runs; and (iii) model output processing.

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[4] ADB. 2002. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the Kingdom of Cambodia for the Tonle Sap Environmental Management Project.* Manila.

[5] The budget should include annual provision for updating data, maintaining equipment, and regular capital replacements.

13. **Environment Impact Assessment Specialist** (4 person-months). The specialist will help (i) gather information about the EIAs and IEEs of projects undertaken in the Tonle Sap basin, and the actual environmental impact of selected built structures in the Tonle Sap; (ii) analyze this data; and (iii) formulate recommendations for environmental safeguards in future infrastructure development.

14. **Database Management Specialist** (3 person-months). The specialist will help (i) liaise with the data sources, including institutes and project administration units; (ii) gather data; (iii) conduct ground-truthing; and (iv) input data on built structures into the database.

D. National Project Director

15. CNMC will assign one experienced staff to serve part-time as national project director and counterpart to the international and domestic resource specialists. The national project director will (i) work to facilitate TA activities and guarantee the close involvement of CNMC and its key members, and (ii) facilitate the involvement of staff of the Inland Fisheries Research and Development Institute in the TA.

E. Reporting Requirements

16. The WorldFish Center will produce (i) an inception report within 4 weeks of the start of the TA, (ii) a midterm report within 20 weeks, (iii) a draft final report within 36 weeks, and (iv) a final report detailing TA outcomes and recommending actions, in a form suitable for publication as an ADB document. The guidelines on the design, number, and operation of built structures will form part of the final report. Under separate financing, such as ADB's Cooperation Fund for the Water Sector, ADB may request intermittent presentations in ADB to promote awareness of the influence of built structures. Such presentations would inform, among others, ADB's recent work on cumulative impact assessment. CNMC will, on its part, complete a TA completion questionnaire to evaluate the TA's outputs and activities, identify lessons learned, and suggest follow-up actions.