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What do MRC studies tell us about the implications of Mekong mainstream dams for fisheries?

- A 1994 Mekong Secretariat fisheries evaluation of Lower Mekong mainstream dams concluded that more knowledge was needed to make reliable assessments of the dams.
- Since 1995, donors have invested substantially in research by the Mekong River Commission (MRC).

MRC research confirms:

- The immense value of the Mekong's capture fishery in terms of its contribution to the economies of all Lower Mekong countries, as well as household nutrition, income, livelihoods and food security.
- Sustained and sustainable fisheries productivity is contingent on the ecological integrity of the Mekong river system.
- The principal threats to the future viability and sustainability of the Mekong's fish and fisheries are developments that:
 - Obstruct fish migration
 - Degrade aquatic habitats
 - Affect the flow regime
- The Mekong mainstream dams will obstruct fish migration and degrade aquatic habitats. The extent of impact on flows will depend on the size and operation of the dams.
- There are no known effective mitigation measures against the barrier effect of dams on fish migration in the Mekong.

This brief draws primarily on information published by the Mekong River Commission (MRC) that documents the importance of Mekong fish and fisheries, and the potential implications of mainstream dams on fisheries, economy and livelihoods.

Background

In 1994, a few months prior to the signing of the 1995 Mekong Agreement, the Mekong Secretariat published a study which identified and ranked up to eleven potential hydropower dam sites on the Lower Mekong mainstream. Of these, the study prioritised nine ‘run-of-river’ mainstream dams for further study, with a total generating capacity of 13,350 megawatts [1]. These were intended as an alternative to the cascade of large-storage dams envisaged in the Mekong Committee’s Indicative Plans of 1970 and 1987.

The Mekong Secretariat also commissioned an evaluation of the likely impacts of mainstream dams on fish and fisheries [2]. The fisheries evaluation highlighted, among other things, the lack of detailed information on fisheries ecology – fish stocks, migration patterns, location and character of spawning and rearing habitats – in all reaches of the Lower Mekong Basin (LMB), and concluded that “these projects cannot be safely designed or mitigated without first establishing a sound and reliable database.” [2:92].

Thus, the fisheries evaluation recommended a series of short- and long-term studies to assess “specific project impacts, mitigation, cumulative or combined impacts, and alternative project sites and dimensions,” as well as “detailed study of main stem and floodplain fisheries ecology, including social and economic aspects.” [2:92]. These recommendations echoed those of a 1992 Review of the Fishery Sector in the LMB published by the Interim Mekong Committee, which stated that “Development of mainstream dams should not proceed without such detailed assessments.” [3:xii].

Fourteen years on, renewed interest in damming the Mekong mainstream has again raised questions about potential impacts on fisheries and the livelihoods of people in the basin. As Jeremy Bird, the CEO of the MRC Secretariat recently noted, “Unfortunately, the

necessary studies to fill these information gaps were not initiated. We now need to move forward quickly to make up for lost time. The challenge is to see what can be done with the available knowledge to take a more integrated perspective.” [4].

MRC-generated fisheries knowledge

Since its inception in 1995, millions of dollars have gone into the MRC’s Fisheries Programme in generating knowledge of Mekong fish and fisheries. Although not specifically addressing the impacts of mainstream dams, the Fisheries Programme has produced a wealth of information regarding the size and value of the Mekong fishery, its economic and livelihood significance, the ecological processes and functional characteristics that support fisheries, including the role of fish migrations, and the principal threats to the ongoing productivity and sustainability of the Mekong’s fishery.

Size and value of the Mekong’s fishery

Aquatic biodiversity

Although estimates for the Mekong’s inland fish biodiversity range from 785 to 1,500 species depending on the source, it is widely recognised that the Mekong hosts one of the most diverse aquatic faunas in the world, with high rates of endemic species [5:12]. The high diversity of fish and aquatic species is intimately linked to the Mekong’s complex ecosystems, and is a major factor contributing to the exceptionally high fisheries productivity and yield [6].

Fish productivity and yield estimates

The growing acknowledgement of the importance of the Mekong’s fish and fisheries is reflected by estimates of total yield, which has increased significantly since the early 1990s, as evidenced by estimates presented in MRC Fisheries Programme research and annual reports over the years (see Table 1).

Recent published estimates indicate a yield of over 3 million tonnes per year, of which over 80 per cent comes from wild capture fisheries. This has led experts to affirm that the Mekong is the largest inland fishery in the world [7, 8], representing about 2 per cent of the total world marine and freshwater capture fishery [9].

Year	Yield/tonnes
1991	approx. 356,000
2000	> 1 million
2002	> 2 million (1.53 million tonnes from capture fisheries)
2005	> 3 million (2.64 million tonnes from capture fisheries)

Table 1: Estimates of fish yield in the LMB
Source: MRC Fisheries Programme Annual Reports 2001:4; 2002:4; 2005:4-5.

Economic value

The Mekong fishery has an estimated value of US\$2-3 billion per year [8, 10], contributing significantly to the economies of all Lower Mekong countries. Even so, the MRC notes that this estimate “certainly understates the macro-economic significance of the fisheries sector because it does not include the incremental value derived from resale, exports or associated industries.” [10:4]. Thus, “Allowing for multiplier effects the fishery is worth several times that figure, and its replacement value is far higher.” [11:4]. Moreover, fisheries yield estimates and their contribution to national economies does not truly capture the value of fisheries in terms of household income, nutrition, livelihoods and culture.

Livelihood and nutritional value

MRC research states, “All official data of fisheries yield are less than estimates derived from consumption data. National data exclude or under-report the important artisanal and subsistence fisheries which make a major contribution to yield.” [12:74]. In its 2003 State of the Basin report, MRC also notes, “It has become obvious that people in the region are far more dependent on the Mekong’s fishery for household nutrition, income and livelihoods than was previously believed.” [13:106].

Survey results have shown that between 64 and 93 per cent of rural households in the Lower Mekong Basin are involved in fisheries, with wild capture fisheries a significant contributor to household nutrition and income generation [6:14]. The consumption of fish and other aquatic animals provide 47 to 80 per cent of

animal protein intake, depending on country [12], and is a major source of “essential elements (including calcium, iron and zinc) and vitamins – particularly vitamin A”. [12:2].

While difficult to quantify, the nutritional value of fish and aquatic animals are economically significant given that “economic consequences of these deficiencies are a cycle of malnutrition, low productivity and poverty.” [5:12]. There is no readily available substitute for fish in the diets of people in the Mekong Basin [11]. Moreover, despite large investments in aquaculture, it is estimated that 90 per cent of consumption is derived from capture fisheries, indicating limited capacity of aquaculture to replace wild capture fisheries [12:74].

Fisheries – ecological processes, functional characteristics

Fish migrations

Fish migrations play an important role in the functioning and productivity of the Mekong’s ecosystem. Eighty-seven per cent of Mekong fish species for which information is available are migratory [14]. Many species travel long distances, often crossing national borders, to reach feeding, refuge and spawning habitats at different times and stages of their life-cycle. The reliance of fish on seasonal habitats that are geographically separated is considered a driving force behind fish migrations, which are intimately linked to the Mekong’s hydrological regime [15, 16, 17].

- **Seasonally inundated floodplains** are considered the main “fish production sites” [17]. As noted by a 2002 MRC Technical Paper, “Without the floods and the floodplains the fish catch would only be a small fraction of what it is now.” [16: 62]. Rich in nutrients, food and shelter, the floodplains provide crucial feeding and rearing habitats for many fish species [17]. The main floodplain habitats are located from southern Cambodia to the Mekong Delta in Vietnam of which the Tonle Sap Lake and surrounding floodplains is the most important. As water levels recede, fish move out of the floodplains seeking refuge in deeper sections of main river channels and tributaries [15].

- **Deep pools** provide important dry season refuge for a number of important migratory fish species. The stretch of the river from Kratie to Khone Falls has been identified as the most important in terms of deep pools. This stretch of the river is also believed to provide important spawning habitats [15].

Flow regime, fish life cycles and habitats

There is an intimate link between the Mekong's hydrological regime, the life cycles of fish, and their migration between widely separated habitats, as evidenced by the strong correlation between mass migrations of fish and the annual Mekong flood-drought cycle. The size and extent of the flood has significant influence on fisheries productivity. Generally, fish yields are higher when there is "a larger flood, which lasts for a longer period and which occurs when fish are ready to reproduce." [18:8].

Change in water level (and discharge) is the most commonly cited "trigger" for fish migrations. Although a recent review of fish migration triggers published by the MRC notes that there is little knowledge on the physiological or environmental factors that trigger migration, of the species for which migration cues are known "ninety per cent respond to changes in water level or in discharge." [14:ix].

Fisheries depend on migratory stocks

From subsistence-based to large commercial operations, Mekong fisheries are largely based on and have adapted to the capture of migratory fish. In Cambodia, for example, migratory stocks constitute a dominant part of the annual harvest, which averages an estimated 400,000 tonnes per year [19]. Similarly, the bulk of the annual catch in Khone Falls, one of the most important fisheries in Lao PDR, is comprised of migratory fish [14]. At a basin-wide level, it has recently been estimated that over 70 per cent of the total fish catch in the Lower Mekong Basin is dependent on long distance migratory fish [8].

Given the importance of migrations to fish life-cycles and fisheries, MRC Fisheries Programme has called for an "ecosystem approach" to fisheries management in the LMB. This approach focuses on protecting the ecological integrity of the river system, maintaining the

connectivity between critical habitats (i.e. migration corridors) and emphasises the importance of the annual hydrological pattern, including its role in the creation of seasonal floodplain habitats [15, 16, 20].

Concurrently, there has been growing recognition that although unsustainable fishing practices place pressure on fishery resources, the principal threats to the sustainability of the Mekong fisheries arise from developments in the basin that affect the ecological integrity of the Mekong river system [15, 16, 20].

Threats to Mekong fisheries

It is now widely agreed that the principal threats to the Mekong's fisheries involve activities that alter the natural flow regime, damage or destroy fish habitats, and/or block or restrict fish migrations [15, 16, 18, 20]. "Dams and flood control schemes in particular diminish river-floodplain fisheries, as they cause all of these impacts." [18:30]. The threat that dams pose on the future sustainability of Mekong fisheries is acknowledged by MRC and others:

- A 2004 MRC Technical Paper identifies the impacts of water infrastructure as "The overriding threat to the future of the Mekong's fish and fisheries." [20:19].
- A 2007 report published by the Cambodian National Mekong Committee (CNMC) and the WorldFish Center (WFC) asserts that "Dams are the main type of structure having an impact on fisheries production, through their negative impact on fish migrations." [19:24].
- In a paper presented at an international fisheries symposium held in Ubon Ratchathani University in September 2008, Chris Barlow, MRC Fisheries Programme Manager, stated that dams on the Mekong mainstream "will be very deleterious for the fisheries based on migratory species (the 'white fishes') in the Mekong." [21:19].

Key fisheries impacts of three existing dams in the LMB [excerpts from MRC (2003) *State of the Basin: 2003*, p.112.]

Nam Song dam, Lao PDR: *“Following completion of the Nam Song weir in 1996, 40 fish species disappeared and 20 trans-boundary migratory fish species were lost from catches in neighbouring countries. Of these, 20 species were trans-boundary migratory (TBM) or long distance migratory species (LDM).”*

Pak Mun dam, Thailand: *“Before filling the Pak Mun Dam... 265 fish species were recorded in its diverse variety of aquatic habitats, and the fish spawning grounds were accessed by fish from the Mekong mainstream. Following the construction of the dam, only 96 fish species have been recorded upstream of the dam, and of those, 51 fish species have declined in abundance. The construction of the dam has caused the upstream extinction of long distance trans-boundary migratory species, which previously returned annually to spawn in the rapids.”*

Theun-Hinboun dam, Lao PDR: *“Many Mekong River fish species in the Cyprinidae and Gyrinocheilidae families feed primarily on periphyton (algae attached to substrate)... Increased water levels caused by the Nam Hinboun and the Theun-Hinboun hydropower projects in Lao PDR wiped out periphyton communities and with them, the periphyton-feeding fish species.”*

What does this mean for mainstream dams?

Key findings from the 1994 Mekong Secretariat fisheries evaluation of mainstream dams

The 1994 fisheries evaluation published by the Mekong Secretariat is the only publicly available study that specifically assesses potential fisheries impacts of the Lower Mekong mainstream dams. While the study highlights the lack of fisheries baseline data as a major constraint to adequately assessing the impacts of mainstream dams, it does raise several points of concern that suggest the proposed ‘run-of-river’

dams carry significant risks for the future viability and sustainability of the Mekong fisheries:

- With respect to the six projects proposed for northern Laos and the Lao-Thai border area (i.e. Pak Beng, Luang Prabang, Pak Lay, Xayabouri, Chiang Khan/Xanakham, Pa Mong/Pak Chom), the authors note that if all six dams were built, “they will remove almost all of this reach as a free-flowing stream and convert it into a cascade system that will inundate spawning areas, remove wetland and littoral habitat, increase downstream incubation drift time, block upstream migration, cause turbine mortality, flood the confluences of tributaries, and induce species changes and reduce biodiversity.” [2:53]
- The study describes Khone Falls as “an ecologically unique area that is essentially a microcosm of the entire lower Mekong River... Such a site is so rare in nature that every effort should be made to preserve all of Khone Falls from any development.” [2:90].
- Regarding Sambor dam in Cambodia, the study states “The Sambor project [will] impact upstream and downstream [fish] migration. Target species will be separated from spawning areas between Sambor and Stung Treng. Not only will spawning migrations be eliminated but increased water level behind the dam will affect the migration of young fish into (wet season) and out of (dry season) floodplain habitat... The effect of isolating fish stocks from historical spawning and rearing areas will have effects far upstream to perhaps Pakse and beyond, and on the Great Lake fishery.” [2:79-80].
- Noting that the proposed Sambor dam site would be located within a “highly complex migration and rearing corridor and floodplain,” the study states the project “will require an effective passage system for all migratory fish species to avoid or minimize significant impacts. Effective fish passage may be a remote possibility, requiring substantial research and development that may not prove fruitful.” [2:vi].

- The study highlights the potential consequences of the barrier effect of the mainstream dams to fish migrations: “This one impact alone may cause a wholesale decline in the fishery throughout the lower Mekong River. Blocking migration cuts out a critical link in the biological chain of migrating species.” [2:88-89].

Other studies pointing to impacts of mainstream dams on fisheries

Although the MRC has undertaken an economic evaluation of fisheries impacts and a review of the draft EIA of the Don Sahong dam, and has initiated a range of assessments of the mainstream dams (e.g. strategic environmental and cumulative impact assessments) [4], these have not yet been made publicly available. Nevertheless, research published by the MRC and other institutions make reference to the implications of mainstream dams on fisheries:

- A 2007 science brief published by the WFC highlights the especially important role Hou Sahong channel, site of the proposed Don Sahong dam, plays in fish migrations basin-wide. Drawing on 28 scientific studies, the brief notes, “Obstructing fish migration at Khone Falls therefore would have social, ecological and economic implications basin-wide.” [7:2].
- According to the MRC’s 2003 State of Basin report, “A mainstream dam, on the Mekong below the Khone Falls... would prevent the migration of adult white fish from the floodplains and others to their spawning grounds upstream in northeast Cambodia... At these times [of peak migration] at least 50,000 fish per minute are swimming past a given point in the Tonle Sap River. No existing fish ladder design could cope with these numbers of fish.” [13:114].
- Highlighting the importance of deep pools and rapids in Sambor, a 2002 MRC Technical Paper on fish migrations states that, “[Sambor dam’s] impacts on migratory fish stocks would be significant.” [17:56]. Reasons include: change in hydrology upstream and downstream, which would “lead to deep pools refuge habitats filling up with sediment and disappearing”; blocking

or significant impairment of migration corridors between floodplain and refuge habitats; and “interference with the larval drift system, causing increased direct mortality as well as indirect mortality.” [17:56]

- A paper presented at the 6th Technical Symposium on Mekong Fisheries in 2003 was more up-front in its analysis of Sambor dam’s potential impacts on fisheries, stating “Any dam on the Mekong mainstream in this part of Cambodia could be disastrous for fisheries, but this site [Sambor] is the worst possible location from this perspective.”[22:65].
- The World Bank/Asian Development Bank (2006) draft working paper for the Mekong Water Resources Assistance Strategy (MWRAS) notes, “The Mekong River in Cambodia has potential for mainstream hydropower, but even a run-of-the-river dam would inundate a comparatively large area and would have major impacts on fish migration in that stretch of the river. Such development would pose serious ecological, social and economic risks that could outweigh the potential benefits from power generation.” [23:15].
- According to a hydrological analysis of potential development scenarios commissioned by the World Bank as part of MWRAS, “any development which directly impedes fish migration in the mid and lower reaches of the river will have significant negative impacts on fish production. Mainstream dams or weirs in the mid and lower Mekong are therefore most unlikely to be part of any balanced development scenario that complies with the objectives of the [1995 Mekong] Agreement. It is also clear that floodplain connectivity is fundamental to fisheries production and river health and must be protected.” [24:73].

Can the impacts of mainstream dams on fisheries be mitigated?

Despite various attempts to mitigate fisheries impacts, a 2007 report by CNMC and WFC, “found no examples of positive long-term impacts of dams on fisheries, nor any effective mitigation measures in the Mekong Basin.”

[19:24]. Commonly proposed measures to mitigate fisheries impacts include the establishment of reservoir fisheries and the construction of fish passes to facilitate migration past the dams. The 2007 CNMC and WFC study states, “Out of the hundreds of species in the Mekong Basin, only nine are known to breed in reservoirs,” and a reservoir fishery “usually does not compensate for the loss of downstream fisheries.” Furthermore, “there are no examples of fish passes that work in the Mekong Basin.” [19:24].

Similarly, a 2002 MRC Technical Paper asserts, “there is no existing fishway technology able to overcome the obstacle created by a dam or weir on the Mekong mainstream or on the lower reaches of its major tributaries. On the mainstream, the choice therefore remains: fish or dams.” [16:86].

At the MRC Hydropower Programme consultation in September 2008, a presentation on behalf of an Independent Expert Group Meeting, which was convened to examine the barrier effect of mainstream dams on fish migration, also concluded there is no existing mitigation technology that can effectively deal with the barrier effect of mainstream dams on fish migrations [8].

Despite the recognition that there are no effective mitigation measures for fisheries, according to one participant at the MRC Hydropower Programme consultation, the ensuing discussion continued to largely focus on trade-offs and mitigation [25]. In particular, the experience of Columbia River was raised as a successful mitigation operation, despite questions about its applicability to the Mekong context. “Columbia River is home to between five and eight salmonid species, rather than 1,300 species identified in the Mekong.” [25:4].

It is not yet clear what factors and valuations will be applied in the consideration of the ‘trade-off’ between Mekong fisheries and dams on the mainstream, or whether and how fisheries and ensuing social impacts will be internalised in assessing the costs and benefits of the proposed mainstream dams.

What is clear from research conducted to date is that fisheries are of central importance for large parts of the Mekong basin population. As a

2002 MRC Technical Paper notes, “The cost of replacing this essentially-free resource with another source of food, income and employment would be prohibitive. With this perspective, it is clear that the conservation of capture fisheries is crucial to maintaining food security and social stability.” [16:53].

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AMRC's Mekong Brief Series

This Brief is the ninth in a series of information sheets to be produced by the Australian Mekong Resource Centre (AMRC), University of Sydney, for students, teachers and others with an interest in the Mekong Region.

The AMRC was established in 1997 to promote research, discussion and debate on development and environmental issues in the Mekong Region. The AMRC is a focal point for information, dialogue and activities in support of an equitable and sustainable development path for the Mekong Region.

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