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MEKONG MAINSTREAM HYDROPOWER DAMS: RUN-OF-THE-RIVER OR RUIN-OF-THE-RIVER?

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ABSTRACT

A sweeping set of proposals for mainstream dams on the Middle and Lower Mekong River (Laos, Thailand, and Cambodia) has just been issued by the Mekong Secretariat (MEKONG SECRETARIAT, 1995). The Main Report is accompanied by an Executive Summary and two Annexes. A study of the implications of these projects for Mekong fisheries and fisherfolk was done by an independent consulting firm (HILL & HILL, 1994).

The documents referred to describe all of the proposed dams as "run-of-the-river." A more apt description might be "ruin-of-the-river." The projects are no more run-of-the-river than is Pak Mun Dam. True run-of-the-river projects are not discussed by MEKONG SECRETARIAT (1995). Predictable negative impacts include, but are by no means limited to, extirpation or extinction of many fish species, including strongly migratory species that are the main basis for Mekong wildcapture fisheries.

Development based on true run-of-the-river Mekong hydropower is suggested as a more people-friendly and more environmentally-friendly alternative to these mainstream dams.

INTRODUCTION

"No work of man violates nature so completely, so irrevocably, as a dam."
—David Brower

We are witnessing a longterm, progressive decline of fish and fisheries in the Mekong basin due to a combination of negative human impacts including but not limited to deforestation, dams, and pollution. Some of the decline has been due to overfishing, but if present trends continue environmental deterioration caused by man will soon be the major source of concern. And whereas overfishing is partly self-correcting and can otherwise be mitigated or reversed by management, other impacts are largely irreversible and unmitigable. Negative impacts of dams, direct and indirect, must be emphasized. Proponents of dams have downplayed the negative impacts in general, and the negative impacts on fisheries in particular. They have belatedly acknowledged some of the direct negative impacts on fisheries, but have continued to ignore or play down indirect impacts such as toxic pollution due to riverside industry based on hydropower.

The Mekong Secretariat publication that is the main subject of this commentary was prepared by the Compagnie Nationale du Rhône, Lyon, France, in cooperation with Acres International Limited of Calgary, Canada and a study team of the Mekong Secretariat. The accompanying report on fisheries impacts, by Mark T. and Susan A. Hill of Don Chapman

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Figure 1. Mainstream of Mekong River with proposed dam sites. Boundary of Mekong watershed indicated by stippling.

Consultants, Boise, Idaho, USA, although not titled as such, actually is a preliminary environmental impact assessment of the effects of the proposed hydropower projects on Mekong fisheries and fisherfolk. Copies of both reports may be obtained from the Mekong Secretariat (Bangkok). As they are moderately lengthy, it is not possible to present a complete or exhaustive review in the present commentary. Nevertheless, I hope to provide some idea of the probable or predictable negative impacts of the proposed projects on fish and fisheries.

David Brower is one of the foremost environmentalists and conservationists in North America. His lifelong struggle against federal and other proponents of big dams has been documented in several books including his autobiography, from which the quotation at the head of this introduction was taken (BROWER, 1990).

SUMMARY OF HYDROPOWER PLANS

A total of twelve sites for mainstream "run-of-the-river" hydropower projects are identified and discussed in MEKONG SECRETARIAT (1995). Five are located on the entirely Laotian part of the Mekong well above Vientiane; three are on the Mekong where it is shared by Thailand and Laos; one is on the Mekong in southern Laos about 1 km upstream from Cambodia; and three are in Cambodia (Figure 1). Characteristics of these projects, including their likely negative impact on fish, are summarized in Table 1.

Table 1. Characteristics of Mekong hydropower projects proposed in MEKONG SECRETARIAT (1995). 1 = kilometers from sea; 2 = dam height in meters; 3 = extreme flood level under natural conditions in meters above sea level (msl); 4 = existing low water level in msl; 5 = length of operating pool in kilometers; 6 = height of operating pool in meters above extreme flood level; 7 predicted negative impact on wildcapture fisheries. Data from HILL & HILL, 1994: table 2 and elsewhere, unless superseded by MEKONG SECRETARIAT, 1995.

Project	1	2	3	4	5	6	7
Pak Beng	2188	39	345	301	120	0	substantial
Luangprabang	2036	46	294	274	200	26	major
Sayaboury	1930	36	254	234	80	16	major
Pak Lay	1818	39	227	211	130	23	substantial
Chiang Khan	1772	34	213	196	140	17	substantial
Pa Mong	1651	37	188	170	120	19	substantial
Bung Khan	1418	--	--	--	--	--	substantial
Ban Koum	928	30	120	90	140	0	major
Khone Falls	722	--	--	--	--	--	major
Stung Treng	670	--	--	--	--	--	major
Sambor	560	32	23	4	75	17	major
Tonle Sap	360	--	--	--	--	--	major

Three projects: Bung Kan, on part of the Mekong shared by Thailand and Laos; Stung Treng, in northeastern Cambodia; and Tonle Sap, on the outflow of Cambodia's Great Lake are discussed only briefly and then dismissed as impractical or unacceptable by MEKONG SECRETARIAT (1995). They are included in Table 1, but will not be discussed further in this commentary.

FISHERIES IMPACT ASSESSMENT

For a thoughtful, informative, and extended discussion of impacts of the proposed hydropower installations on fisheries and fisherfolk, the reader should consult HILL & HILL, 1994. We should be grateful to the Mekong Secretariat for engaging these consultants and helping them to fulfill their task. On the other hand, there is precious little mention of their report in the Executive Summary or in the Main Report, and the most serious negative impacts and reservations expressed by them are totally absent from the Main Report (MEKONG SECRETARIAT, 1995). At the least, the three-page summary in HILL & HILL (1994: v-vii) should have been included. Every copy of the mainstream hydropower proposals distributed by the Secretariat should be accompanied by a copy of the document on fisheries impacts.

My assessment of the overall negative impacts on fisheries of the individual projects proposed by MEKONG SECRETARIAT (1995) is given in Table 1. It is "substantial" or "major" in every instance. Substantial impact is predicted if projects involve construction of a high dam (i.e., one over 15 m in height) on the main channel of the Mekong and creation of a large upstream and downstream area of unfavorable or poor fish habitat (i.e., reservoir, operating pond or backwater and outflow channel with unnatural flow and other poor qualities). Major impact is predicted when both of the above plus additional factors are involved. Additional factors include negative impact on a migratory corridor, important mainstream rapids, important primary tributary, or important artisanal and/or commercial wildcapture fisheries. It should be stressed that the predictions of negative impacts on fisheries in Table 1 are based on individual projects. If two or more projects with impact assessed as substantial are built on the same river stretch, assessment of negative impact on fisheries would be major. Impacts of two or more projects are likely to be multiplicative rather than merely additive. If several of these projects are built, the combined negative impact on fisheries (and other environmental features) could be as great or greater than that of a high dam with an enormous reservoir such as the originally proposed Low Pa Mong project. The Low Pa Mong is now widely regarded as unacceptable due to the negative environmental and social impacts it would involve, as acknowledged in MEKONG SECRETARIAT, 1995.

Five of the projects predictably would result in major negative impacts on fisheries: Luangprabang; Sayaboury; Ban Koum; Khone Falls; and Sambor. Luangprabang and Sayaboury, in addition to being among the higher dams proposed, would create particularly long stretches of unfavorable fish habitat in the Mekong River, and would seriously impact the Nam Ou, the most important Mekong tributary in northern Laos. The stretch of the Mekong River including Ban Koum, has already been severely impacted by Pak Mun Dam. The Ban Koum dam would create a long stretch of unfavorable mainstream fish

habitat and multiply the negative impacts of Pak Mun Dam. The Khone Falls project would destroy Hoo Sahong, the most important channel for migratory fish species below Khone Falls, and would seriously impact other important migratory channels, including Hoo Sadam. Stung Treng would have serious negative impacts on important wildcapture fisheries of the Se Kong (the most important Mekong tributary in southern Laos and northeastern Cambodia) and the Mekong mainstream. Sambor would destroy the most important rapids anywhere in the Mekong mainstream and the wildcapture fisheries associated with them, just as Pak Mun has destroyed the Mun rapids and the Mun fisheries.

For comparison, the negative impact of Pak Mun Dam (although not itself on the Mekong mainstream) on fisheries of the Mekong basin would be rated as substantial. Its impact on fisheries of the Mun River is of course major.

For anyone who might wonder whether my assessments of the probable negative impacts on fishes are exaggerated, it should be pointed out that they essentially agree with the independent assessments by HILL & HILL. As they point out, "all of the proposed dams will block fish migration, and this one impact alone may cause a wholesale decline in the fishery throughout the [middle and] lower Mekong" (HILL & HILL, 1994: 88). And blockage of fish migration is by no means the only negative impact expected from dams. For a partial list of other impacts see HILL & HILL, 1994: 37–39.

"RUN-OF-THE-RIVER"

Describing the big mainstream Mekong dams proposed by MEKONG SECRETARIAT (1995) as "run-of-the-river" is dishonest doubletalk. The dams will not permit run-of-the-river conditions, and they will not be environmentally friendly.

"Run-of-the-river" was perhaps first applied to dam projects that are not true run-of-the-river projects by engineers and other dam proponents working for The World Bank. The first time I experienced the term used in this way was when I met Mr. Darayes Mehta, Senior Power Engineer, in his office in The World Bank in Washington, D.C., and he used it to describe Pak Mun Dam. Pak Mun Dam was also called a run-of-the-river project by Dr. Nattawuth Udayasen, Chief Engineer of Pak Mun Dam for EGAT (Electrical Generating Authority of Thailand) (USHER & TANGWISUTTIJIT, 1991). How many people who know anything at all about rivers really think the 17-m high Pak Mun Dam is run-of-the-river? Yet it is only a mini-example of the sort of "run-of-the-river" installations proposed for the Mekong mainstream by MEKONG SECRETARIAT (1995).

The twelve hydropower projects described in MEKONG SECRETARIAT (1995) are all labeled "run-of-the-river" but not a single one of them is. Every one involves a cross channel dam. All but two—Khone Falls and Tonle Sap excepted—involve dams 30 to 46 m high, and "operating pools" (i.e., permanently inundated areas) 75 to 200 km long (Table 1). Such large and deep impoundments can never, from a biological or ecological standpoint, be regarded as run-of-the-river.

True run-of-the-river projects, which do not involve cross channel dams or reservoirs, are not addressed by MEKONG SECRETARIAT, 1995, as correctly pointed out by HILL & HILL, 1994: vi. "Run-of-the-river" refers to hydroelectric generation based on minimal water storage or straight flow-through of the river. It may involve low dams, but allows all that

flows into it including nutrients and sediments as well as water to flow out. It can be turbines (suspended from a barge or raft or otherwise anchored) relying solely on kinetic energy of the otherwise unimpeded flow of the river. There is room for discussion as to what constitutes minimal storage, but any dam higher than 15 m is considered a high dam. The operating pool behind each would be large enough for significant water loss by seepage and by evaporation (including evapotranspiration by aquatic vegetation), so that the amount of water leaving the dam would be significantly less than flowing into the operating pool. The operating pools themselves would also be sufficiently large as to constitute significant barriers to upstream and downstream movements of migratory and other riverine fishes, and to downstream movements of ichthyoplankton (i.e. developing eggs and larval stages of fishes).

For an installation to be truly (biologically and ecologically) run-of-the-river, the nutrients that flow into it must flow out. Nutrients carried downstream from upper reaches contribute substantially to food chains of Mekong fishes and other higher aquatic organisms. In the case of the presently envisioned projects, nutrients will flow into the upper end of more or less large impoundments, with relatively deep water. As the nutrients from the river flow into the more sluggish waters of the impoundment, they will tend to be deposited along with sediments. Eventually the sediments will flow out of the impoundment, perhaps relatively unchanged, but perhaps changed in biologically significant ways as yet difficult to predict or poorly understood. Nutrients deposited upstream will be largely changed, degraded or totally consumed by bacterial activity before they can flow out.

Nearly all discussions of the environmental impacts of hydroelectric projects have a glaring omission : they fail to mention the profound negative implications for rivers of the loss of their energy. Vitality of rivers depends on their natural hydropower. Hydropower performs a great deal of useful work in rivers. It is essential for natural stream flow characteristics, habitat maintenance, downstream transport of nutrients, aeration of water, build up of food chains, disposal of wastes, dispersal of stream organisms, completion of life histories. All riverine and riparian organisms in the Mekong basin (including rice farmers in the delta) depend on geomorphic and other service functions performed by naturally-occurring hydropower. Take away too much hydropower and the river will die. What is left that is "free flowing" or "run-of-the-river" only looks like a river because it still flows within the old channels of what used to be a river.

At the Luangprabang site, to take the most extreme example from MEKONG SECRETARIAT (1995), the cross channel dam on the Mekong River will be 46 m high. The operating pool will be kept at a constant level of 320 meters above sea level (msl). This is 46 m above existing low water level and 26 m above extreme high water level, and will involve backing up the Mekong mainstream for 200 km. Such conditions cannot possibly be regarded as run-of-the-river.

How then does the Mekong Secretariat manage to label the mainstream projects now being proposed as run-of-the-river? It is not based on the amount of water entering the project operating pool from upstream, but on the amount of water accumulating at the dam itself. Under normal operating conditions, the water level at the dam site will be maintained at a constant level (HILL & HILL, 1994; MEKONG SECRETARIAT (1995). This narrow, biologically and ecologically unacceptable definition of run-of-the-river cannot even be accepted at face value. The level of the reservoirs or operating pounds will not be maintained

at constant levels. On a daily basis, the level will fluctuate in relation to peak demands for electrical generation, resulting in an unnatural daily rhythm that might foster certain kinds of invasive plant and animal communities (including introduced pests such as water hyacinth, *Eichhornia crassipes*) but be deleterious to others. Even more important, whenever drought causes the level in the operating pool to fall below operating levels, the watergates will be shut down until the level rises sufficiently to restore efficient electrical generation. Thus fish populations will be denied run-of-the-river conditions precisely when they have the greatest need of such conditions for their survival.

FISH MORTALITY CAUSED BY TURBINES

An extended discussion of fish mortality due to turbines and especially to Kaplan-type bulb turbines (the kind proposed by MEKONG SECRETARIAT,1995) is provided by HILL & HILL, 1994. Kaplan turbines are the kind installed in Pak Mun Dam (pers. commun., Mr. Sanya Charoen Wirakul, Senior Environmental Consultant, EGAT, 26 Jan. 1995). For much of the time the only possible downstream route for fishes past Pak Mun Dam is through the turbines, and this presumably will be the same for the Mekong mainstream hydropower projects. According to earlier estimates of The World Bank, less than 8% of fish passing through the Pak Mun turbines would be killed (WORLD BANK, 1991). According to HILL & HILL, (1994: 26), the magnitude of fish loss that could be expected from turbine injuries and mortalities at the projects proposed by MEKONG SECRETARIAT (1995) is unknown. Mortality depends on many factors : tailwater levels, turbine type, operational conditions, and fish size; larger fish tend to be more adversely effected than small ones, and fish eggs and larvae relatively little effected except under special circumstances; the species of fish supposedly matters relatively little (HILL & HILL, 1994). Fish reportedly are having their heads removed as they pass through Pak Mun turbines. Perhaps this is due to small turbine clearance in relation to fish size, a possible kill factor mentioned by HILL & HILL, 1994: 26.

The problem of estimated turbine mortality discussed by HILL & HILL and many others cited by them, is that most of the studies have been done (or at least were guided) by engineers, based on theoretical considerations. Fishes may have other considerations that have escaped the engineers. It is difficult to believe that Mekong species as delicate as the herrings *Clupeichthys aesarnensis* and *Tenualosa thibaudeaui* or the specialized predatory cyprinid *Macrochirichthys macrochir* will pass through the turbines without significantly greater mortality than others.

The obvious way to get meaningful information on what happens to Mekong fish when they pass through Kaplan turbines is to go to Pak Mun Dam and release known numbers of live fish through the turbines. Total collection of dead and live fish coming out of the turbines should not be difficult to manage by appropriately installed traps. Thai fisheries workers have excellent techniques for handling and transporting fish without injuring them, so that this should not prejudice the results. Key experiments should be performed on effects of changes in revolutions per second, rate of flow discharge, etc., on mortality of various Mekong species. So far as the writer is aware, no such studies are being done or are contemplated. This is the sort of genuine impact study that should be

done before any additional hydropower plants are installed in the Mekong basin.

FISH LADDERS

Fish ladders are often mentioned as an important means of mitigating the impacts of dams on nigratory fishes. Provisions for fish ladders are included in all of the projects proposed in MEKONG SECRETARIAT, 1995. The ladders will be similar to that installed on Pak Mun Dam (MEKONG SECRETARIAT, 1995: fig. 5–1). For a critique of fish ladders in general, see HILL & HILL, 1994; for critiques of the one on Pak Mun Dam see ROBERTS, 1993 and TRAISAWASDICHAI, 1995.

Reasons for the past and probable future failure of fish ladders on dams in the Mekong basin have been discussed in detail in ROBERTS (1993) and won't be repeated here. Suffice it to say that fish trying to go up Pak Mun fish ladder are breaking their heads on the cement steps. As Pak Mun fishermen have commented, Mekong fish don't jump. This is probably true of the great majority of the species, and especially of the catfishes. It is rumored that the plans advocated by fisheries biologists called for a much longer fish ladder, but that it was built much shorter (and steeper) to cut costs. A longer, more gradually sloping ladder (with lower steps and longer intervals) would be easier for fish to climb, but would not alter the outcome: important migratory fish species are going to disappear from the Mun River because of Pak Mun Dam (ROBERTS, 1993).

A final point concerning Mekong fish ladders. The Payao type of ladder has been installed only on two dams, Payao and Pak Mun. In both instances the migratory fish species were greatly reduced by negative impacts before the ladders were installed. The Pak Mun ladder, on a much larger tributary than the Payao ladder, is steeper and proportionately larger, but otherwise similar. Ladders planned for dams on the Mekong mainstream presumably would be somewhat larger but otherwise similar to that on Pak Mun. A single such ladder would be woefully inadequate if a normal largescale mainstream migration of *Cirrhinus* spp. or other important migratory species attempted to utilize it. Within hours so many tens or hundreds of thousands of fish would occupy the steps of the ladder that they would literally be packed as tight as tinned sardines. This would likely result in massive injury and subsequent mortality.

DAMS NEAR LUANGPRABANG

It is impossible to provide detailed discussion in this commentary of all predictable negative impacts of the hydropower projects proposed for upper Laos, but one or two things should be mentioned about fisheries.

Dams a few km upstream and somewhat farther downstream from Luangprabang Town supposedly are planned in such a way that there will be no significant impacts on fisheries of the Nam Ou, a large and important tributary (HILL & HILL, 1994: 11). Nam Ou drains nearly all of Phong Saly, the northernmost province in Laos, then flows the length of Luangprabang Province before joining the Mekong mainstream just above Luangprabang Town. Nam Ou has important fisheries, presumably based mainly on

strongly migratory fish species, but this is poorly documented. While the backwaters or operating pools of the dams planned for the Mekong near Luangprabang will not flood the mouth of the Nam Ou, they will certainly have major negative impacts on any strongly migratory fish migrating to and from the Nam Ou and the Mekong mainstream, as will the dams themselves. Depending on the fish species and their migratory behavior, this could ruin the fisheries of all of the Nam Ou or at least that part of it that has been providing high quality fresh fish for Luangprabang.

KHONE FALLS: HOO SAHONG

"You must be kidding. Nobody could be that stupid. Are they really going to do it?"
—Hang Khone fisherman

Immediately below Khone Falls is the site of the most important wildcapture fisheries in all of Laos, and one of the most important riverine wildcapture fisheries to be found anywhere in tropical Asia. Fishing has been the main activity of the Khone villages for many generations.

The remarks quoted above were made by Ban Hang Khone fisherman and fish trader Sit Sysongkham, 47, in February 1995. His tone changed from disbelief to dismay as he was first told about the plan to dam Hoo Sahong and then shown a copy of the map locating the proposed hydropower dam on Hoo Sahong.

Hoo Sahong is crucial to fish migrating up and down the mainstream of the Mekong River. It is by far the most important channel for fish moving upstream and downstream past Khone Falls. Blocking it would be a disaster for the Khone fisheries. It would have major negative impacts on Mekong fisheries far upriver and downriver from Khone Falls.

Construction of dams of any kind should be totally excluded from the ecologically and socially unique area surrounding Khone Waterfalls.

PAK MUN DAM AS A MODEL

"Of particular interest are data on the effect of the Pak Mun Dam project and on the effectiveness of [its] fish passage facilities."
—MEKONG SECRETARIAT, 1995: 8–3.

Pak Mun Dam has been identified as a source of substantial or major negative impacts on Mekong fisheries (ROBERTS, 1993). Pak Mun is our best model or example of the kinds of impacts to be expected from the mainstream hydropower projects proposed in MEKONG SECRETARIAT (1995). The Pak Mun design, including Kaplan turbines and Phayao-type fish ladder, is similar in many respects to that proposed for the mainstream dams. Many or most of the migratory and other fish species in the Mekong mainstream expected to be most severely effected by dams also occur (or occurred until Pak Mun Dam was built) in the Mun River.

The need for monitoring and study of the Pak Mun turbines and fish ladder already

has been mentioned. Additional study is needed to determine whether Pak Mun Dam causes significant loss of water and nutrients, changes in water quality, and other limnological parameters. Effects on fish, invertebrates, plankton, and higher plant life should be studied with care. To be of any value at all, such studies must be longterm. They are needed to evaluate not only the actual negative impacts of Pak Mun Dam itself but also the probable impacts of similar dams on the Mekong mainstream. They should be continued until Pak Mun Dam is decommissioned.

EXTIRPATION AND EXTINCTION OF FISH SPECIES

Mainstream dams and the unfavorable habitat changes they engender would cause the local extinction or extirpation of many fish species. Species most severely affected would include long distance migrators important to wildcapture fisheries such as the carps *Bangana behri, Cirrhinus microlepis, Gyrinocheilus* spp., *Labeo pierrei, Probarbus jullieni* and *Scaphognathops bandanensis;* the catfish *Pangasius conchophilus;* and the sciaenid *Boesemania microlepis.* None of these species are likely to survive in reservoirs or head ponds created by mainstream dams.

Especially hard hit will be the true eel *Anguilla marmorata.* Adults live in high gradient mountain tributaries but must return to the sea to reproduce. Mainstream dams would block the downstream reproductive migration of adults as well as the upstream migration of young eels.

Mainstream dams probably would also cause the extinction of a number of species that occur only in the Mekong basin and are largely or entirely confined throughout their lives to the mainstream of the Mekong River: the freshwater herring *Tenualosa thibaudeaui;* carps *Aaptosyax grypus* and *Probarbus labeamajor;* and the Mekong giant catfish *Pangasius gigas. Pangasius gigas* and *Tenualosa thibaudeaui* already are endangered species, and the magnificent 1.5 m predator *Aaptosyax grypus* is a rare species. A single mainstream dam could cause their extinction.

The diadromous catfish *Pangasius krempfi* deserves special mention. This strongly migratory species occurs in coastal waters of the South China Sea from China's Kwantung Province south to the Mekong delta, and in the Mekong River at least as far upstream as Vientiane. It is one of the most important species in commercial catches below Khone Falls and is also caught commercially along the Vietnamese coast. *Pangasius krempfi* evidently reproduces only in freshwater in the Mekong basin, and probably only in the Mekong River and one or more of its largest tributaries such as the Se Kong upstream from Kratie. It does not occur in the Tonle Sap or Great Lake. A single dam at Sambor, Stung Treng or Kratie could kill this species.

CONCLUSION

Great rivers such as the Mekong should be recognized as precious non-renewable natural resources, of inestimable value to humanity. Exploiting them to obtain the maximum amount of hydropower in the shortest amount of the time will not contribute to sustainable

economic development. Future generations will recognize it for what it is: assaulting the environment for short term gains that turn out to be long term deficits.

My attitude is not anti-development. In fact I am pro-development. I am only against development that is environmentally and socially destructive, without any semblance of rational control or concern for the future, without sustainable social or economic benefits.

The rapid and unwise exploitation of Mekong hydropower could provide Southeast Asia with the most rapid economic rise and most devastating decline yet experienced. The basic law of earth-bound physics also serves as a metaphor for earth-bound economics: what goes up must come down. And as corollaries: the more rapidly a thing goes up, the sooner it will come down, and the bigger the thing that goes up, the harder it will fall.

Are there no alternatives to these dams? Perhaps not if prevailing trends continue. But of course there are alternatives. Development can proceed in a much wiser, more evenly paced, egalitarian and environmentally-friendly fashion. The land along the Mekong includes some highly desirable real estate, most of it very sparsely populated. Much of it should remain forested and sparsely populated to protect the watershed. True run-of-the-river hydropower installations can provide more than enough electricity for moderate riparian urbanization, and environmentally-friendly, non-polluting light industry. People could live in places with clean air and water and no pollution. Khone Falls should be preserved as one of the great natural wonders of Asia. It can be used to attract tourists and researchers, but is ecologically too fragile to become the object of intensive tourism such as that at Angkor Wat. Many other areas of Mekong wilderness and biodiversity should be preserved for present and future generations.

With care and effort, the Mekong basin and its watershed can be protected. Wildcapture fisheries can be maintained or restored, and fisherfolk can pursue their traditional pursuits and occasionally eat som kai pba eun. And the Mekong Secretariat and the newly formed Mekong Commisson can play a leading and judicious role in regional development.

REFERENCES

BROWER, D. 1990. For Earth's sake: The life and times of David Brower. Peregrine Smith Books (Salt Lake City), xvii + 556 pp.

HILL, M. T., AND S. A. HILL. 1994. Fisheries ecology and hydropower in the Mekong River: an evaluation of run-of-the-river projects. Mekong Secretariat (Bangkok), x + 106 pp.

MEKONG SECRETARIAT. 1995. *Mekong Mainstream Run-of-River Hydropower* Mekong Secretariat (Bangkok) (four volumes: Main Report, Executive Summary, and two Annexes).

ROBERTS, T. R. 1993. Just another dammed river? Negative impacts of Pak Mun Dam on fishes of the Mekong basin. *Nat Hist. Bull. Siam Soc.* 41 (1993): 105–133.

TRAISAWASDICHAI, M. 1995. *Dam poses uphill battle for fish species* [on Pak Mun Dam fish ladder]. The Nation (Bangkok), Jan. 27, 1995, p. A 11.

USHER, A. D., AND N. TANGWISUTTIJIT. 1991. *Harnessing the Mool* [on Pak Mun Dam]. The Nation, 11 July 1991.

WORLD BANK. 1991. *Pak Mun Hydropower Project. Environmental Fact Sheet and Summary of Issues Raised by NGOs.* [Distributed by World Bank at August 1991 annual meeting in Bangkok]. 4 pp.