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Research Report 15

Tropical River Fisheries Valuation: A Global Synthesis and Critical Review

Arthur E. Neiland and Christophe Béné

WorldFish CENTER

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Tropical River Fisheries Valuation: A Global Synthesis and Critical Review

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and
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Cover photograph by C. Béné shows a woman from a river fishing/farming community on her way to pick up her nets in the early morning hours (Democratic Republic of Congo).

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Contents

Acronyms and Abbreviations

CA	Conjoint Analysis
CBA	Cost-Benefit Analysis
CEBRAC	Centro Brasileiro de Referência e Apoio Cultural
CEV	Conventional Economic Valuation
CIFA	Committee for the Inland Fisheries of Africa (UN FAO)
CPR	Common Pool Resource(s)
CPUE	Catch per unit effort
CS America	Central and South America
CVM	Contingent Valuation Methodology
DC	Developed Country
DevC	Developing Country
DFID	UK Department for International Development
DFRP	Directoria de Fauna e Recursos Pesquieros (Brazil)
DoF Bangladesh	Department of Fisheries Bangladesh
EcIA	Economic Impact Assessment
EEA	Economic Efficiency Analysis
EIA	Environmental Impact Assessment
EOP	Effect on Production Method
ES Africa	East and Southern Africa
GDP	Gross Domestic Product
HEP	Hydro-Electric Project
IADB	Inter-American Development Bank
IDDRA	Institut du Développement Durable et des Ressources Aquatiques
IUCN	The World Conservation Union (formerly International Union for the Conservation of Nature)
LA	Livelihood Analysis
Lao PDR	Lao Peoples Democratic Republic
M&E	Monitoring and Evaluation
MRC	Mekong River Commission
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non-Government Organisation
NPV	Net Present Value
PE	Preventative Expenditures Method
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
RC	Replacement Cost Method
SE-LA	Socio-Economic and Livelihoods Analysis
SIAMAZONIA	Sistema de Información de la Diversidad Biológicay Ambiental de la Amazonía Peruana
SLA	Sustainable Livelihoods Approach
TCM	Travel Cost Method
TEV	Total Economic Value
TMS	Traditional Management Systems
UNDP	United Nations Development Programme
UN FAO	United Nations Food and Agriculture Organisation
WAICENT	World Agricultural Information Centre
WC Africa	West and Central Africa
WCD	World Commission on Dams

Background Review Papers

Baran, Eric; Jantunen, Teemu; and Chong,Chiew Kieok. 2007. Special Review: Values of inland fisheries in the Mekong River Basin. In Neiland, A.E.; and Béné, C. (eds.) WorldFish Center Special Report on Tropical River Valuation, WorldFish, Penang, Malaysia, 58 p + Annexes.

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Norman-Lopez, Ana, and Innes, James P. 2007. Review of river fisheries in tropical Asia. In Neiland, A.E.; and Béné, C. (eds.) WorldFish Center Special Report on Tropical River Valuation, WorldFish, Penang, Malaysia, 32 p + Annexes.

Turpie, Jane K. 2007. The valuation of riparian fisheries in Southern and Eastern Africa. In Neiland, A.E.; and Béné, C. (eds.) WorldFish Center Special Report on Tropical River Valuation, WorldFish, Penang, Malaysia, 41 pp.

Abstract

River fisheries, and inland fisheries in general within the tropical regions of the world (between 30°N and 30°S of the Equator), provide a range of benefits for many Developing Countries including a means of livelihood and a source of food for millions of people. However, national policies relating to crucial issues such as economic development, poverty alleviation, food security, conservation and sustainability, often fail to recognize these important attributes. Within this general context, the following report considers the role of valuation and its contribution to policy-making and river fishery management. This report is based on a series of regional review papers and aims to provide a review of the global status of tropical rivers and inland fisheries valuation, to consider the impact of changes in river basin management, and to compare the range of valuation approaches which have been used.

As part of the study methodology, a simple typology of valuation approaches was developed consisting of three 'types' as follows: (i) Conventional Economic Valuation (CEV) methods such as economic cost-benefit analysis (using economic values), (ii) Economic Impact Assessment (EcIA) methods such as using the gross value of fish landings based on market prices (using financial values), and (iii) Socio-Economic and Livelihood Analysis (SE-LA) methods such as wealth-ranking participatory appraisal (using qualitative information). It was recognised that each of these approaches to valuation is trying to assess the 'importance' of natural resources and, in many cases, to see how this is affected by specific projects (e.g. dams) or other policy interventions. In other words, 'value' is being used in a fairly broad sense, and it is this which unifies the three types: each is looking at 'importance' from a particular perspective, either from that of society as a whole or that of a particular group of stakeholders. The key point, however, is that the three methods are all answering different questions, depending partly on whose objectives and interests are being optimised. As such they are complementary and if used in combination can provide useful information to policy makers and other decision-makers.

The report provides three main sets of findings as follows:

First, the investigation of the status of knowledge of the value of tropical river fisheries revealed that there is a general paucity of information globally. This is especially the case for information derived from CEV methods. Information derived from both EcIA and SE-LA methods is more widely available, but even so there are still serious gaps and deficiencies in these domains. The best estimate of current tropical inland fisheries production is 5.46 million tonnes valued at US$ 5.58 billion (gross market value), which is equivalent to 19 percent of the current value of annual fish exports from Developing Countries (US$ 29 billion).

Second, the status of knowledge of the impact of changes in river management on the value of tropical river fisheries is also weak and patchy, although there is widespread recognition of the impact of changes. The impact of large dams on the hydrology, ecology and livelihood support attributes of tropical rivers is especially well-known. However, there have been few valuation studies of these impacts, and the generation of more information in this area is severely limited by various constraints. For example, many countries and river systems lack the institutional capacity to undertake valuation studies.

Third, a range of valuation techniques have been adopted throughout the world in recent years, which can be categorized using the simple typology: CEV, EcIA and SE-LA. The current report provides a comparative assessment of these three types of methods, and highlights the comparative advantages and

disadvantages of each type, and the possibilities for complementary work.

In conclusion, this report emphasizes the need for further valuation studies of tropical river fisheries and inland fisheries in Developing Countries. It is vital for policy-makers, and other particular groups of stakeholders, to understand the importance of these natural resources for society and in turn to use this as a basis for making appropriate decisions concerning the role of tropical river fisheries in national development policy. The report also stresses the importance of matching valuation methodologies and their application to the needs of policy-makers and the policy process in each country. It is recommended that capacity-building in valuation should become a major priority for relevant departments concerned with fisheries management and policy-making.

Tropical River Fisheries Valuation: A Global Synthesis and Critical Review

Arthur E. Neiland and Christophe Béné

Introduction and Objectives

It is widely acknowledged that common pool resources (CPR) such as forests, rangeland, water and fish stocks located in tropical regions (between 30°N and 30°S of the Equator) help to underpin the livelihoods of millions of people in Developing Countries (DevC) (Runge 1986; Beck and Nesmith 2001; Neiland and Bennett 2003). As a form of natural capital and a source of wealth, CPR can be utilised both directly (e.g. through employment) and indirectly (e.g. wealth generated and extracted is re-invested in the economy) to contribute to economic development and poverty reduction (Johda 1992; Campbell and Luckert 2002; Cunningham and Neiland 2005). It has also been shown that CPR such as fish stocks and their associated fisheries, in particular, provide a livelihood safety-net for the poorest of people, in situations where there are few other economic opportunities, and where the barriers of entry to the resource and its exploitation are minimal. For example, many open-access floodplain fisheries, where fish can be caught using small nets or traps in the shallow margins, provide food and income for millions of rural people in countries such as Bangladesh, Cambodia and Mali (Capristrano et al. 1994; Quensière 1994).

However, despite the apparent importance of fisheries and other CPR for large numbers of people in DevC, it is also widely known that in many countries national policies relating to such central issues as economic development, poverty alleviation, food security, conservation and sustainability, often fail to recognize their crucial role. This has resulted in a widespread failure to establish effective CPR management systems. As a consequence, it seems likely that CPR and the benefits which they provide will become increasingly overexploited and degraded in the near future. This pattern of decline, which clearly has already started to take hold will lead to severe competition and conflict between resource users, and may lead to a gradual lowering of socio-economic conditions and increased poverty.

But what can be done to address this serious and widespread problem? For a start, there is a chance that if the importance (or 'value') of CPR for sustainable development was given greater recognition, and included to a greater degree within national policy-making processes, leading to the creation of effective CPR management systems, then the existing pattern of decline might be halted and even reversed. However, in order that national policy processes can be better informed about choices and decisions relating to CPR management and sustainable development, policy-makers will need a wide range of appropriate information. For most DevC, institutional and capacity constraints mean that information about CPR in general, is very limited. This is particularly the case for information on the value of CPR, which has tended to be overshadowed by the technical and environmental information priorities of government agencies, responsible for resource utilization, development and management.

In many countries, the need to incorporate CPR valuation within the policy process has become increasingly recognized. At the same time, new valuation techniques are starting to emerge internationally. The big challenge now is to devise approaches by which DevC can utilise these new valuation approaches to assist policy-making for CPR. Amongst the key questions to be addressed in order to develop an appropriate information-policy approach or strategy, are: What information is needed by policy-makers? What methods can be used to generate this information? And what institutional capacities are needed to use valuation methods?

In the following review, the valuation of tropical river fisheries in DevC has been considered. River fisheries represent a specific type of CPR which under-pin millions of rural livelihoods, globally. They are particularly interesting for a number of reasons. First, river and inland fisheries are often well-integrated within farming systems and associated agrarian livelihoods (this makes the valuation of fisheries problematic using a strictly sectoral approach). Second, river fisheries have been greatly impacted by new water management regimes, including dams and irrigation (this means that the nature of change must be included within the valuation methodology). Third, there is a close and immediate interaction between river fisheries and other users of water resources, including power generation, farming, water supply for urban uses, navigation and industry (this requires that the process of valuation should be treated with urgency to help to deal with resource-use conflicts and interactions).

In order to consider how valuation might make an important contribution to policy decisions on tropical river fisheries in DevC in the future, this review considers three important issues, framed as questions viz.,

- What is the *status of knowledge* of the value of tropical river fisheries at present?
- What is known about the *impact of changes* in river or water management?
- What *valuation techniques* have been used to date and how do they compare in terms of their usefulness for future valuation assessments?

It should be noted that this study represents a contribution to knowledge in the field of tropical river fisheries valuation. As a starting point, the study has focused on ‘rivers’ and ‘river fisheries’ since it was considered that these features of inland aquatic systems have been greatly impacted by changes in water management, throughout the tropical regions, over the past 50 years (WCD 2000). In turn, this has affected the ‘value’ of the river fisheries and their role in the economies of the riparian countries concerned; most of which are also developing countries. Inevitably, the study also covers other inland aquatic systems and fisheries, particularly large lakes and swamplands, and wherever possible this overlap has been identified in this report. In the future, a more comprehensive survey and assessment of tropical inland fisheries will be required, to take forward this initial study.

General Approach and Methodology

The approach and methodology used for the study consist of four key parts viz., Review Papers, Synthesis, Assessment of valuation methods, and Conclusions and Recommendations.

Review Papers

This report is based on a series of five review papers, commissioned to provide a global perspective covering Central and South America, West and Central Africa, Eastern and Southern Africa, and Asia. These studies were undertaken by experienced researchers with expertise in the field of fisheries valuation and knowledge in each of the four regions. In addition, a special review focusing on values of inland fisheries in the Mekong River Basin – one of the most important inland fisheries in the world for which a wide range of information exists – is also included in this synthesis.

These five review papers provide a good overview of the regional situations. At the same time, there are some important variations between each paper, as summarised in table 1 below. The main reason for these variations is the amount and type of information on the subject of river valuation available in each region. In general, all five papers have revealed that there is a scarcity of valuation studies and information in each region.

In the case of Central and South America, Bennett and Thorpe (2006) present wide-ranging general descriptions about inland fisheries in the region, by river basins and by country. However, the paper is dominated by the massive Amazon River System and its various tributaries, and associated regional fisheries, which have been the focus of most investigation. The theoretical framework gives an overview of value concepts, and highlights various valuation methods, and the links to policy decision-making. The paper presents a series of case-studies of fisheries (mainly Amazonian) which give direct use values based on market prices. However, the paper also tries to consider other values (when available) within the general Total Economic Value (TEV) framework (figure 1), and issues relating to socio-economic and livelihood perspectives. While many river systems in this region have been impacted by changes in management (e.g. dams, water abstraction, mining and industrial uses), there is a paucity of information on the impact on fisheries value(s). The paper has assembled 12 case-studies to illustrate different impacts and effects, mainly in Brazil and the Amazon Basin.

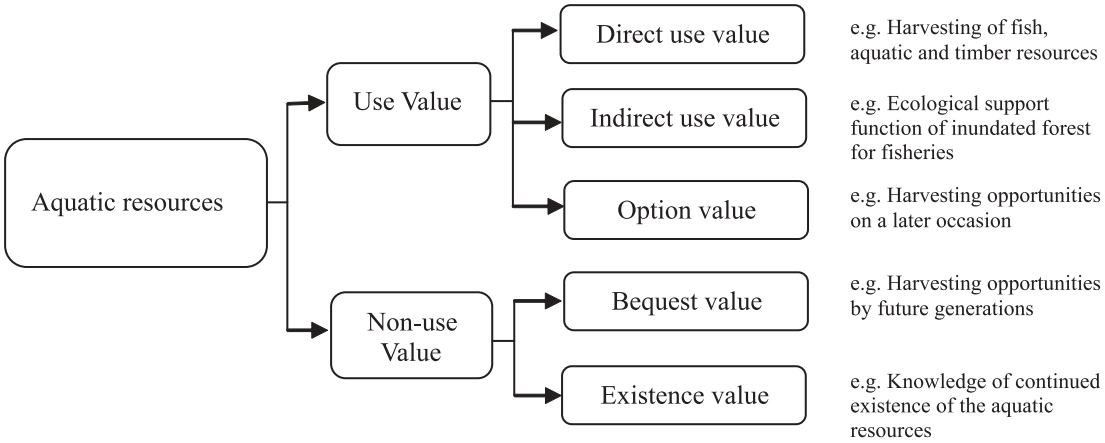
For West and Central Africa, Neiland and Béné (2006) present fisheries valuation information for the seven major river basins: Senegal-Gambia river basin; Volta River basin; Niger-Benue river basin; Lake Chad basin; Congo-Zaire river basin; Atlantic coastal basins;and three major lakes: — Lake Volta, Lake Kainji, and Lake Chad, supplemented with specific case-studies, and also present national profiles for countries with important inland fisheries. There is also a general overview of relevant valuation theory, and a presentation of valuation methods in three categories – conventional economic valuation (CEV), economic impact assessment (EcIA) and socio-economic and livelihood analysis (SE-LA). The results of regional and national studies using the three sets of methods are reported in the paper, although values from EcIA tend to occur most frequently in the literature. In common with Southern and Eastern Africa, there are few studies on the economic impact on river fisheries due to changes in riverine management – four studies from Nigeria, Cameroon and Mali on dam and irrigation development are included.

The paper on Southern and Eastern Africa by Turpie (2006) presents 15 case-studies of rivers in nine countries from Kenya down to South Africa. A general overview of valuation is given, and the predominance in the literature of studies, which focus on direct use and market values (which are obvious at local rather than global levels), is emphasized. For each case-study, a series of

TABLE 1.
Profile of the five review papers on river fisheries valuation.

	Central and South America	West and Central Africa	Southern-Eastern Africa	Asia (+ Mekong Study)
Geographical and riverine coverage	Wide-ranging general coverage, but inevitable focus on River Amazon.	Seven major river basins, series of key case-studies within each, and national profiles of countries with major inland fisheries.	Fifteen case-studies of river systems in 9 countries (Kenya, Tanzania, Malawi, Zambia, Namibia, Mozambique, S. Africa, Lesotho, Swaziland); Some use of national statistics.	Review paper: Wide-ranging coverage, with 13 case-studies in 12 countries; also national profiles; (China not included). Mekong Study: Basin-wide and by country reporting, very detailed; including Yunnan Province Republic of China.
Theoretical framework	Examination of the elements of Total Economic Value (TEV), valuation techniques and usage of valuation in decision-making.	General overview of valuation; plus examination of approaches within three main categories: (i) conventional economic valuation (CEV); (ii) economic impact analysis (EcIA); (iii) Socio-economic and livelihood analysis (SE-LA).	General overview of 'valuation' concepts and methods given; Focus on direct use values, market values and economic values; Consideration of global, national and local perspectives on value also.	Review paper: Valuation concepts and theory, TEV, and assessment methods; including stated and revealed preference methods. Mekong Study: general overview of valuation; and TEV; 4-part framework: economic valuation, economic impact, socio-economic and livelihood analyses.
Methodology and approach	Series of case-studies mainly report direct use values based on market prices; Consideration is also given to economic impacts and socio-economic issues; Nature of other TEV values also considered.	CEV case-studies studies report net economic benefits (US$); EcIAs report value of production (US$) by river basin and by country using market values (financial); SE-LA report oncontributions to households, community and society.	For each case-study annual values (US$) reported per household & for total study area; Key values: gross income, net value, cash income, net economic value.	Review paper: Values reported by case-study; mainly market-based direct use values; some economic values; set in wider NR context. Mekong Study: Basin-wide information on all 4-part framework components (above); by country, mainly direct use values (catch, market, consumption), plus SE-LA; (limited pure economic data).
Availability of information on impact of changes in riverine management	Few studies in the literature overall; 12 case-studies are presented.	Few studies available in the literature; 4 studies included from Nigeria (x2), Mali and Cameroon.	Few studies of economic impact; Two included of dams on Tana River (Kenya) and the Lesotho Highlands.	Review paper: Relatively few studies of economic impact available; three case-studies reported. Mekong Study: Information reported basin-wide and by country.
Authors	Bennett and Thorpe (2006).	Neiland and Béné (2006).	Turpie (2006).	Review: Norman-Lopez and Innes (2006). Mekong: Baran et al. (2006).

FIGURE 1.
Total Economic Value and Valuation methods.



Source: Barbier et al. 1997

values are reported in US dollars, including gross income, net value, cash income and net economic value, for both households and for the total study area. There are relatively few studies (and values) concerning the economic impact on river fisheries of changes in management in Southern and Eastern Africa – the paper includes results from studies on the Tana River (Kenya) and the Lesotho Highlands where dams were constructed or proposed.

In the case of Asia, the paper by Norman-Lopez and Innes (2006) presents valuation information from 12 countries with important tropical river fisheries in the form of 13 case-studies. This includes India, Bangladesh and Sri Lanka, countries of the Mekong Basin (Thailand, Cambodia, Laos, Vietnam), Malaysia and Indonesia. China is not included since it has a limited area of river basin in tropical latitudes. A general overview of economic valuation is provided, including consideration of TEV, applications of resource valuation, and methods (stated and revealed preference approaches). The majority of case-studies estimated direct use values, with a major focus on financial values (market-based). Non-use values (within the overall TEV framework) were examined by only a few studies. Regarding valuation studies on the impact of changes in riverine management, three case-studies are critically reviewed.

Finally, the special review report of values of inland fisheries in the Mekong River Basin by Baran et al. (2006) presents both a basin-wide analysis and a country analysis covering the five riparian countries: People's Republic of China (Yunnan Province), Lao People's Democratic Republic, Kingdom of Thailand, Kingdom of Cambodia, and Socialist Republic of Vietnam. The report outlines a broad 4-part valuation framework including economic valuation analysis (direct/indirect use values), economic impact analysis, socio-economic analysis, and livelihood analysis. The basin-wide section provides a good overview of the available information and values in all four areas. The country analyses focus mainly on direct use values (catch values, market values and consumption values), backed up by information from socio-economic and livelihood analyses. Once again, as with the Asia review paper (above), the study has found that there is limited information on TEV and on pure economic values, rather there is a predominance of financial (market-based) values as a means of estimating the importance of fisheries. There is an increasing and useful body of studies in the SE-LA category, including fish consumption estimates. The report examines the impact of changes in riverine management at regional and national levels, although there are few economic valuation studies.

Synthesis

The information contained in each of the regional papers has been reviewed and then synthesized to form two distinct elements of the results section (below), as follows:

- an overview of the value of river fisheries by continental region;
- an overview of the impact of changes in riverine management on the value of fisheries by continental region.

The values in each case have been disaggregated and reported according to a simple typology of valuation approaches which distinguishes between values derived from conventional economic valuation (CEV), economic impact assessments (EcIA) and socio-economic and livelihood analysis (SE-LA), as described below.

Assessment of Valuation Methods

The regional review papers have also been used as a basis to review and assess the range of valuation methodologies which have been employed to date. The findings are reported in a separate section below. In order to assist the process of collation, synthesis and comparative analysis for both the valuation results and the valuation methodologies indicated above, it was decided to adopt a simple 3-part typology of valuation approaches as a basic unifying framework, as shown in table 2.

Each of these three types of approaches (CEV, EcIA and SE-LA) tries to assess the 'importance' of natural resources and to evaluate how this is affected by specific projects (e.g. dams) or other policy interventions. In other words, 'value' is being used here in a fairly broad sense, and it is this which unifies the three concepts: each is looking at 'importance' from a particular perspective, either from that of society as a whole or that of a particular group of stakeholders. The key point, however, is that the three types of valuation approach are built upon different concepts and theoretical frameworks. Consequently, the three types of methods are answering rather different questions, depending partly on whose objectives and interests are being optimised. As such they are complementary, and if used in combination, can provide useful information to policy-makers.

It should however be recognized that there is the possibility for confusion and misunderstanding – for example, economic and financial cost-benefit analysis are separate (but related) techniques, and while each can be used in economic analysis (leading to economic values), it is important that decision-makers understand the difference and use the resulting values appropriately (see the case-studies indicated in table 2 footnote 3). It is important, therefore, for the approaches and methods to be employed carefully and transparently, and for those involved in using the methods and the results to have a relevant level of training and expertise.

Deriving Conclusions and Recommendations

The results and information presented is used to draw out a set of conclusions about river fisheries value and valuation in DevC. A set of recommendations also highlights the possibilities for improving the contribution of valuation to policy-making in the future.

TABLE 2.
Simple typology of valuation approaches. [1]

Type	Approach	Techniques
Conventional Economic Valuation (CEV)	Underpinned by economic efficiency analysis (EEA) which focuses on the maximisation of social welfare; applied using cost-effectiveness analysis and/or cost-benefit analysis. In a policy planning context, results of analysis can be compared and used as a basis for decisions.	Direct techniques: using direct investigations of systems or situations, using (market values or simulated market values) • survey-based economic cost-benefit analysis [3]; • contingent valuation method (CVM) and conjoint analysis (CA).
(Note: use true economic values)[2]	Natural resources provide a range of values making up Total Economic Value (TEV). Use (direct, indirect and option values) and non-use values (bequest and existence values) can be measured (see techniques opposite).	Indirect techniques: (or revealed preference uses information to build economic models of choice, used to determine value of environmental change) • travel cost models • hedonic price models
Economic Impact Analysis (EcIA) (Note: often use financial values)[4]	EIA aims to establish the effect which a new policy or project has on specific variables or criteria. EcIA does not try to assess whether policy or projects in terms of economic worth to society. Levels of benefits are considered, but not costs (there is no benefit-cost analysis involved). Starting point is usually to measure direct use (financial values) in a particular policy context, and then to measure/predict impact of change on values.	Simple output-revenue values: changes in output production (e.g.fish landings) valued using market prices to give a gross financial value. [5] Revenue analysis proper: estimation of demand function for harvested product in order to determine the impact of changes in supply on market price (and hence total sales revenue). Multiplier analysis: to measure the total economic activity generated by a policy or project intervention (e.g. impact of new fisheries management approach on output, income and employment) as a consequence of the interdependence between fishing and other parts of a regional economy.
Socio-economic and livelihood analysis (SE-LA)	Socio-economic analysis aims to 'reveal' how the net costs and benefits of policy changes affect different social groups within society. Livelihood analysis (LA) extends this and aims to provide a broad 'understanding' of the factors which affect people's access to benefits.	Characterization of social groups and strata using various participatory techniques (PRA) (e.g. group discussions and wealth-ranking). Followed by more in-depth economic studies (e.g. income-expenditure surveys) to provide a better understanding of benefit flows in relation to policy interventions. LA examines types and levels of assets held by a household or community, the context (policies, institutions and processes), and the actual/likely effect of a range of factors such as shocks and adverse trends.[6]

Notes:

[1] For a more detailed explanation of valuation methods in general please refer to Barbier et al. (1997), Winpenny (1991, 1995);

[2] Economic values represent the true value of a resource to society; they are calculated using efficiency prices to remove any distortions due to imperfect market mechanisms;

[3] Economic cost-benefit analysis is a commonly used approach, see the worked examples provided by Barbier et al. (1991) and Bojö (1989);

[4] Financial values represent the value of a resource to an individual (and not society); uses actual market prices at which inputs are purchased and goods are sold;

[5] The monitoring of catch and fish prices is a simple and effective method for valuing a fishery, and is used in many locations worldwide; however, it is important to distinguish this approach from economic valuation (using true economic values); this is a common source of confusion;

[6] For LA analysis see Carney (1998).

Synthesis of Valuation Results – A Global Comparison

The Values of Tropical River Fisheries – Status of Knowledge

In this sub-section, the status of knowledge for the value of tropical river fisheries in the four continental regions of the developing world covered – Central and South America, West and Central Africa, East and Southern Africa, and Asia – is reviewed. A summary of the findings of the four relevant review papers is presented in table 3. According to the simple typology of valuation methods, the valuation information has been sub-divided into conventional economic valuations (CEV), economic impact assessment (EcIA) and socio-economic livelihood analysis (SE-LA). Overall, the knowledge base for the value of tropical river fisheries on a global basis shows four broad characteristics, which are summarised in box 1.

(a) There is a general paucity of valuation information globally

The four review papers highlight the general paucity of valuation information for river fisheries across all the continents. All four papers indicated that it was difficult to locate valuation information in both the formal and grey literature. It is evident that the deficiency of valuation information is consistent in all continental regions and for most of the major river basins of the world – a fact, which is further confirmed by the limited amount of valuation information reported by the statistical service of the Food and Agriculture Organization of the United Nations (FAO http://www.fao.org/figis and http://faostat.fao.org/fisheries), as a complement to national fisheries production or fish landings, other than values for traded fish commodities.

TABLE 3.
Summary of values for river fisheries.

	Central-South America (Bennett and Thorpe 2006)	**West-Central Africa** (Neiland and Béné 2006)
Major inland systems	• Amazon Basin (5 million sq. km); Brazil; • Nordeste Basin; Brazil; • Tocantins-Araguaia; Brazil; • Paraguay; Brazil; • Parana-Paraguay; various countries; • Rio de la Plata; Brazil; • Sao Francisco; Brazil.	• Senegal-Gambia river basin (Senegal, Gambia); • Volta River basin (Ghana, Burkina Faso); • Niger-Benue river basin (Nigeria, Mali, others); • Lake Chad basin (5 countries); • Congo-Zaire river basin (Congo, others); • Atlantic coastal basins (various) • Lake Volta, Lake Kainji, Lake Chad.
CEV	No dedicated CEV studies on inland fisheries appear in literature;TEV calculations not possible given paucity of data in general;Some CEV derived from economic studies associated with dam assessments (table 5).	Only two studies in literature (use values only): • Hadejia-Jam-are Wetlands (Barbier et al. 1991); Net economic benefits from fishing was US$9million/yr (or US$90/ha/yr); • NE Nigeria inland fisheries (Neiland et al. 1998) US$6 million/yr.
EcIA	Amazon-Solimoes River (Almeida et al. 2003) • Annual catch is 46K tonnes; • Fishing income is US$160 million (sectoral); • NPV Fishing US$1.62 million or US$374K/ha; • 80,000 fishers employed. Lower Amazon (Almeida et al. 2000) • Economies of scale are minimal. Middle Amazonian fisheries (Isaac et al. 1998) • Annual catch is 4-6K tonnes; • Fishing income is US$4-6 million p.a.; [price: US$1000/t] • 1.2 million people depend on fisheries.	<u>For all major river basins</u> (collated from various sources, most recent data): • Total fisheries employment: 227,000 • Fisheries production: 569,000 tonnes/yr • Use value fisheries prod: US$295 million/yr • Price [US$518/t] • Potential fisheries production: 1,300K tonnes/yr • Potential use value: US$749 million/yr. <u>For the 12 countries in West Africa with major inland fisheries</u> (collated from various sources, most recent data): • Total fisheries production: 597,500 tonnes/yr

(Continued)

TABLE 3. (Continued)
Summary of values for river fisheries.

Amazon fishery (Ruffino, 2001) • Annual catch is 200K tonnes; • Use value is US$100 million p.a.; Amazonian fishery (FRMP – Provarzea, 2001) • Annual catch is 43,904 tonnes; • Use value is US$21.38 million • [price: US$486/t] Amazon (Mamiraua Reserve) (Begossi 2002) • catch value is US$1 million p.a.; • 5,277 people; mean earnings of US$900. Amazon (Rio Negro) (Chao and Prang 1997) • export value of ornamental fish: US$2.22 million (18.5 million fish); Peruvian Amazon (SIAMAZONIA 2002) • fish landings could be computed from database. Review of Brazilian catch statistics (DFRP 2001) • inland landings are c.200,000 t p.a. FAO FishStat (1999) • inland fisheries production in CSA is 356Kt	• Use value of fisheries production: US$1,416 million • Price [US$2367/t] • Mean fish supply: 11.09 kg/capita • Employment (fishers plus onshore): 667,560 • Fisheries as % GDP Agric (mean value): <5% Largest fisheries: By river basin: • Actual: Niger-Benue (236Kt/yr; US$95 million/yr) • Potential: Congo-Zaire (520Kt/yr; US$208 million/yr) By country: • Nigeria (130Kt/yr; US$180 million; <2% GDP Agric); • Chad (100Kt/yr; US$ not known; >5% GDP Agric estimated); • Mali (100Kt/yr; US$350 million; 0.94% GDP Agricultural).	
SE-LA	Few SE-LA studies *per se*, issues noted in other studies: • Large no. people depend on fisheries employment; • Subsistence and commercial fishers; • Importance of fish as protein supply; • Increasing levels of exploitation and inadequate management; • Fisheries as one component of livelihoods; • Declining fisheries due to non-sectoral impacts (e.g. dams, mining); • Inland fisheries dominated by a network of intermediaries (restricts local capital accumulation and autonomy).	Increasing number of SE-LA studies appearing in this region; some key issues which emerged: • Fishing communities are highly stratified in terms of income and wealth, ranging from very rich to very poor; • The occurrence and impact of traditional fisheries management systems varies within/between countries; with reference to benefit distribution; • The relationship between fishing and wealth(poverty) level is more complicated than originally thought (fishers can be rich or poor depending on circumstances); • LA has revealed the importance of sectoral and non-sectoral factors, and their interaction.
	East-Southern Africa (Turpie 2006)	**Asia** (Norman-Lopez and Innes 2006); (Baran et al. 2006)
Major inland systems	• Rufiji floodplain and delta (Tanzania); • Kilombero floodplain (Tanzania); • Lower Shire River (Malawi); • Zambezi & Barotse Floodplain (Zambia); • Okavango River (Namibia); • Zambezi-Chobe Floodplain (Namibia); • Chobe River & Lake Liambezi (Namibia); • Zambezi Delta (Mozambique); • Mutshindudi River (South Africa); • Crocodile River (South Africa).	Overview of inland systems in 11 countries: Bangladesh, India, Sri Lanka, Cambodia, Lao PDR, Thailand, Vietnam, Myanmar, Indonesia, Philippines, Malaysia; Case-studies: • Mekong River Basin (China, Myanmar, Thailand, Lao PDR, Cambodia and Vietnam); • Bangladesh (rivers and floodplains); • India (reservoir re-stocking, Kerala); • Indonesia (Musi River, Sumatra) • Malaysia • Sri Lanka (reservoirs and swamps).
CEV	Few CEV studies overall; no obvious TEV estimates; net economic use values arising mainly from household analyses shown below along with EcIA (indicating that CEV methods have been applied more widely than in W/C Africa).	Few CEV studies; no TEV estimates; Mekong Delta (Trong Nhuan et al. 2003) Ben Tre Province, Total economic value of wetlands: US$2.82K – 3.10 / ha; Economic value of fisheries / aquaculture: US$2.80 – 3.07 / ha (90% total); Bangladesh (Ahmed 1992; 1996); Riverine fisheries, annual catch: 189,087 t; Gross benefit: US$176 million; Estimated price: US$931/ t; Economic value: US$43 million;

(Continued)

TABLE 3. (Continued)
Summary of values for river fisheries. (Continued)

		Bangladesh (Ali 1997) Estimation of floodplain lake re-stocking; Annual economic return after 6 years; Indonesia : economic evaluation of river / swamp fisheries (Koeshendrajana; Cacho 2001) River catch: 22,833 tonnes; Revenue: 27,743 M Rp (US$12.84 M); Potential resource rent: 16,270 M Rp (US$7.53 M); Actual resource rent: 6,283 M Rp (US$2.91 M).
EcIA	Rufiji floodplain and delta (Turpie 2000) • Annual fish+shrimp catch: 11,218 tonnes; • Gross income: US$7.75 million; [US$691/t] • Net economic value: US$7.40 million; • 9,173 households in fisheries. Kilombero floodplain (Mapunda 1981) • Annual catch: 2-7K tonnes (US$14-44K). Lower Shire River (Turpie et al. 1999) • Annual catch: 9,750 tonnes; • Gross income: US$4.96 million; • Net economic value: US$4.59 million; • 53% households fish (pop. 395,000). Zambezi-Barotse floodplain (Turpie et al. 1999) • Annual catch: 10,500 tonnes; • Gross income: US$4.96 million; • Net economic value: US$4.59 million; • 54% households fish (pop.224,000). Zambesi-Chobe floodplain (Turpie et al. 1999) • Annual catch: 1,279 tonnes; • Gross income: US$1.5 million; • Net economic value: US$ 694K; • 75% households fish (pop. 30,000). Chobe-Lake Liambezi (Turpie and Egoh 2002) • Annual catch: 154 tonnes; • Gross income: US$39K; • Net economic value: US$2,880. Okavango River (LaFranchi 1996) • Annual catch: 1,045 tonnes; • Gross value: US$0.5-1 million; • 56,000 people fishing. Zambezi Delta (Turpie et al. 1999) • Annual catch fish+prawns: 16,264 tonnes; • Gross income: US$5.12 million; [US$315/t] • Net economic value: US$5.37 million; • Up to 78% households fish (pop. 250,000). Mutshindudi River (Van der Waal 2000) • Annual catch: 4 tonnes (R20-40K). Crocodile River (Cox et al. 2001) • US$1.17 million/yr for subsistence fisheries; • US$2.5 million/yr for recreational fishery.	Regional overview (mean values) based on 11 national reviews: • Total riverine fisheries production: 5,798,371 t; • Market price: US$1,156 / tonne (Range: US$847 – 1,465); • Total value of production: US$6,702,917,454; • Total Employment: 5 million (at least); • GDP contribution of fisheries: < 1% (mean) (Cambodia 10%, Bangladesh (2%); Laos (1.4%). Major river systems (annual production/value) (Norman Lopez and Innes 2006): Bangladesh: Padma-Ganges; Jamuna-Brahmaputra; Meghna Rivers: 124,000 – 561,824 t [US$136,152 – 616,883]; India: Ganges, Indus: 28,500 t [US$22,686]; Sri Lanka: Total inland: 16,797 t [US$13,462]; Cambodia: Mekong and Tonle Sap: 289,000 – 682,150 t [US$157,216 – 371,090]; Lao PDR: Mekong and tributaries: 182,700 t [US$101,033]; Thailand: Total inland: 200,000 – 500,000 t [US$259,400 – 648,500]; Vietnam: Total inland: 136,000 – 844,850 t [US$114,512 – 711,364]; Mekong (Cambodia, Lao PDR, Thailand, Vietnam); Production: 809,000 – 2,642,000 t [US$550,120 – 1,796,560] Myanmar: All rivers (esp. Irrawady): 253,373 – 2,900,000 t [US$197,884 – 702,900] Indonesia: Total inland: 297,300 – 900,000 t [US$152,812 – 462,600] Philippines: Total inland: 131,644 t [US$54,632] Malaysia: Total inland: 3,369 – 10,008 [US$6,175 – 18,345] Case-studies: Mekong Basin (Ringle and Cai, 2003): • Riverine Catch: 1.16 Mt; Price: US$750/t; Value: US$872 M; Net profit: US$546 M; Profit by country (US$ million): • China/Yunnan: 0.05; Lao: 19; Vietnam/Mekong Delta: 188; Thailand: 151; Cambodia: 188; Mekong Basin (Sverdrup-Jensen 2002) • River: 1.53 Mt; Price: US$680/t; Value: US$1042M; • Aquaculture: 260Kt; Price: US$1050/t; Value: US$273M; • Reservoirs: 240Kt; Price: US$680/t; Value: US$163M; • Total: Catch: 2.03 Mt; Value: US$1,478 M

(Continued)

TABLE 3. (Continued)
Summary of values for river fisheries.

		India (Peters and Feustel 1997) • Stocking of Malampuzha Reservoir, Kerala; • Fishing income Rs 50 / day / fisher (or US$1/day) (lower than other jobs); Indonesia (Ali and Lee 1995) • Chenderoh Reservoir, Perak River; • Annual catch: 25 t; Total annual value: US$24,300 Sri Lanka (Renwick 2001) • Kirindi Oya Irrigation and Settlement Project (KOISP); • 5 reservoirs, Net financial value of fishing: US$544,000 – 566,000/yr
SE-LA	• Increasing number of SE-LA studies, many interesting observations including importance of fisheries for subsistence income, cash and food (data available); • Fisheries form part of risk management strategies with other activities, often seasonal; traditional management systems important in some places; • Overall weakness of management and problem of market access in large wetlands.	• Some SE-LA studies, particularly in Cambodia and Bangladesh, key issues identified: • Importance of fisheries to rural livelihoods, for income and food (often subsistence); • Contribution of inland fisheries to GDP is significant for some countries (e.g. Cambodia, Bangladesh and Lao PDR); • Distribution of benefits from fisheries needs to be better understood.

(b) The availability and coverage of valuation information also varies within regions

Despite the overall lack of comprehensive coverage of valuation information for river fisheries, there are some parts of the world where attempts have been made over the past few years to undertake valuation assessments, as shown in table 3.

In the case of Central and South America, the focus is on the Amazon River Basin and its many component fisheries. This is hardly surprising given the size and importance of this river. Estimates of the value of fisheries production using market prices have been made for many Amazonian fisheries, and more recently, the Provarzea Project has undertaken a large-scale exercise in valuing catches. However, there are many fisheries both within and outside the Amazon which have not been investigated at all.

In West and Central Africa, it is possible to estimate fisheries production and value for most of the large river basins, using a combination of information derived from government fisheries departments and research projects. The major exception is the Zaire-Congo – a river basin of global importance – where all fisheries information is minimal or non-existent. In East and Southern Africa, valuation of river fisheries is relatively new, and while there is good information on certain specific case-studies, there is a lack of global valuation information for the major river basins and riparian countries.

Finally, in Asia, there is some valuation information for rivers, but the data is sparse and tends to relate to specific countries or locations.

Box 1: Values of River Fisheries – Status of Knowledge

- There is a general paucity of information globally;
- The availability and coverage of valuation information vary within regions;
- Valuation using economic impact assessment is widespread;
- Global estimates and information gaps can be determined using existing information.

For example, there is some valuation information now available for the Mekong in Cambodia, in particular, as a result of the recent work of the Mekong River Commission, with the assistance of various international research projects. The same applies to Bangladesh and its river and floodplain fisheries. However, there are massive gaps in the information base for the Ganges in India and for other major Asian rivers including the Irrawaddy, the Indus and the Brahmaputra. There is a limited amount of valuation information available for fisheries in Sri Lanka, Indonesia, the Philippines and Malaysia also.

(c) Valuation using economic impact assessment is widespread

The type of valuation information for rivers which is most commonly determined and reported is similar across all four continental regions – namely, economic impact assessment (EcIA) information. Typically, fisheries production (or landings) is valued using local market prices. The review papers were able to locate this type of information for many major river basin fisheries and riparian countries. By comparison, other types of valuation information, especially that derived from conventional economic analysis (CEV), are less common.

In the case of Central and South America, there were no CEV studies. In contrast, a range of estimates have been made for value of fish catch in different parts of the Amazon.

In West and Central Africa, a number of CEV studies have estimated the net economic benefits derived from fisheries in northern Nigeria, demonstrating that river fisheries were generating a net economic surplus in the region of US$6-9 million/year.

In Eastern and Southern Africa, a range of river fisheries systems have been investigated, and both CEV and EcIA information is available for these specific fisheries.

Finally, in Asia, there are a small number of CEV studies in the literature (Bangladesh and Indonesia), whereas EcIA information is available for a number of river systems and the Mekong River, in particular.

The use of socio-economic and livelihood analysis (SE-LA) for river fisheries appears to be increasing in many parts of the world. The value of river fisheries to income (both cash and subsistence) and food supply (especially protein) for rural communities was significant. The application of SE-LA has also proved to be particularly successful in identifying key issues affecting fisheries management, the distribution of fisheries benefits and livelihoods.

(d) Global estimates and information gaps can be determined using existing information

Despite the patchiness of valuation information throughout the world, there are some possibilities for using the available data to produce global estimates. The estimation of such values may prove to be useful for policy-makers who need some broad guidance on the contribution of fisheries to a regional or national economy. In the absence of alternative valuation information, these types of estimates may be useful. In the case of both Central and South America, and West and Central Africa, estimates have been made for the value of regional fisheries production using market prices – in fact, the values estimated have been derived from a wide variety of sources of information (the exact methodology is described by Neiland and Béné in the paper on West and Central Africa, 2006).

The question can therefore be asked: "Is there sufficient information available to estimate the use value (gross financial value) for tropical river fisheries?" At a very basic level, the answer is 'yes', assuming that one can accept the principle of 'transfer values' (transferring value estimates from one region to another, where similar conditions exist). It is also known that tropical river fisheries make a large contribution to total inland fisheries production, although the exact proportion is not known.

In summary, therefore, the current status of knowledge for tropical inland fisheries (with river fisheries as a major component of this total) in tropical countries is summarized in table 4. The estimate of annual inland fisheries production

TABLE 4.
Tropical inland fisheries: Production weight and value by continental region (summarized from table 5).

	Region	Production weight (million tons / year)	Financial value (gross, US$ billions)
1.	Asia	2.85	3.30
2.	Africa	2.10	1.90
3.	Central and South America	0.51	0.38
	Total	5.46	5.58

(not including aquaculture) in tropical countries is 5.46 million tonnes (or 6% of total global fisheries production [90 million tonnes], not including aquaculture). The ranking of the continental regions by production level is shown in table 4.

It is not possible, at present, to determine a global economic value for tropical inland fisheries – although there are some local studies which have calculated that certain inland fisheries are generating economic benefits (economic rents and surpluses). There is a major deficiency of conventional economic information on inland fisheries worldwide.

In terms of economic impact assessment, it is possible, by making various assumptions, to calculate the financial (or market) value of tropical inland fisheries production. The estimated global total is US$5.58 billion. The ranking of the continental regions by the use value of inland fisheries is also shown in
table 4.

Other measures (or indicators) also reveal the value of inland fisheries. In terms of employment and income, inland fisheries may involve between 50 and 100 million people (table 3). However, there is relatively little accurate information in this domain, although many studies confirm that inland fisheries are an important subsistence and part-time activity (usually integrated with farming), particularly in Asia.

Inland fisheries also contribute to fish supply (apparent consumption) with mean global figures which range from 6.47 kg/caput/yr (Africa) to 14.8 kg/caput/yr (Asia). For countries like Bangladesh (10.2 kg/caput/yr), Cambodia (11.9), and Uganda (8.9), inland fisheries provide a majority of this supply.

The value of fish exports and imports are included in the UN FAO Fisheries Statistics (Vannuccini 2004; see also ftp://ftp.fao.org/fi/stat/summary/default.htm). They provide a means to gauge the relative importance of the direct use values of inland fisheries. For example, for developing countries, the total current value (2002 data) of annual fish exports (US$ 29 billion) and imports (US$ 10 billion) are significantly higher than total direct use values for inland fisheries (US$ 5.58 billion).

Finally, it is also important to note that this analysis is based on current published estimates of yields from inland fisheries. Some authors e.g. Welcomme (2004) estimate that many river fisheries have been underestimated by as much as 100%. The values discussed here should therefore be considered in this context. It seems very likely that in some cases actual values may be substantially higher, as revealed by the overview of the Mekong River Basin by Baran, Jantunen and Chong (2006). More accurate figures would however require a substantial increase in field surveys of inland fisheries in the future, at greater cost and requiring higher levels of technical and institutional capacity – considerations which may act as constraints in many tropical and developing countries.

TABLE 5.
Overview of tropical river and inland fisheries values and valuation.

Tropical Regions (30°N- 30°S)	Annual inland fisheries production (tons) (% total production)[1]	Valuation of river and inland fisheries			
		Conventional economic value [2]	Economic impact assessment		Socio-economic & livelihood analysis
			Gross market value (financial values, mean and range) (US$ millions) [3]	Other measures (export/import values in US$ millions) [4]	
CS America	513,747 (9%)	Not known globally; some important case-studies.	382 (250 – 514)	Total employment: >1 million Per caput fish supply: 8.9 Kg/yr Value fish exports: 5,503 Value fish imports: 594	Some studies, particularly in Amazon.
WC Africa	901,965 (17%)	As above	1301 (467 – 2135)	Total employment: > 2 million Per caput fish supply: 6.47 Kg/yr Value fish exports: 2,703	Increasing number of studies
ES Africa	1,194,161 (22%)	As above	600 (376 – 825)	Value fish imports: 1,008	Increasing number of studies
Asia (not including China)	2,849,428 (52%)	As above	3294 (2,413 – 4,474)	Total Employment: >50 million Per caput fish supply: 14.8 Kg/yr Value fish exports: 17,155 Value fish imports: 6,859	Some studies; esp. Bangladesh, Mekong.
Total	5,459,301 (100%)	Severe deficiency of information, overall.	5,577	Total Employment: 50-100 million Per caput fish supply: 13.8 Kg/yr Value fish exports: 25,361 Value fish imports: 8,461	Patchy distribution of information.

Notes:

1. Source: FAO (www.fao.org/figis) (accessed July 2005) : see table 6 for summary.
2. For further information refer to table 3 in this paper; some estimates of fisheries contribution to national GDP are available (mainly calculated on basis of marine export earnings, little information for inland fisheries).
3. Direct use (financial) values calculated using production estimates (column 1) and prices (column 3); mean national prices are not available for most countries, so the available prices (derived from market information reported in each regional paper) have been used as a best estimate, as follows:

Market price range for fish reported in the literature (further details in table 3, above) (US$/ton, wet weight)		
Tropical region	Low value	High value
Central/South America	486	1,000
West-Central Africa	518	2,367
East-South Africa	315	691
Asia (not including China)	847	1,465

4. Total employment (people involved in fisheries sector, catching plus other activities) is very difficult to estimate with accuracy; current estimates for CS America and Africa almost certainly underestimate part-time and subsistence fishers and other workers; See table 3 for additional information; Per caput fish supply sourced from FAO (www.faostat.fao.org/fisheries); Fish Export and Import values (not including Japan or Korea for Asia) sourced from FAO also, and include fish from both marine and inland sources (this fact needs to be considered when using the data).

Further information is available in table 3.

TABLE 6.
Inland fisheries production in tropical countries (tons/year, wet weight, fish only).

South and Central America		West and Central Africa	
Bolivia	5,615	Benin	18,190
Brazil	224,076	Burkina Faso	9,000
Colombia	60,461	Cameroon	55,000
Ecuador	400	Central African Republic	15,000
Guyana	800	Chad	70,000
Paraguay	25,000	Congo, DRC	215,000
Peru	36,073	Congo, ROC	26,027
Suriname	250	Cote D'Ivoire	22,000
Venezuela	48,815	Equatorial Guinea	1,000
Costa Rica	1,000	Gabon	9,500
Cuba	2,692	Gambia	2,500
Dominican Republic	1,336	Ghana	75,000
El Salvador	2,645	Guinea	4,000
Guatemala	7,300	Guinea-Bissau	200
Haiti	500	Liberia	4,000
Honduras	100	Mali	100,000
Jamaica	500	Mauritania	5,000
Mexico	95,884	Niger	55,860
Nicaragua	274	Nigeria	174,968
Panama	26	Senegal	20,720
TOTAL	513,747	Sierra Leone	14,000
		Togo	5,000
		TOTAL	901,965

Asia		East and Southern Africa	
Bangladesh	646,389	Angola	10,000
Bhutan	300	Botswana	122
Brunei Darussalam	1	Burundi	14,697
Cambodia	308,250	Egypt	270,164
(China)	(1,730,770)	Ethiopia	9,213
India	651,522	Kenya	112,644
Indonesia	298,730	Lesotho	24
Korea, DPR	5,000	Madagascar	30,000
Korea, ROK	3,948	Malawi	53,543
Lao PDR	29,800	Mozambique	10,948
Malaysia	3,605	Namibia	1,500
Myanmar	288,917	Rwanda	7,400
Nepal	18,888	Somalia	150
Pakistan	165,703	South Africa	900
Philippines	70,042	Sudan	53,000
Sri Lanka	24,340	Swaziland	70
Taiwan	453	Tanzania	301,855
Thailand	196,900	Uganda	239,931
Vietnam	125,826	Zambia	65,000
Papua New Guinea	10,814	Zimbabwe	13,000
TOTAL	2,849,428	TOTAL	1,194,161

Source: (http://www.fao.org/figis) (accessed July 2005, data for year 2003)

The Impact of Changes in River Management on the Value of River Fisheries

In this sub-section, the extent to which changes in river basin management and the impact which this has on river fisheries, in terms of value, will be considered. A summary of the findings of the five relevant review papers covering Central and South America, West and Central Africa, East and Southern Africa, and Asia is presented in table 7. Once again, as in the previous sub-section, the valuation information has been sub-divided according to the simple typology of valuation methods – conventional economic valuation (CEV), economic impact assessment (EcIA) and socio-economic and livelihood analysis (SE-LA).

Overall, on the basis of the information presented by the review papers, it is possible to highlight three key themes which appear to be important on a global basis, as shown in box 2.

Box 2: Impact of changes in river management on the value of river fisheries - three key themes

- Dams are a significant issue, but not the only cause of river basin change;
- The impact of change is recognized, but not valued;
- There is an emerging demand for valuation information, but there are a range of issues which need to be addressed in order to respond appropriately.

(a) Dams are a significant issue, but not the only cause of river basin change

The construction of dams across major rivers has been undertaken all over the world at a rapid rate in the past 30 years. Dams to provide electricity for industry, agricultural irrigation, water for industry and for household supply to urban areas have become a regular component of the economic development plans of almost all developing countries. However, dams have also been constructed for other reasons. They also cover a wide range of sizes, and it is likely that small earthen dams for agriculture uses far outnumber and have had a greater impact overall than the large dams for hydroelectricity. There is no doubt that dams can radically alter the nature of river basins by changing flow rates and patterns. They can create massive new water bodies (reservoirs) and at the same time they can greatly reduce natural floodplain areas. However, change in river basin management can also manifest itself in other forms including the construction of large canals or waterways for transportation (South America), and the preferential usage of rivers for industrial purposes (water cooling and pollution discharge).

(b) Recognition of impacts, paucity of valuation

There is a clear recognition in all parts of the world of the impact which changes in river basin management can have on the environment. There are many detailed descriptions and analyses of the changes in river courses and flows, siltation effects, and the nature of aquatic and terrestrial environments (including bio-diversity) which are lost (e.g. floodplains, submerged land) and created (e.g. reservoirs) through major dam schemes, for example. However, on a global basis there is a lack of valuation information to accompany the description of the physical and environmental effects of these changes. Furthermore, we know very little about the value or valuation of the social and cultural attributes of peoples and communities who might be seriously affected. With regard to fisheries in particular, the reviews show that there is very little valuation information concerning the impact of river management changes.

As shown in table 7, there are a number of CEV (partial analysis) study results. However, worldwide, the majority of valuation information is derived from EcIA studies – typically this

involves the simple calculation of changes in output in relation to some reference point (before the riverine change took place). There have been relatively few dedicated socio-economic or livelihood analyses of the impact of changes in riverine management, although many general studies usually make reference to the nature and activities of fishing communities.

TABLE 7.
The impact of changes in riverine management on river fisheries value.

	Central-South America (Bennett and Thorpe 2006)	**West-Central Africa** (Neiland and Béné 2006)
General	CS American countries have harnessed inland water for energy, long-distance transport and irrigation; Much general information on EIA, less on fisheries impacts (not easy to separate out).	Dam and irrigation schemes have modified many of the rivers and floodplain systems of West Africa.
CEV	Few studies or information overall could be easily located on economic impact on fisheries.	Kano River Project (Hadejia-Jam'are Floodplain, Nigeria) (Barbier et al. 1991; Barbier et al. 1993) • cost-benefit analysis revealed that the dam/irrigation scheme has a lower NPV compared to the floodplain (partial analysis for agriculture). Fisheries of NE Nigeria (Neiland, 1998): • cost-benefit analysis shows that net economic profit of fisheries in R. Benue (-96%) and Nguru-Gashua Wetlands (-11%) have declined (modified by dams).
EcIA	C/S America in general (Jackson and Marmulla 2001): • Many dams & reservoirs in NE Brazil, 50% catch now Tilapia, low productivity (no values). Itaipu Dam, Parana R, (Agostinho and Gomes n.d.): • 130 dams, no fish passes, stocking of exotics, artisanal catch and biodiversity low; • US$989 million in royalties given to states (is this used to compensate losers? Not known). Tucurui Dam, Tocantins R. Bra (La Rovere; Mendes 2000): • Overall rise in catch, 45% decline downstream; • Compensation paid to municipal district of Rs 30-287K (value resource lost/foregone?); • Indigenous group fund of US$740,000 (replacement/ relocation costs); partial analysis. Cana Brava, Tocantins R., Brazil (IADB 2002): • a new development still under construction with EIA and other monitoring in place; • 258 families to be re-located, US$4 million re-settlement costs (replacement of livelihoods or US$15K per family); no specific fisheries study. Yacyreta Dam, Parana River, Brazil (Ferradas 2000): • catches fell, access to river was more difficult; • fishermen offered US$8,000 compensation). Ita Dam, Uruguaia River (Bermann 1999): • 4,000 families and US$48K relocation costs. Porta Primavera Dam, Parana R. Braz. (Kudlavicz 1999): • catch fell 80%; 700 fishers affected; (no values). URRA Dam, Sinu Basin, Colombia (Correa 1999): • catches fell 6K to 1.7K tonnes (no valuation); Ralco Dam, Bio Bio R. Chile (Aylwin 2002): • expected loss of fishing livelihoods of indigenous people; 92 families to be relocated; US$20 million costs ($217K/ family), loss of culture? (bequest val.). Parana-Paraguay Hidrovia, Bra.(Bucher and Huszar n.d.): • evaluation of project does not include environmental costs of impact on Pantanal wetlands. Araguaia-Tocantins Hidrovia (CEBRAC 2000): • expected serious impact on fisheries not accounted.	Maga Dam and Yaéré Floodplain (Cameroon): • reduction of Yaéré floodplain due to dam, value of fish catch lost is US$120 million (1979-2001). River Niger, Mali: • impact on fisheries production induced by severe drought (1973), loss of fish catch valued at US$20 million per year.

(Continued)

TABLE 7. (Continued)
The impact of changes in riverine management on river fisheries value.

SE-LA	Increasing number of these studies, and relevant observations also appear in project evaluations, including: dam and hidrovia schemes impact on fishing livelihoods and communities, often by reducing benefits; Does compensation reflect real livelihood losses? How to relate payments to TEV? Do compensation payments reach right people?	There are no specific SE-LA studies examining the impact of river modification on fisheries. Certain projects do make reference to impacts: e.g. a survey of fishing village heads in NE Nigeria revealed that aquatic environment and related livelihoods had experienced a recent decline (related to river modification?) (Neiland 1998).
	East-Southern Africa (Turpie 2006)	**Asia** (Norman-Lopez and Innes 2006) (Baran et al. 2006)
General	Losses in downstream fishery production as a result of dam construction have been reported in E/S Africa, but there are few associated valuations. EIA have not required valuation of environmental impacts until recently.	In Asia, as in other parts of the world, dam construction has had a major impact on river fisheries. Dams for hydro-electric power are an important component of many development plans. For example, 160 dams are proposed for the Mekong Basin alone.
CEV	Few studies or information overall could be easily located on economic impact on fisheries, except Tana River dam schemes (Emerton 1994; Emerton 1996): • further dam construction was expected to reduce wetland fisheries (-25% original level) and marine (-50% present levels) over next 50 years; loss valued at KSh 67 million; • with further dams situation would worsen more rapidly: worse scenario (High Grand Falls Dam); same reductions (above) expected in 10 years; estimated to represent a cost (NPV) of KSh144 million (compared to past) and KSh77 million (compared to present). (Emerton 1994).	Nam Theun 2 Hydroelectric Project, Lao PDR (Wegner 1997): • environmental assessment and management plan (EAMP) showed that dam would destroy 45K ha land, supporting 4,500 people and natural habitats; • social and environmental costs: US$60-130 million (half of this opportunity cost of land); • mitigation budget: US$60-75 million (additional unforeseen costs up to US$50 million); • Wegner (1997) comments that costs are underestimated and benefits overestimated; • CVM used (but no documentation available to review its implementation).
EcIA	Cahorra Bassa Dam, Zambezi R. Zambia, Mozambique (Gammelsrod 1996): • reduction of river flow (and nutrients) correlated with lowering of marine prawn landings offshore from Zambezi Delta, by 1,500t/yr, valued at US$10 million; • prawn catches could be restored by increasing river flow, without reducing economic outputs from dam (not acted upon so far). Stieglers Gorge HEP, Rufiji River, Tanzania (Hobson 1979): • proposal for this scheme includes estimations of total catch and impact of dam (no valuation though). Lesotho Highlands Development Project (Majoro 2000): • predicted future value of fish catch in Katse River would decline by 10-20% for some species.	Pak Mun Dam, Thailand: • World Bank (2000) highlighted to World Commission on Dams (WCD) the lack of detailed baseline studies on fisheries and the related unresolved problems such as compensation and loss estimates for CBA; • Biodiversity loss is problematic to assess (what is due to dam?) – number fish spp. has dropped but is this the result of overfishing? Ganges River, India/Bangladesh: • 2 major dams at Hardwar and Farakka; both have produced major environmental changes, and caused political problems between countries concerned; • impacted negatively on fish migration; reservoir fisheries have given good production; overall no valuation studies to make global assessment.
SE-LA	There are few specific SE-LA studies on the impact of river management change, although the likely and actual impact on fishing communities and livelihoods is considered in other general studies on the fisheries. For example, Tana River study (above) characterises the nature of fishing activity as part of the valuation exercise, and highlights the large numbers of people (54K) dependent on fisheries (especially for subsistence).	No specific studies located, SE-LA dimensions mentioned in general studies on fisheries.

(c) Emerging demand for valuation and appropriate responses

The need for valuation information to assist and underpin the decision-making process concerning the usage and modification of water resources and river basins has been recognised for some time. This has been given additional impetus in recent years by a number of factors including the growing public awareness of the 'value' of the environment in general terms, and the emergence of 'environmental economics' to provide methodologies for valuation which highlight the concept of TEV. There has been associated pressure on government from the public and from NGOs to ensure that valuation information is recognised in policy decisions and the determination of mitigation and compensation costs (for example, when livelihoods are lost or communities have to be relocated).

However, despite the growing demand for valuation information to assist decision-making, a number of issues have to be addressed in order to produce an appropriate response to this.

First, there are significant methodological challenges to be overcome if 'valuation' is to become more prominent and relevant to policy-making. For a start, valuation methods of different types depend on using information about the bio-physical characteristics of river basins; in fact, there is a paucity of information in this domain especially, for massive river systems such as the Amazon, Congo and Ganges.

Second, if 'valuation' information is to become a credible component of decision-making in the future, then valuation methods and outputs must be well-implemented, transparent in their usage of data and the outcome validated. The credibility of 'valuation' can be easily undermined if these conditions are not met. In the case of two major dams in Asia for instance – the Nam Theun 2 (Lao PDR) and the Pak Mun (Thailand) – serious questions have been asked as to whether the 'valuation' for compensation losses has underestimated the funds which should be paid out.

Third, the expansion of valuation information will require new technical capacity in many developing countries, unless 'valuation services' can be provided internationally. There is probably a need for a complementary approach to this constraint, overall. In part, the credibility of 'values' and 'valuation' for river basins and fisheries has been undermined in certain countries by the implementation of 'valuation procedures' by non-specialists (a number of the review papers have highlighted this issue).

Fourth, valuation has an important contribution to make to key debates such as the impact of dams on river systems. It is important that 'valuation' and techniques such as economic CBA provide a basis for informed debate and decision-making. For example, there are many countries where dams provide the only source of energy (a benefit). There are also situations where dam schemes have flooded land and forests, reducing bio-diversity and disturbing communities and cultures (costs). The challenge remains as to how to compare these benefits and costs, and to identify options for future development policies.

Finally, the global review of the impact of changes in river management on fisheries value revealed that there is a paucity of information in all the four continental regions. In other words, we do not have a good understanding of river fisheries values and the impact of change, and in fact, we now know that such values are difficult to measure. In the next sub-section, the focus will be on wetlands valuation, where a number of investigations have already been carried out in different parts of the world (more so than for inland fisheries). What lessons can be learned from wetlands valuation and applied in the future design of fisheries valuation studies?

Broadening the analysis – some examples of wetlands valuation

In this section, the valuation of aquatic resources, which has so far focused almost exclusively on

fisheries, will be broadened to examine wetlands valuation. There is a close link between the two areas — in many parts of the world, inland fisheries constitute only one component of a larger system of wetlands contained within riverine floodplain, estuary and even lake-shore areas.

The World Conservation Union (IUCN) has recently published a series of case-studies in wetland valuation from different parts of the world, as shown in box 3.

The case-studies have been summarised in table 8 in order to highlight: the nature of the wetlands and the key issues, the valuation approach used, and the experience of using valuation in river basin management.

Box 3: Case-studies of the valuation of wetlands (IUCN 2003)

- Sri Lanka – Muthurajawela Marsh (safeguarding wetland protected areas in cities);
- Zambia – Barotse Floodplain (local economic dependence on wetland resources);
- Cambodia – Ream National Park (balancing the local opportunity costs of wetland protection);
- Cameroon – Waza Logone Floodplain (economic benefits of wetland restoration);
- Pakistan – Indus Delta (economic costs of reduction in freshwater flows);
- Kenya – Tana River (integrating downstream values into hydropower planning);
- Uganda – Nakivubo Swamp (managing natural wetlands for their ecosystem services);

TABLE 8.
Summary of IUCN case-studies in wetland valuation (IUCN 2003).

Nature of wetlands and key issues	Valuation approach and values	River basin management experience and use of valuation
(1) Muthurajawela Marsh, Sri Lanka: safeguarding wetland protected areas in cities (Emerton and Kekulandala 2002)		
• SW coast of Sri Lanka is very densely populated, urbanized & industrialised; little attention to 'green spaces' in land use planning; • marsh in urban park & wetland sanctuary north of Colombo, but under serious threat, despite 1990s Masterplan; • largest saline peat bog in Sri Lanka (3,068 ha), high biodiversity, 5K people, 300K local area; • large no. industries nearby; • marsh buffers water flows (runoff) and quality; • provides water for local households; • supports fishing for 3K households (150 kg/ha/yr fisheries production).	• develop & apply integrated biodiversity -economic assessment methods; • to identify critical threats, major benefits and key actions required; • economic value of marsh: US$8 million/ year (US$2.6K/ha/yr).	• marsh has experienced considerable changes to biodiversity, ecology and hydrology due to drainage & waterflow management engineering, industrial & urban development; • 1992 Masterplan to manage change, including sanctuary declaration, fisheries, forestry zones (but implementation has been weak); • valuation in relation to biodiversity assessment raised awareness of wetland values, and socio-economic status; • series of economic tools/measures to help management: • sustainable income-generation (to encourage restoration by locals) • punitive action against wetland degrading practices (real costs of damage through better information).
(2) Barotse Floodplain, Zambia: local economic dependence on wetland resources (Turpie et al. 1999)		
• Zambezi River Basin system, and especially wetland,s have high economic value, but also increasingly vulnerable to pressures of economic and population growth;	• What is the value of local level wetland resource use by wetland communities? • overall study in two parts: scoping exercise followed by household surveys (quantitative data) and focus groups;	• there are no developments upstream of the Barotse wetlands (although a large no. of hydropower schemes, dams and reservoirs have been identified for possible development along the Zambezi);

(Continued)

TABLE 8. (Continued)
Summary of IUCN case-studies in wetland valuation (IUCN 2003).

Nature of wetlands and key issues	Valuation approach and values	River basin management experience and use of valuation
(2) Barotse Floodplain, Zambia: local economic dependence on wetland resources (Turpie et al. 1999)		
• wetland degradation through resource over-exploitation, land drainage & encroachment for agric., plus hydropower and irrigation schemes; • ecological & economic value of wetlands to rural communities is not fully appreciated in river basin planning, land/water management; • Barotse Floodplain is 550K ha (total Zambezi wetlands is 1.2 million ha); mainly grassland; • 225,000 people (27,500 households); • local livelihoods & culture of Lozi people linked closely with seasonal flooding; • mixed livelihood strategies (farming/ fishing); subsistence economy; 76% poverty; • Fishing and cattle are most important activities.	• data analyzed using a static economic model to determine value of each wetland resource: financial (private net cash income) and economic returns (net value to national income); • local use of wetland resources has net economic value of US$8.64 million per year; or net financial rtn of US$405/hh/ yr (83% was subsistence values and home consumption); • dynamic model used to calculate NPV of wetland resources under different future management scenario (do nothing; wise use; protected areas & agric. development); • most economically valuable future management option was 'wise use' of wetlands.	• the current study emphasized that any upstream development, if it influenced downstream river flow and flooding, would be likely to incur devastating economic losses to local communities on the Barotse Wetlands; • local economic values have not been a factor in decision-making in Zambezi Basin, but need to be in future to avoid inappropriate management which jeopardized livelihoods.
(3) Ream National Park, Cambodia: balancing the local opportunity costs of wetland protection (Emerton et al. 2002)		
• in 1993, a protected area network (23 sites) were designated under Royal Decree; followed by efforts by Min. Environment to establish enabling national policy/legal framework (post civil war); • the major challenge: how to address the high reliance of park-adjacent and park-dwelling populations on protected area resources? • possibly through community-based conservation approaches & buffer zones? (little progress or experience so far); • Ream National Park (21K ha) has extensive mangroves and other coastal habitats; but over one-third of area has been heavily modified by farming, logging, mangrove clearing for aquaculture and other activities. • 30K (5,500 hh) live close to park (3% pop. rate), high poverty rate, and depend on income diversity, including use of land, fishing and firewood from park; • a zoning and management plan for the park has been developed (1997-1999).	• aim of valuation study – to lend support to the ongoing management planning processes in Ream; • to highlight importance of community-based approaches to park planners; to find measurable indicators of protected area benefits (for use by local planners & managers); • household & village-level surveys found: almost all local residents depend on Park resources for income & subsistence; total net value of US$1.2 million/yr or US$220 per h/h (direct use financial values); • fishing (US$516K/yr), forestry and farming (US$698K/yr); • median family income is US$316/yr (33% earn <$200/yr), 50% hh highly vulnerable to poverty; • mangroves are particularly important providing subsistence goods (US$600K/yr) plus ecosystem services (US$300k/yr): total of US$900K (or US$500/ha/yr) > income from clear cutting or crab farming.	• valuation study has demonstrated benefits derived by local people from a diversity of activities within the Ream National Park; • draft zoning and management plan will prohibit and curtail many of these activities (many of 30K local people will find it difficult to survive); • therefore there is a significant cost to biodiversity protection; • collaborative management & sustainable resource utilization (although important) are unlikely to provide sufficient economic incentives for park conservation (they provide no income alternatives); • existing Provincial socio-economic development plans (although poverty oriented) take little note of protected areas or resource conservation; • current study underlines the importance of Ream National Park to long-term development of area, as an economic asset for which conservation is well-worth investing in.

(Continued)

TABLE 8. (Continued)
Summary of IUCN case-studies in wetland valuation (IUCN 2003).

Nature of wetlands and key issues	Valuation approach and values	River basin management experience and use of valuation
(4) Waza Logone Floodplain, Cameroon: economic benefits of wetland restoration (IUCN 2001)		
• floodplains make up a large proportion of Cameroon's f/w resources; • over last 10-15 yrs dams/canals built (mainly by the Rice Development Authority, SEMRY, to encourage grain cultivation; • widespread devastating impacts on floodplain hydrology and ecology, and associated livelihoods (especially fishers & pastoralists); • these impacts (values) have not been taken into account during planning of irrigation schemes; • Waza Logone Floodplain covers 8K sq.km in northern Cameroon (south of Lake Chad); 220K inhabitants (85% rural people depend on floodplain for income and livelihoods); • since 1979 inundated area of floodplain has been reduced by 964 sq.km (30% reduction), due to SEMRY Project at Maga Dam; • in 1990s options for flood re-release were explored; pilot releases led to re-flooding of 200 sq.km with recovery of fisheries, pasture and wildlife; • 1999 revised and updated proposal for re-inundation made.	• to estimate the economic value of re-inundation, & costs of flood loss; to justifying investment in flood release measures; • study updated earlier work; • 3 steps: (i) scope of study defined (focus on incremental values in particular); (ii) identify economic values associated with inundation (focused mainly on direct use values, and costs of schemes, and opportunity costs of flood release); (iii) define methods and data needs for valuation (market prices, substitute values, mitigation costs); • information collected using field surveys and secondary sources; then CBA applied in model to calculate NPV for flood loss & reinundation (various scenarios); • before modification Waza Logone contributed US$10 million/yr (or $3K/sqkm/yr) to regional economy; • post modification US$2 million lost; • flood release could generate US$1.1-2.3 million/yr, or US$5.6- 7.8 million/yr ($50 added per floodplain person);	• environmental conservation and restoration has not figured prominently in poverty alleviation strategies; • results of valuation presents a convincing argument for investment in flood release measures in the Waza Logone floodplain as a mechanism for rural poverty alleviation and sustainable livelihood development; • also highlighted costs to poor rural populations of ignoring environmental values in original SEMRY irrigation investment.
(5) Indus Delta, Pakistan: economic costs of reduction in freshwater flows (Iftikhar 2002)		
• Pakistan's vast irrigation network supplies 15 million ha farmland; • however, there is a significant environmental cost (e.g. upstream abstraction impacts on downstream ecosystems, and coastal and marine areas); • in the Indus Delta, costs are borne by poor local populations, through declining agricultural yields and fisheries production; • Indus River (3K km long, drainage area of 950 sq.km); • Indus Delta covers 600K ha. (largest area of arid climate mangroves in world, depends on river discharge); • Indus Delta does not today receive the 12 billion cubm freshwater needed to maintain it (largely as a result of upstream abstract, drought and the breaking of the 1991 Water Accord since 1994 by the Punjab), with saline intrusion a serious impact; • 900K people live in Delta and large numbers depend on mangrove resources for livelihoods.	• valuation study aimed to generate information about economic costs (relevant to water allocation and maintenance of downstream flows to delta); • focused on inland impacts of saltwater intrusion on crop agriculture and freshwater fisheries (economic benefits of delta ecosystems already studied); • study covered three Talukas (sub-districts) with 155K people, using various field surveys & secondary data: data on ecological impact of sea intrusion and economic data on agric/fisheries products (link between environmental change and loss of h/h production); • results showed that crop and fish production had declined as salinity had increased: Crop damage of US$210K, fish loss of $135K; jeopardised livelihoods of 135K people.	• study presented a number of strong policy recommendations: • the priority should be to release freshwater downstream to curtail salt water intrusion in the Indus Delta (to sustain ecosystem and livelihoods); • how will this be achieved when Pakistan's socio-economic development plans depend on expanding irrigated land; • conflict over water allocations are likely to escalate as long as the economic value of ecosystem needs for freshwater flows is marginalised in national decision-making.

(Continued)

TABLE 8. (Continued)
Summary of IUCN case-studies in wetland valuation (IUCN 2003).

Nature of wetlands and key issues	Valuation approach and values	River basin management experience and use of valuation
(6) Tana River, Kenya: integrating downstream values into hydropower planning (Emerton 1994)		
• Tana River (length 1K km) runs through Kenya and enters Indian Ocean through delta (1.3K sq.km); • catchment (100K sq.km) has 4 million people; • only permanent river in arid region and is a vital water resource; • also heavily used for hydropower (5 dams supplying 75% Kenya's electricity) which has reduced down-stream flows; • valuation study conducted as EIA of new scheme: the Mutonga-Grand Falls Dam. • seasonal flooding of floodplain is now much reduced (loss of floodplain habitats), new dam will almost completely stop annual flooding and lower water-table; • over 1 million people depend on river's flooding regime for livelihoods (including farmers, pastoralists, fishers); and 2.5 million livestock.	• with a variety of design options for new dam, the study aimed to quantify the environmental economic costs and benefits of further changes to Tana's hydrology; • results to be targeted specifically at influencing on-going economic appraisal and dam design processes (incorporate data into CBA used to assess dam profitability); • CBA for dams had not previously considered environmental economic impacts of flood loss; • 2 sets of data generated: impact on dam on each major eco-system; a set of economic indicators of the overall ecological desirability of dam design options; • NPV of cost to date of existing dams: US$26 million; • NPV of incremental cost of Mutonga-Grand Falls dam: US$19.13 million • human population affected: 1.1 million; (what is true cost in terms of loss of social and cultural disruption?).	• the major implication of the valuation study (and the wider EIA) was strong support lent to measures to mitigate or minimise the effects of the dam on downstream riverflow and flood regimes; • some dam designs were better than others when environmental economic costs were taken into account (mitigation was shown to be economically desirable and often carried an additional economic premium, since they could reverse some of the changes – and costs – that had already occurred through dam schemes.
(7) Nakivubo Swamp, Uganda: managing natural wetlands for their ecosystem services (Emerton et al. 1999)		
• in Uganda, wetlands cover 30K sq.km (or 13% land area); • many wetlands are under pressure (industrialization, urban expansion), and only recently have wetlands and other environmental considerations been taken into account; • this pilot study focuses on the economic value of wetland wastewater purification and nutrient retention functions; • does urban and industrial development in Kampala's wetlands make good economic sense? • Nakivubo Swamp: largest in Kampala (5.29 sq.km; catchment: 40 sq.km,) domainted by papyrus, reeds and grass; • surrounded by residential and industrial development; 100K people live close-by and 200 factories; • facing reclamation and conversion because land is cheap and close to city centre; • provides a unique and important set of services: buffer between wastewaters and Lake Victoria; wetlands play a significant role in maintaining the quality of the city's water supply and Murchison Bay part of Lake Victoria.	• Nakivubo study aimed to quantify the value of wetland wastewater purification and nutrient retention functions, against potential gains from wetland conversion for industrial and residential developments; - 2 valuation methods: (i) the avoided costs of replacing natural wetland functions with man-made alternatives (connection to a sewage treatment plant and new pit latrines for low- cost settlements; data acquired from two independent sources); (ii) the foregone expenditures on mitigating or offsetting the effect of wetland loss (move inflow of Kampala's water supply if wetland lost); - other costs (e.g. managing wetlands to allow existing function to continue and to be extended) also considered; - valuation results show that Nakivubo Swamp has high economic value: US$1 – 1.75 million per year (costs of managing are US$235K).	• Nakivubo Swamps provide a cheap way of dealing with Kampala's wastewaters (compared to man-made options); • significant saving of money for government authorities; • economic costs of loss of wetland functions would be borne by poorest sectors of society and public sector agencies; • it has been widely recommended that Nakivubo Swamps should be fully recognized and designated as an economically important and environmentally sensitive area in city's plans; • the greatest threats are private interests which are reclaiming swamps in the absence of proper planning and controls (private vs. public CBA).

There are 6 important themes which cross-cut the case-studies (box 4):

Box 4: Wetland valuation case-studies – 6 important cross-cutting themes

- the value of wetlands is demonstrable;
- a range of valuation methods can be applied;
- it is important to understand the origin and meaning of particular values;
- different types of knowledge are linked within a valuation assessment;
- a broad-based, holistic and multi-disciplinary approach has advantages;
- valuation information can influence policy-making and management decisions in different ways.

First, the case-studies have shown that wetlands are valuable entities within both the regional and national economies of the countries concerned. The monetary net values calculated were often in excess of US$ 1 million, which undoubtedly represent sizable sums of money for any developing country. For example, in Sri Lanka, the economic value of the Muthurajawela Marsh is US$ 8 million/year. In Cambodia, the total direct use value of resources from the Ream National Park is US$1.2 million/yr. Clearly, if the wetlands were to be radically changed or removed then this value would be reduced or even lost completely. For the governments of DevC with valuable wetlands, it is clearly important to weigh-up whether these particular environments should be conserved (or not) or managed, and included within national development plans. However, it is interesting to note that although many valuation exercises generate large figures (US$ millions), when these figures are compared to other macro-economic statistics, they appear to be relatively small. It is understandable therefore when government policy-makers choose to ignore the relatively low levels of benefits arising from wetlands, within the context of cost-benefit analyses conducted at a national level.

Second, it has also been shown that a range of valuation methods are available and can be applied to the assessment of wetlands. The choice of method(s) must be carefully tailored to suit a particular situation, and this requires a degree of training and experience in order for the process to be successful. For example, in Zambia, household surveys and focus groups were used to determine local level resource use by wetland communities (net economic value of US$8 million per year), whereas in Uganda, the value of the Nakivubo Swamp (up to US$1.75 million per year) was determined using replacement and mitigation costs for the water purification services provided naturally.

Third, it should also be recognised that it is important to clearly understand the origin and meaning of particular ‘values’ generated by valuation studies, and to appreciate the possibilities for, and limitations to, comparing values. For example, it is important to understand the difference between gross (only benefits) and net values (benefits minus costs). Also the difference between financial and economic values (see table 2). Agricultural and fisheries production is commonly valued using local market prices (e.g. the Indus Delta, Pakistan case-study). These financial (gross) values cannot be directly compared with net economic values (e.g. the Waza Logone, Cameroon case-study). ‘Values’ must be used in a consistent and proper manner within specific case-study locations or in making comparisons between locations. It should also be noted that the series of IUCN wetlands case-studies have concentrated on assessing use values. It can be argued that this ‘partial’ analysis runs the risk of undervaluing wetlands, since the non-use components of Total Economic Value (TEV) are not considered.

Fourth, the IUCN case-studies also show the importance of the link between different types of knowledge which contribute to valuation

assessments. Wetland systems are usually made up of a wide variety of terrestrial and aquatic habitats, which people exploit in many different ways, often on a seasonal basis. The analysis of this complexity must utilize and combine ecological, environmental, economic and social information. For example, in Kenya, the Tana River case-study revealed the extent to which the diverse and complex seasonal relationships between people and natural resources, which constitute well-adapted livelihoods, would be disrupted by further dam construction. Using this knowledge, it was possible to calculate that the Net Present Value (NPV) of the incremental cost of the new Mutonga-Grand Falls Dam would be US$19 million with over 1 million people affected. This case-study also alluded to other costs (e.g. social and cultural costs) which might be considered, but did not attempt to assess them.

Fifth, the wetland case-studies also highlight the advantages of adopting a broad-based, holistic and multi-sectoral approach to valuation. This is especially the case in developing countries where many rural households tend to diversify their income and livelihood activities to cope with risk. In this context, a purely sectoral analysis would be limiting and inappropriate. For example, in the Indus Delta in Pakistan, household surveys provided information on the range of resources used and production levels (also market information), and this was analyzed against the background of environmental change provided by hydrological and ecological information.

Sixth, the case-studies also reveal some of the possibilities by which 'valuation' information can influence policy-making and management decisions. Overall, the studies emphasize and generate awareness about the economic losses (monetary values) and economic impacts (numbers of people affected and livelihoods disrupted) which might occur if wetlands are modified or removed, as shown by the Muthurajawela case-study in Sri Lanka. The fact that wetlands values have not been included at all up to now in river basin planning is also emphasized by a number of the case-studies (e.g. Barotse Floodplain, Zambia). In the Waza Logone, Cameroon case-study the possibility of restoring the value lost through wetlands rehabilitation is highlighted as an important option for the future.

The 'bigger picture' as far as policy context and policy-making is concerned is also considered by a number of the wetlands case-studies – this is part of the multi-disciplinary and holistic nature of wetlands studies in general. In Cambodia, the needs of the impoverished local population, who farm, fish and harvest wood in and around the Ream National Park have to be considered. The direct use of resource exploitation has been valued at US$1.2 million per year. Clearly, if the environment of Ream National Park is to be conserved for the future, then the Cambodian Government will have to provide alternative means to support the 30,000 people who realise this direct use value. Interestingly, the case-study revealed that other policy domains (e.g. poverty alleviation policy), which might be relevant to livelihoods and regional economic development take little note of resource conservation in the Ream National Park.

This specific problem of 'policy coherence' (or 'incoherence') is important for the future of rural people in DevC, and valuation assessments have an important role to play in understanding the issues involved. What is also clear, is that wetlands, like other sources of goods and services derived from natural resources, make an important contribution to the 'poverty safety-net' for rural people in DevC in situations where there are few other income or livelihood alternatives. In fact, for a number of the wetland studies (e.g. Barotse Floodplain, Ream National Park) which have used household surveys (of mainly poor people), it might be argued that the value of the 'poverty safety-net' has been calculated, and that this represents a vital piece of information which should be used in policy-making for rural development or poverty alleviation programs.

Valuation Methodology Compared and Reviewed

Introduction and approach

In this penultimate section, a comparison will be made between the different 'types' of valuation methodologies which have been used for river and inland fisheries to date, with a view to highlighting their potential utility in the future.

The comparative analysis was undertaken as part of the workshop session in Phnom Penh (WorldFish Workshop February 2003), and the results reflect the consensus which was reached between workshop participants (including the authors of the background review papers associated with this report).

A simple methodology was developed as follows:

First, the simple typology of three 'types' of valuation approaches – Conventional Economic Valuation (CEV), Economic Impact Assessment (EcIA) and Socio-Economic/Livelihood Analysis (SE-LA) (table 2) - was accepted as a useful starting point for the comparison.

Second, within each valuation method type, a single method was nominated to represent each type – CEV: economic cost-benefit analysis using household surveys; EcIA: market monitoring of outputs and prices and SE-LA: wealth-ranking participatory rural appraisal (PRA). The three specific methods were considered to be in common usage for valuation studies, particularly in Developing Countries (DevC).

Third, two sets of criteria were established to use as a basis for the comparative analysis of the methods. The first set of 15 criteria focused on a series of questions related to the institutional capacities and development needs of DevCs as shown in table 9.

TABLE 9.
Valuation methods: useful criteria in relation to capacities, needs and governance.

Criteria	Conventional Economic Valuation (CEV)	Economic Impact Assessment (EcIA)	Socio-economic/ Livelihoods Analysis (LA)
	e.g. household surveys	e.g. market monitoring of outputs/prices	e.g. wealth-ranking PRA
Criteria relating to institutional capacities and development needs			
Design phase	*	**	**
Data Collection	*	***	**
Reporting	*	**	**
Skill level	*	**	*
Time requirement	*	***	***
Criteria relating to analysis implementation			
Statistical values	***	**	*
Generalisability	***	**	*
Causality	***	**	**
Explanatory power	**	*	***
Accessibility	*	***	**
Training	*	***	**
Cost	*	***	***
Risk/uncertainty	*	***	**
M&E capacities	*	***	**
Criteria relating to principles of governance			
Transparency	*	***	***
Accountability	***	**	*
Participation	*	*	***

The second set of criteria is related to basic principles of governance. Governance was defined as follows:

'Governance refers to the process whereby elements of society wield power and authority, and influence and enact policies and decisions concerning public life, and economic and social development' (Governance Working Group of the International Institute of Administrative Sciences 1996)

The process of governance described above uses information and information systems in different ways (e.g. as a basis for designing policy, for informing citizens, for assessing policy performance), and of course, this will vary by country. The contribution which methods in valuation might make to information flows, for more effective governance, can be assessed using the standard criteria used in the literature:

(i) Transparency and access to information: Is the process by which information is generated transparent? Is information reliable and accessible to all citizens in an appropriate and timely manner? Does policy information clearly set-out the likely impact of policies on livelihoods?

(ii) Participation: To what extent do citizens participate in information generation and analysis? Is there opportunity for citizens to provide feedback to government on information and related policy decisions?

(iii) Accountability: Are mechanisms in place to ensure that institutions are accountable to citizens for information which affects policy design and implementation?

Fourth, the two sets of criteria (above) were then used to compare the three types of valuation methodology. Each method was given a score for each criterion, ranging from one star (low score) to three stars (high score), based on the following matrix:

Results of the Comparative Exercise

The results of the comparison are shown in table 9. The key findings from this simple exercise can be summarised as follows:

First, the three types of valuation method & have a particular set of characteristics in terms of their relationships to development needs, institutional capacities and principles of governance. In other words, each method will be suitable and can be applied to address certain specific valuation questions, and not others. It would be wrong to say that one type of method is better than another; all three methods have both strengths and weaknesses with respect to particular applications. It is appropriate here to re-consider the conceptual underpinning of the three types of methods (table 2). Conventional Economic Valuation (CEV) is underpinned by economic efficiency analysis and focuses on the maximization of aggregate social welfare (efficient resource use is desirable and the generation of economic surpluses are beneficial for national economic development). Economic Impact Analysis (EcIA) simply considers levels of benefits and does not assess policy interventions in term of economic worth to society. Socio-economic and livelihood analysis (SE-LA) aim to reveal the distribution of costs and benefits of policy changes across societal groups and to understand the factors which affect people's livelihoods. Clearly, if the three types of methods can be used together in a complementary manner, they can provide a very useful range of information for policy-makers.

Second, the CEV methods (e.g. economic cost-benefit analysis using large-scale household survey data) were capable of providing statistical values which could be used as a basis for complex analytical and modeling exercises, with

	Low score ⟶	High score
Criteria		
design/implementation	problematic/ involved/ complex/time-consuming/ high technical capacity required	not problematic/simplified approach/ not time-consuming /pragmatic/ low technical capacity required
analytical/general utility	low or weak or inappropriate	high or strong or appropriate

associated high levels of causality testing and explanatory power. However, the disadvantage of these methods is that they require a high level of technical capacity and skill level (limiting their accessibility to non-experts), and the overall implementation is time-consuming, complex and expensive, and does not cope well with risk and uncertainty (it is difficult to adapt the methods to changing circumstances without costly revisions to methods). The potential for an effective role in the monitoring and evaluation of policies is also limited because of these disadvantages.

Third, by comparison, methods classed under EcIA (e.g. market monitoring of outputs and prices) tend to produce information which is less robust statistically (cannot be easily generalised or used for explanatory purposes when used solely in a specific location) and is less amenable to sophisticated analysis and modeling applications (although it could be argued that fairly complex Input-Output models for regional economic analysis can be developed using similar data). However, the methods have other advantages. In particular, they require a lower level of technical capacity, skills and training, data collection and reporting process is less complicated and less time-consuming, and overall these methods are less costly. EcIA methods are also less vulnerable to risks and uncertainty (they can be adapted easily to changing circumstances at low cost), and can also be employed for monitoring and evaluation. Finally, these methods and the resulting information are also easily accessible to non-experts.

Fourth, the remaining methods – socio-economic and livelihood analysis (SE-LA) – which include, for example, wealth-ranking exercises (PRA), have a different set of characteristics compared to the other two types. On the whole, they tend to be relatively easy to design and implement (although the information output is almost always qualitative and can be voluminous and difficult to handle systematically), and require a medium level of technical capacity and training. These methods are also relatively inexpensive, and amenable to adaptation under risk/uncertainty, and have applications for monitoring and evaluation. Overall, although the information is not statistical in nature, and is not amenable to conventional analytical or modeling applications, it does have its own particular form of explanatory strength and capability (with particular reference to holistic perspectives on livelihoods), and is highly accessible to non-experts.

Fifth, in terms of the criteria relating to the 3 key principles of governance – transparency, accountability and participation – the three types of methods, once again, each show a slightly different profile. CEV methods are less transparent or open to participation by a wide range of stakeholders (in terms of the complexity of the techniques and the level of technical expertise required), but can be made highly accountable (given the formal nature of the methodologies involved). On the other hand, CEV methods such as (CVM),Contingent Valuation Methodology, (based on a survey of individuals' stated preferences) might be considered by some to be the ultimate in transparency. EcIA methods are very transparent and provide the basis for a high level of accountability (formal, but less technical methods), but involve a low level of participation by stakeholders (tending to be extractive in nature). Finally, SE-LA methods, are highly transparent and participatory in nature, but less amenable to strong accountability (less formal).

Valuation Methods – Other Important Issues

Finally, in addition to the findings of the above comparative exercise, it is also appropriate to re-consider some of the methodology issues identified and discussed in the background review papers.

The Review for Central and South America (Bennett and Thorpe 2006) emphasized four issues. First, it was observed that the failure to include non-use values in assessments is likely to seriously undervalue fisheries. Total economic

value (TEV) must include consideration of both use and non-use values. Second, it was questioned whether re-location grants to local people can be used as a 'proxy' for the value of fisheries, in relation to their disruption by dam construction. The problem here is that many fishing communities have a low bargaining power and their acceptance of a re-location package may be wrongly interpreted as a 'willing to accept' payment for their lost/changed livelihoods. Third, although there is a great paucity of valuation information, the small number of discreet studies which have taken place in Central and South America provide some indication of the 'values' for fisheries which can be obtained and also provide a basis for developing 'best practice' guidelines for these exercises. Fourth, recreational uses for rivers and fisheries are becoming increasingly important in this region, but there have been very few valuation studies to date in this sub-sector.

The Review for West and Central Africa (Neiland and Béné 2006) undertook a preliminary comparison of the three types of valuation methods (a prototype of the exercise outlined in Sub-Section 'Introduction and approach' above) by asking three simple questions: Which methods are most easily used and applied? Which methods produce information outputs with the greatest utility? Which methods are most cost-effective? On the basis of recent personal experience of using these methods, and by adopting a simple scoring system to compare the attributes of the methods, it was judged that the most successful are the EcIA methods compared to SE-LA or CEV methods. The WC Africa review also highlighted the importance of considering actual versus potential values. This distinction is important especially with reference to Common Pool Resources (CPR) since there is a tendency for natural resources or CPRs to become over-exploited and hence for the flow of benefit (=value) to be reduced. In effect, the review shows that in most cases the potential value of the fisheries considered is large relative to their current value.

The Review for Southern and Eastern Africa (Turpie 2006) discussed a range of issues relating to the usage of valuation methodology including: First, it is important to define the scope of a valuation study – the geographical scope (e.g. which users to include in an assessment?) and analytical scope (e.g. will the valuation study generate an overall value in terms of gross contribution to the national economy, or contribution to individual households?). Second, direct use values have been used most commonly for fisheries assessments in this region, and there is a growing body of information and field experience to assist the future design of such valuation exercises (e.g. how to conduct household surveys, measure outputs and price effectively). Third, it is important to set values for activities such as fisheries within a relevant context – otherwise values generated by specialist studies can be fairly meaningless to decision-making (e.g. contribution to household, local, regional or national economy). Fourth, it is also important to establish the probable relationship between annual (current) values for fisheries, and likely future values (e.g. how will the calculation of a NPV relate to the sustainable development of a fishery over the next 10 – 50 years? Is it possible to estimate this? Can methods such as the production function approach be applied to estimate the impact of environmental change?). Fifth, and finally, Turpie discusses the question 'Should valuation be carried out more efficiently or rapidly?' The author concludes that there are important trade-offs in making choices between detailed and intensive valuation approaches (CEV methods) and more rapid evaluations (EcIA and SE-LA methods). Both sets of methods have desirable attributes, and can be used in a complementary manner. Ultimately, the rapidity with which a study is carried out should be determined on the basis of its purpose, and with its potential future application in mind.

The Review for Asia (Norman-Lopez and Innes 2006) identified a number of important methodological issues as follows. First, the

current review study has shown that almost all valuation studies to-date (or major studies with a valuation component) have estimated direct use values, but none have examined indirect use values. Non-use attributes are equally important as use values, and despite the difficulty of estimating them, they should be included in future valuation work. Second, it is important that value studies provide not only the present value of a fishery, but also include the change in value under different conditions. This is vital in order to understand the impact of different management regimes on the resource and on society. Third, although the estimation of the importance or value of tropical inland fisheries can be undertaken roughly using use values (based on production and market price), the results need to treated with caution given the lack of reliable data for many fisheries at the preset time (a point further emphasized by Baran et al. 2006 in the study on the Mekong River Basin). In the future, more rigorous studies will need to be conducted before we can be confident that the figures generated reflect the true value of tropical fisheries to society.

Finally, it is worth noting a number of basic issues concerning valuation which appear in the literature, and which are relevant to the study framework and papers used in the current study, as follows:

(i) *Incremental versus total value*: Most decisions involve marginal or incremental changes from current conditions (e.g. the impact of a dam, policy measure, etc) and accordingly, it is marginal values which are relevant. The sort of question might be: if we reduce the area of wetland by 1 hectare, by how much will the value of output change? Total values are not always very meaningful, as exemplified by the famous paper in Nature by Costanza et al. in 1997 (People and the Planet 2004) who claimed that the value of global ecosystems was US$33 trillion p.a. Figures for the total value of wetlands are implicitly making an 'all or nothing' comparison – either it is there in its entirety, or not at all – which is not particularly realistic.

(ii) *Multi-criteria decision methods*: In connection with the simple typology presented for valuation approaches (table 2), it should be noted that cost-benefit analysis, which is how CEV is commonly applied, has lately been extended by the use of multi-criteria decision methods (e.g. multi-objective modeling, multi-attribute utility theory, analytical hierarchy process). These all attempt to include criteria other than the maximization of economic efficiency *per se*, and as such re-define 'social welfare' so that it depends not simply on the overall balance of costs and benefits but also on who are the winners and losers.

Valuation and Policy-Making

Finally, the Phnom Penh workshop also discussed the relationship between valuation and policy. It was accepted that valuation of different types may provide decision-makers with vital information about the benefits and costs of the alternative uses of natural resources such as river and inland fisheries and wetlands – without this information the full range of options for resource development and management may not be fully taken into account.

The participants reached a consensus on three major issues, as follows:

(i) The generation of valuation information is not a sufficient condition to ensure successful policy relating to the management of the environment in Developing Countries;

(ii) A better understanding of the policy process is required;

(iii) Identification of opportunities and constraints for influencing policies using valuation is required, with respect to the criteria used to compare the three types of methodology and the relation to governance.

Conclusions and Recommendations

The global review of tropical river (and inland) fisheries valuation reported here has reached the following conclusions and recommendations:

Conclusion 1: There is a general paucity of information on river (and inland) fisheries in tropical and Developing Countries. This is especially the case for Conventional Economic Valuation (CEV), while information derived from Economic Impact Assessments (EcIA) and Socio-Economic and Livelihood Analysis (SE-LA) is more widely available (although even in these domains, the level of information available is low). The best estimate of current global tropical inland fisheries production (not including aquaculture) is 5.46 million metric tons valued at US$ 5.58 billion (first sale value). This is equivalent to 19% of the current value of annual fish exports from Developing Countries (US$29 billion), based on current fisheries statistics from FAO. It has also been revealed by local SE-LA studies that inland fisheries (including river fisheries) contribute to the 'poverty safety-net' for rural people in many countries. The overall implications of this finding (of paucity) is that policy-makers may be unaware of the importance of inland fisheries, leading to policy decisions and interventions, which jeopardize the full range of benefits which these natural resources can provide for society and for development and poverty alleviation, in general.

Recommendation 1: The global information base on the value of inland fisheries should be increased and upgraded urgently, and this information made available to national and international policy-makers.

Conclusion 2: There is also a general paucity of information on the impact of changes in tropical river management on the value of inland fisheries in Developing Countries. In general, there is a widespread recognition of the existence of impacts – the impact of large dams on the hydrology, ecology and livelihood support attributes of tropical rivers is especially well-known. However, there have been few valuation studies of these impacts, and the generation of information in this area is severely constrained by a range of factors, including the lack of technical capacity in many countries.

Recommendation 2: The information base on the impact of changes in tropical river management on the value of fisheries in Developing Countries should be upgraded and this information made available to policy-makers. This will require governments to support capacity-building in this area.

Conclusion 3: There is a wide variety of valuation approaches and methods available and in use, which can produce a range of information types and perspectives on tropical river and fisheries management. There is significant potential to combine different methods, depending on the situation and the focus of the work, to provide a powerful mechanism for information generation and analysis. For example, EcIA methods such as production and market-price monitoring can provide a basic flow of cheap and easily-accessible information, while at the same time using periodic SE-LA such as livelihood profiling to increase understanding of local issues and to identify problems for further in-depth CEV studies such as contingent valuation and modeling applications.

Recommendation 3: A 'valuation toolbox' for tropical inland fisheries should be developed, and include a manual, methodology, training packages and supporting literature and links to valuation professionals (to provide mentoring services). The 'valuation toolbox' would need to be developed using theoretical and empirical research, in order to establish 'best practice' guidelines and a standardised approach to information needs. An essential part of this 'valuation toolbox' approach would be the establishment of guidelines for the integration of

valuation methods into the policy process. This would require a methodology for characterising the policy process of a particular country and understanding the demand and need for particular types of valuation information. It is also recommended that a 'valuation toolbox' approach should articulate and support important and relevant international policy frameworks, including the Code of Conduct for Responsible Fisheries (fisheries management), the Ramsar Convention (wetlands) and the Millennium Development Goals (poverty alleviation).

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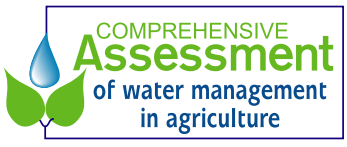

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