

LAO PEOPLE'S DEMOCRATIC REPUBLIC

INTRODUCTION

Area: 236,798 sq.km.

Population: 3,584,800 (1985).

Laos is a land-locked, mountainous country, with much of its western border formed by the Mekong River. It is situated between latitudes 13°55' and 22°30'N and longitudes 100°05' and 107°40'E, and borders on Burma, China, Kampuchea, Thailand and Vietnam. The country is rather sparsely populated by a number of different ethnic groups, broadly categorized into Lao Loum (speaking T'ai languages and inhabiting low and mid-elevation areas), Lao Theung (Mon-Khmer, inhabiting mid-elevation areas) and Lao Soung (Tibeto-Burman, inhabiting high elevation areas). With altitudes ranging from about 65m above sea level in the south to over 2,800m in the mountains in the north, Laos possesses a wide range of forest habitats from lowland tropical forest to subtropical montane forest. In contrast, natural open-country habitats are scarce, and there are few large wetlands other than the Mekong River, its major tributaries and several man-made reservoirs.

The climate throughout most of Laos is dominated by the southwest and northeast monsoons. The wet, southwest monsoon lasts from mid-May to early October, while the northeast monsoon dominates from early November to mid-March. Over much of the country, the average annual rainfall is between 1,400 mm and 2,500 mm, and there is a pronounced dry season from November or December to March. However, in parts of the northwest, in the central region east of Vientiane and in the southeast, the rainfall is considerably higher, exceeding 3,500 mm in places, while in small areas in the north, the annual rainfall is less than 1,000 mm. Except in the northern mountainous regions, temperatures remain high throughout the year, the mean temperature of the coolest month exceeding 18°C. In the subtropical regions of the north, the temperature range is much higher, and cold air from China and Siberia occasionally penetrates during the dry season, lowering air temperatures to near zero.

According to official sources, 92.5% of the country is covered with some form of natural, unmanaged vegetation. About half of this is second growth from shifting agriculture, in the form of bush and grass fallows and bamboo. The other half (about 46% of the country) is considered to be forest (Sayer, 1983a; Devitt & Sayer, 1987). MacKinnon and MacKinnon (1986) give the extent of forest cover as 35%, while Davis *et al.* (1986) have estimated that well-stocked forest cover may be as little as 19% of the total land area. The principal forest types are: (a) tropical lowland and hill evergreen, mainly along the wet Annamite Chain, the Sekong Valley east of the Bolovens Plateau, occasionally in the Mekong Valley and generally below 1,000m; (b) dry dipterocarp and mixed deciduous forest in the south around Pakse and between Vientiane and the Burmese border; (c) pine forest in the Xieng Khouang

region and on sandy soils between 600m and 1,400m; and (d) bamboo forest (Mekong Committee, 1978; Davis *et al*, 1986). Loss of forest cover is currently proceeding at 1-2% per annum (Davis *et al*, 1986).

Over 60% of the population is concentrated in the permanently cultivated alluvial plains along the Mekong, which cover only 11% of the land area. Electricity from the Nam Ngum Dam is the country's largest export earner. The second largest export, timber, is extracted by nine state forest enterprises. At present, the main emphasis is on mechanization of timber extraction, and little attention has been given to management for sustainable yield (Sayer, 1983a). Shifting agriculture is widely practised, particularly by Muong and Meo tribesmen in the north, with new sites being cleared at between one and 20 year intervals depending on soil fertility. This, together with the extensive logging activities, has resulted in widespread deforestation, degradation of watersheds and reduced soil fertility. Heavy hunting pressure throughout the country has compounded the problems for wildlife, the populations of which are now much depleted, especially in the Mekong Valley. Nevertheless, large, sparsely populated areas continue to support climax forest with two species of bears, Tiger *Panthera tigris*, Leopard *P. pardus*, six species of deer, Asian Elephant *Elephas maximus*, four species of wild cattle (including Kouprey *Bos sauveli*) and possibly a rhinoceros, either *Dicerorhinus sumatrensis* or *Rhinoceros sondaicus* (Sayer, 1983a). Over 600 species of birds have been recorded.

A large proportion of foreign aid to the forest sector is dedicated to mechanization, although a UNDP/FAO forest management project had a small nature conservation and environmental education component (Sayer, 1983b). The Swedish International Development Agency (SIDA) is currently supporting a Forest Resources Conservation Project which is being executed by IUCN. The long-term objectives of the project are:

- to conserve and achieve sustainable utilization of the forest and wildlife resources of Lao PDR;
- to establish a nature conservation capability in the Ministry of Agriculture, Forestry, Irrigation and Cooperatives, and to develop programmes for the establishment and management of protected areas, for staff training and for the development of an awareness of conservation issues within the population;
- to promote the integration of conservation considerations into development planning;
- to initiate the development of a National Conservation Strategy for Lao P.DR.

The project is currently funded for the period 1988-90 (R.E. Salter pers. comm.).

In 1986, an international agreement was signed between Laos and her neighbours Kampuchea and Vietnam for long-term cooperation in the field of conservation of nature and biological resources. The first project under this agreement concerns the protection of the Kouprey, and could involve the establishment a trans-frontier reserve (Mackinnon, 1986).

Summary of Wetland Situation

About 88% of Laos lies within the Mekong drainage basin, the Mekong River itself flowing for about 1,700 km along the border of Laos or through Lao territory. This river, its narrow alluvial plains and the lower reaches of its major tributaries comprise the only extensive natural wetland ecosystems in the country. There are no large natural lakes, and indeed few lakes or swamps of any appreciable size away from the Mekong valley. It is possible that there are small lakes, ponds and marshes of considerable conservation interest in some of the broader mountain valleys, particularly in the north, but no information is available for any such site. In recent years, large water storage reservoirs have been constructed on three tributaries of the Mekong, the Nam Ngum, Se Done and Nam Dong, and smaller impoundments have been established elsewhere. Much the largest of the reservoirs is the Nam Ngum hydro-electric dam and reservoir north of Vientiane, completed in 1971. Although the Nam Ngum reservoir has become of considerable importance for fisheries production, it appears to have little if any value for wildlife.

Many other possible hydro-electric power and irrigation projects are under study. Much the largest of these is the Pa Mong Multipurpose Project, which would involve the construction of a hydro-electric and irrigation dam on the Mekong, about 20 km upstream from Vientiane. The dam would create a reservoir of 372,200 ha, partly in Laos and partly in Thailand, and would flood some 360 km of the Mekong River. A project for flood protection and reclamation of some 2,000 ha of swamp and marshland in the Vientiane Plain has already been initiated, and most of this area has now been converted into agricultural land.

The Mekong River supports one of the largest inland fisheries in the world. The total fishery production in Laos was estimated at over 30,000 metric tonnes in 1970 and 25,000 metric tonnes in 1973, with about 16,500 metric tonnes coming from the Mekong itself. However, a number of factors could, in the long term, have a deleterious effect on the fisheries. Deforestation is causing a progressive siltation of the Nam Ngum Dam, pollution problems are likely to increase, and interference with the flow of the Mekong by the proposed Pa Mong Dam is likely to have a serious adverse effect on fisheries production downstream.

The wetlands of Laos are believed to support a wide variety of waterfowl. However, water birds (and indeed almost all species of birds) are scarce, undoubtedly because of the extreme hunting pressure (R.E. Salter, pers. comm.). Waterfowl known to occur in Laos include *Tachybaptus ruficollis*, two cormorants (*Phalacrocorax spp*), *Anhinga melanogaster*, 12 herons and egrets (Ardeidae), five storks (Ciconiidae), three ibises (Threskiornithidae), fourteen ducks and geese (Anatidae), two cranes (Gruidae), at least eight rails, crakes and gallinules (Rallidae), two jacanas (Jacanidae), at least seven resident and 19 migratory shorebirds, one gull and five terns (Laridae) and *Rhynchops albicollis* (Gressitt, 1970; McNeely, 1975). Several of these are endangered, notably the Greater Adjutant, White-shouldered Ibis, Giant Ibis, White-winged Wood-Duck (*Leptoptilos dubius*, *Pseudibis davisoni*, *Thaumatibis*

gigantea, *Cairina scutulata*) and eastern race of the Sarus Crane *Grus antigone sharpii*. Unfortunately, no recent information is available on the status of these or any other waterfowl in Laos.

Other noteworthy wildlife associated with the wetlands of Laos include Irrawaddy Dolphin, Fishing Cat, Common Otter, Smooth-coated Otter, Hog Deer, Wild Water Buffalo, Siamese Crocodile, River Terrapin and Giant Catfish (*Orcaella brevirostris*, *Felis viverrina*, *Lutra lutra*, *L. perspicillata*, *Cervus porcinus*, *Bubalus bubalis*, *Crocodylus siamensis*, *Batagur baska* and *Pangasianodon gigas*) (McNeely, 1975; Sayer, 1983a). No detailed information is available for any of these species, but all appear to be uncommon or rare.

Wetland Research

The lower Mekong basin from northern Laos to the delta in Vietnam has been well-studied through the UN-sponsored water and related resources development programme, the Mekong Project, launched in the late 1950s. A Committee for Coordination of Investigations of the Lower Mekong Basin (Mekong Committee) was established in 1957 by the four governments of the riparian countries, Kampuchea, Laos, Thailand and Vietnam, under the auspices of the Economic and Social Commission for Asia and the Pacific (ESCAP) of the United Nations. The goal of this Committee has been the comprehensive development of the water and related resources of the basin for hydro-electric power, irrigation, fisheries, flood control, drainage, navigation improvement, watershed management and water supply. The Committee's Secretariat, based in Bangkok, Thailand, has collected basic data relating to hydrology, climatology, hydrography, topography, pedology, geology, transportation and demography throughout the lower basin. In order to provide a broad framework for the coordinated development of the lower Mekong basin to the year 2000, the Secretariat completed an Indicative Basin Plan in 1970, on the basis of data collected from field research and pre-investment investigations over a period of more than a decade (Mekong Committee, 1970; Pantulu, 1986a).

The Committee has conducted a number of studies in Laos, including hydrographic surveys along the Mekong mainstream and tributaries, socio-economic investigations, geological and mineral surveys, and studies of the fisheries and agricultural potential (Mekong Committee, 1976 & 1978). The Committee has also conducted a general survey of the wildlife of the Mekong basin, which includes recommendations for the establishment of a network of protected areas (McNeely, 1975). Most of the Committee's work has, however, consisted of investigations on potential water control, hydro-electric and irrigation schemes.

No research has been carried out on the water birds of Laos, and indeed very little information has ever been available. Some work has been conducted on the larger mammals, but very little seems to be known about the reptiles and amphibians.

Wetland Area Legislation

There is at present no conservation legislation concerning wetlands nor indeed any general legislation applicable to conservation. Laos is thus one of the few countries in Asia, which has neither protected area legislation nor protected areas. Provincial forest reserves exist, but no details are available (IUCN, in prep). During colonial times, several decrees were passed by the French administration to control hunting methods and to protect a limited number of rare species. In 1939, the entire central and southern portion of the country was declared a hunting reserve. These regulations, however, have all lapsed (IUCN, in prep), and there are now virtually no controls on either hunting or collecting for the animal trade (R.E. Salter, pers. comm.)

Wetland Area Administration

Until very recently, there has been no authority responsible for nature conservation or the establishment and management of protected areas. The National Environmental Protection Office and National Hunting and Fisheries Office were established in 1983 with the intention of undertaking some nature conservation work. More recently, a Directorate of Wildlife and Fisheries Conservation, under the Ministry of Agriculture, Forestry, Irrigation and Co-operatives, has replaced the National Hunting and Fisheries Office. The National Environmental Protection Office has been acting as the counterpart agency to the FAO/UNDP "Forestry Development and Watershed Management in the North Project". One of the objectives of this project is to implement demonstration and training programmes in improved land use and watershed management. Activities of the SIDA/IUCN Forest Resources Conservation Project include review of background material and design of a protected area system, development of two pilot management programmes (including one at the small Houei Nhang Forest Reserve on the plains north of Vientiane), field surveys of potential protected areas, training of protection level staff, development of public education materials, and development of a national conservation policy (as a lead-in to a formal national conservation strategy) (R.E. Salter, pers. comm.)

Some years ago, the government identified 13 areas as proposed national parks, and Sayer (1983a) and MacKinnon and MacKinnon (1986) list these and a further six sites as proposed protected areas. The latest proposal concerning protected areas, put forward by the Forest Department in early 1988, proposes that 2,500,000 ha of the country be classed as conservation forests (national parks, wildlife sanctuaries and other protected areas), 9,500,000 ha as protection forests (for watershed management) and 5,000,000 ha as production forests (R.E. Salter, pers. comm.). However, the only action taken to date centres on a proposal to establish a small nature reserve and botanic and zoological garden at the Houei Nhang Forest Reserve.

Organizations involved with Wetlands

Governmental Organizations

- Ministry of Agriculture, Forestry, Irrigation and Co-operatives
- Directorate of Wildlife and Fisheries Conservation, Forest Department National Environmental Protection Office
- National Mekong Committee

WETLANDS

Site descriptions based on information received from Mr B. Phanthavong of the Directorate of Wildlife and Fisheries Conservation, and the literature.

Wetland name: Mekong River

Country: Laos

Coordinates: 21°34'N, 101°09'E to 13°51'N, 105°59'E;

Location: the Mekong River from the border with China and Burma in the extreme northwest of the country to the border with Kampuchea in the extreme south.

Area: c.1,700 km of mainstream river.

Altitude: c.250m in the north down to c.65m in the south.

Biogeographical Province: 4.10.4.

Wetland type: 11, 12, 13, 18 & 19.

Description of site: The Mekong River is one of the great rivers of Asia, ranking twelfth in the list of longest rivers of the world. It rises at about 5,000m in the Tanghla Shan Mountains on the northeast rim of the great Tibetan Plateau, and flows for 4,200 km through or along the borders of six countries: China, Burma, Laos, Thailand, Kampuchea and Vietnam. In terms of mean annual discharge, the Mekong ranks sixth in the world. The total drainage basin of 783,000 sq.km includes 160,000 sq.km in China, 12,000 sq.km in Burma, and 611,000 sq.km in Laos, Kampuchea, Thailand and Vietnam (the lower Mekong basin).

Almost 88% of Laos (207,400 sq.km) is drained by the Mekong River and its tributaries. The river itself flows for about 1,700 km along the Lao border or through Lao territory from the Chinese and Burmese borders in the north to the Kampuchean border in the south. For most of its course north of Vientiane, the river flows through a rather narrow valley in hilly and mountainous country. In the region of Vientiane, two large tributaries, the Nam Ngum and Nam Lik, form a broad alluvial plain along the north bank of the Mekong at the edge of the Korat Plateau. For the next 560 km, the river flows placidly through a wide valley. Natural levees begin in this section, and several major tributaries, notably the Nam Theun, Se Bang Fai and Se Bang Hieng, enter from the east. These rivers rise in the Annamite Range on the Vietnamese border, and all form broad alluvial valleys in the Korat Plateau. South of its confluence with the Se Bang Hieng, the Mekong enters the Khemarat Rapids where, in the monsoon season, it reaches speeds of 5m per second and can rise more than 20m. The river continues on through a rocky gorge for a further 160 km before emerging onto the plains above Pakse, at about 100m above sea level. It then wanders south across the lowlands of southern Laos to Khone Falls, where it plunges onto the lower Mekong plain at the Kampuchean border. At the top of the falls, the river is spread broadly over a rocky streambed some 16 km wide.

The northern section of the Mekong is relatively clear and fast-flowing, with many rock outcrops and rapids. Sandy-gravel islands and near-bank shoals are prominent where the riverbanks are low. The water tends to be neutral, with a pH of 6.9 ranging to 8.2. Dissolved oxygen concentrations frequently exceed saturation, and the nutrient level is low. From the region of Vientiane to the Kampuchean border, the river is

turbid, particularly during the rainy season when bank erosion is at its most severe. Suspended lateritic soil gives the water an apparent rusty-tan colour. River temperatures fluctuate between 21.1°C and 27.8°C, and the pH varies from 6.2 to 6.5. The mainstream habitats range from sandy-gravel bars to deep pools up to 100m deep and several kilometers long, interspersed with rocky rapids (Pantulu, 1986a). Snowmelt produces a rather uniform river flow in the upper Mekong, while the lower Mekong exhibits pronounced seasonal variations in flow, reflecting rainfall patterns. The river starts to rise with the onset of the monsoon in May or June, and attains its maximum level in August or September. It then falls rapidly until December and slowly thereafter to reach its lowest level in April. Inundation zones occur where the Mekong overtops its banks at the height of the rainy season, but these are localized and nowhere very extensive.

Climatic conditions: Tropical monsoonal climate dominated by the wet southwest monsoon and dry northeast monsoon. The average annual rainfall ranges from about 1,400 mm near Khemarat in the south to 3,000 mm near Pak Sane, east of Vientiane. In most regions, about 80% of the rainfall occurs during the southwest monsoon in May-October. Both diurnal and annual temperature ranges are relatively high. Cold air from Siberia and China occasionally penetrates the basin, lowering air temperatures to near zero in the north.

Principal vegetation: No information is available on the aquatic vegetation. Throughout most of the regions bordering the Mekong, the lower areas are covered with dry evergreen forests, while the valley floors are invariably cultivated, mainly for rice. Above 1,000m elevation, the climax vegetation is usually hill evergreen forest. However, much of this has been greatly disturbed by destructive shifting agriculture, and now supports unproductive Imperata grasslands and broad-leaved Eupatium.

Land tenure: No information.

Conservation measures taken: None.

Conservation measures proposed: McNeely (1975) suggested that at least one reserve should be established to protect a typical example of the Mekong flood plains. Such a reserve would have to be located as far away from any dams as possible. He tentatively suggested a stretch of about 50 km of river on the Thai border between Ban Pak Se Novan and Ban Keng Yapeut, at about 15°50'N, 105°25'E. McNeely also recommended the establishment of a protected area in a remote region on the upper Mekong River in Houa Khong Province, on the Burmese border at about 21°10'N, 100°45'E. He suggested that this protected area might best be considered as a "Remote Reserve", where humans should be allowed to continue their traditional activities. Hunting would be restricted to the local people, and only minimal protection would be required. Sayer (1983a) has recommended that the area around Pak Ou, at the confluence of the Mekong and Nam Ou in Luang Prabang Province (20°03'N, 102°13'E), be protected as a cultural park or national monument. The area has impressive limestone cliffs and caves containing many Buddha images of religious and historical significance, and the excursion by boat to Pak Ou is popular with visitors to Luang Prabang. The region has little value for nature conservation, as most of the natural vegetation has been destroyed by shifting cultivators and little wildlife remains. However, it is likely that valuable conservation sites exist further

upstream on both rivers. Sayer (1983a) therefore recommends that the upper course of the Nam Ou, Mekong and their tributaries be surveyed in order to identify sites for development as national parks and/or wildlife reserves.

McNeely (1975) has pointed out that some of the forested islands, which will be left in the proposed Pa Mong Reservoir, will be quite large. The largest one, at 4,164 ha, is forest-covered with steep topography and would make an ideal game reserve.

Land use: Fishing and agriculture, mainly the cultivation of rice. The human population in the northern highlands is sparse (5-14 persons per sq.km); most of the inhabitants are of hill-tribe stock. Population densities are considerably higher along the edge of the Korat Plateau and in the south, ranging from 80-150 per sq.km. Here the major crops include rice, kenaf, maize and cassava.

Possible changes in land use: The Mekong Committee has considered some 230 possible development projects on the lower Mekong River and its tributaries. Three large projects have been implemented in Laos, and a further 64 projects are currently considered as feasible. Feasibility or pre-feasibility studies have been carried out for two of these, and desk studies have been made for the remainder.

Of the six mainstream projects proposed by the Mekong Committee in Laos, much the largest is the Pa Mong Multipurpose Project. This involves the construction of a dam 115m in height across the Mekong at Pa Mong, about 20 km upstream from Vientiane. Excess flow in the Mekong would be stored to reduce natural flooding, generate energy and provide water, particularly during the dry season, for the development of irrigated agriculture on both banks of the river. Initial surveys were carried out between 1956 and 1963; a feasibility study was completed in 1971 and numerous follow-up studies have been conducted since then. The dam would flood 360 km of the Mekong River and create a reservoir of 372,200 ha, partly in Laos and partly in Thailand; it would have an initial installed power capacity of 4,800 MW, and permit the irrigation of one million hectares of dry season crops. The dam would eliminate bank overflow of the Mekong from the dam site to the Vientiane/Nong Khai area, and significantly reduce overflow as far south as Pakse. This would enable large areas of floodplain to be reclaimed for agriculture, including about 100,000 ha between the dam site and Pakse. Supplemental flow at low water during the dry season would increase the mean depth of the river by more than threefold over a 460 km stretch from Vientiane to Savannakhet, and double the depth over the 225 km stretch from Savannakhet to Pakse. The creation of the reservoir would entail the relocation of some 100,000 people on the Lao side of the river and 300,000 on the Thai side. The possible impact of this and other projects on the basin's fisheries has been discussed in a report entitled Fisheries and Integrated Mekong River Basin Development (Mekong Committee, 1976a).

Disturbances and threats: Major developments on the Mekong which are likely to conflict with fisheries interests include various proposed irrigation projects, hydro-electric power projects, other industrial development and flood control projects. Dam construction and operation will change the hydrology of the river downstream, reducing seasonal flow peaks and minimizing access to floodplains for feeding and spawning. Changes in water quality and the timing of peak flows are likely to have adverse effects on fish migrations and spawning, and dams will create obvious problems for long distance longitudinal migrants. Impoundment will reduce

sediment flow, particularly in the main channels, and thereby affect the nutrient regime downstream (Pantulu, 1986b). The Pa Mong Dam is likely to have a serious adverse effect on the fisheries in the river below the dam and in the inundation zone due to flood regulation, but it is argued that fisheries production in the new reservoir will far outweigh the loss in production downstream (Mekong Committee, 1978).

Upland mainstream fishes will probably suffer most from the construction of dams since they have small ranges, various degrees of isolation, and are without the security of a large continuous mainstream population (Mekong Committee, 1976). Migratory species of fishes which could be seriously affected by the mainstream dams include *Pangasianodon gigas*, *Pangasius sanitwongsei*, *P. sutchi*, *P. laraudi*, *Probarbus jullieni* and *Cirrhinus microlepis* (Mekong Committee, 1983).

In the upper reaches of the river and its tributaries, water quality does not present a problem at present, except in the vicinity of urban centres. The water quality in the lower Mekong has been affected by domestic wastes and agricultural runoff carrying pesticides and fertilizers, and such problems are expected to increase. Industrial activities, such as pulp and paper mills, textile mills and chemical factories, are increasing within the basin, and these, together with increased waste from shipping, are likely to create a serious pollution problem in the future (Pantulu, 1986a).

Economic and social values: The lower Mekong River supports one of the world's largest inland fisheries. The total Mekong fishery in Laos was estimated at about 16,500 metric tons in 1973, and was thought to employ some 75,000 persons (Mekong Committee, 1976).

Fauna: The fish fauna of the the fast-flowing, upper reaches of the river includes loaches, sucker catfish, Homalopteridae and Garrinae. In the slower middle and lower reaches, the fishes are dominated by species of carp (Cyprinidae; 54%), catfish (Siluridae, Clariidae, Schilbeidae, Bagridae, Sisoridae and Akysidae; 19%) and murrels (Chanidae and Ophicephalidae; 8%). The remaining 19% consist of featherbacks (Notopteridae), herring (Clupeidae), climbing perch and gouramis (Anabantidae) and other miscellaneous groups (Pantulu, 1986b).

One of the most remarkable of the Mekong's endemic fishes is the Giant Catfish *Pangasianodon gigas*. This species, which can attain a length of over three metres and a weight of 250-300 kg, is a main channel migrant, reportedly migrating over a distance of several thousand kilometers from the region of Phnom Penh in Kampuchea to spawning grounds in the province of Yunnan in China. It was once quite common in the lower stretches of the Mekong, with several thousand being caught each year below Khone Falls. However, over-exploitation of existing stocks and environmental changes consequent on development activities in the region have contributed to a serious decline in the population, and the species is now almost extinct below Pak Sane (Pantulu, 1986b).

Only one species of dolphin has been recorded in the Mekong River upstream of Khone Falls: the Irrawaddy Dolphin *Orcaella brevirostris*. It appears to be rare in Laos, and no recent information is available on its status and distribution. Other wetland mammals known to occur include the Smooth-coated Otter *Lutra perspicillata* (rare) and Fishing Cat *Felis viverrina*. Although the river is thought to be rich in water birds, no studies have been carried out in recent years and no details are available.

The endangered Siamese Crocodile *Crocodylus siamensis* is reported to occur in Laos, and may still occur along the Mekong.

Special floral values: No information.

Research and facilities: The Mekong Committee has carried out a number of investigations on the Mekong River and its fisheries since 1957. Fisheries research has been directed principally at assessment of the effects of water resource management projects on fisheries production. The Pa Mong Multipurpose Project has been studied extensively over a period of twenty years at a cost of over US dollar 20 million.

References: IUCN (in prep); Karpowicz (1985); McNeely (1975); Mekong Committee (1970, 1976, 1978, 1981, 1983 & 1984a); Pantulu (1975, 1986a & 1986b); Sayer (1983a & 1983b).

Criteria for inclusion: 123.

Source: See references.

Wetland name: Bung Nong Ngom

Country: Laos

Coordinates: 14°38'N, 106°13'E;

Location: in Pha Pho Sub-District, about 68 km southeast of Pakse, some 35 km east of the Mekong River and 30 km west of the Tonle Kong, Champasak Province.

Area: 1,000 ha at maximum flooding.

Altitude: 200m.

Biogeographical Province: 4.10.4.

Wetland type: 15 & 21.

Description of site: An area of freshwater marshes (600 ha) and surrounding seasonally flooded forest. The marshes have an average depth of about 2m, and retain water throughout the year; the pH is 7.00. During the rainy season (May to October), up to 400 ha of the surrounding forest are flooded.

Climatic conditions: The site lies in the tropical wet and dry zone of the Lower Mekong Basin. The average annual rainfall is 2,000 mm, almost 94% of which occurs during the southwest monsoon, from May to October. The mean annual temperature is 26.4°C (maximum 39.7°C, minimum 7.0°C).

Principal vegetation: The aquatic vegetation is dominated by *Cissus repens* (submerged), *Monochoria hastaeifolia*, *Echinochloa stagnina* (floating), and *Cyperus* spp (emergent). The marshes are surrounded by tropical moist deciduous forest.

Land tenure: No information.

Conservation measures taken: None.

Conservation measures proposed: The Central Government has suggested that the State Government should work closely with the State forest authorities to protect the wetland and conserve its wildlife resources. The area is a likely candidate for field surveys under the Forest Resources Conservation Project, and if found suitable will be proposed as a protected area. The site lies close to the northeastern edge of the Xe Pian proposed wildlife sanctuary (124,000 ha). This area has been proposed by the Directorate of Wildlife and Fisheries Conservation as a reserve for Kouprey *Bos sauveli*.

Land use: Local villagers use the wetland for fishing and hunting. The State Government is exploiting the timber resources in the forests to the north.

Disturbances and threats: The area has been subjected to heavy hunting pressure in the past, and hunting, trapping and collection of birds' eggs continue to pose a threat to wildlife populations.

Economic and social values: The wetland supports a productive fishery and has considerable potential for research, conservation education, recreation and tourism. It is one of the few natural wetlands of its type in Laos, and as such is a vital genetic resource.

Fauna: The wetland supports a rich fish fauna including representatives of the following families: Clariidae, Cyprinidae, Channidae, Siluridae, Pangasiidae, Akusidae, Sisoridae, Cobitidae, Belontiidae, Anabantidae, Osphronemidae, Nandidae and Eleotridae.

The area is known to be important for a wide variety of resident and migratory waterfowl, notably *Phalacrocorax spp*, *Anhinga melanogaster*, several herons and egrets (Ardeidae), storks (Ciconiidae), ibises (Threskiornithidae) and ducks (Anatidae), but no details are available. Cranes (*Grus sp*) are reported to occur on migration.

Mammals known to occur in the area include Asian Elephant *Elephas maximus*, Tiger *Panthera tigris*, Clouded Leopard *Neofelis nebulosa* and deer (*Cervus sp*). A small number of Kouprey *Bos sauveli* still survive in the Xe Pian area to the southwest, and a few individuals occasionally visit the wetland.

The endangered Siamese Crocodile *Crocodylus siamensis* is said to occur, along with freshwater turtles.

Special floral values: No information.

Research and facilities: No research has been carried out at the wetland.

References: MacKinnon (1986).

Criteria for inclusion: 1b, 2a, 2b, 3b.

Source: B. Phanthavong.

Wetland name: Pak Sane and Pak Sa Marshes

Country: Laos

Coordinates: 18°23'N, 103°45'E;

Location: on the north bank of the Mekong, east of Pak Sane town, 125 km ENE of Vientiane, Vientiane Province.

Area: 6,000 ha.

Altitude: 150m.

Biogeographical Province: 4.10.4.

Wetland type: 15.

Description of site: Three areas of permanent marsh in shallow depressions along the Nam Bung, Nam Kadan and Nam Sa rivers, small tributaries of the Mekong between Pak Sane and Sayphon Ngou. The marshes are flooded by intrusion and backwater effects of the Mekong River through the three river mouths, and by overtopping of the Mekong dike in extreme floods (August and September).

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of about 3,000 mm and a short dry season from December to February.

Principal vegetation: Marsh vegetation with some scrub; rice paddies in surrounding areas.

Land tenure: No information.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Some rice cultivation in surrounding areas. The three basins are thinly populated.

Possible changes in land use: The possibilities for flood control and drainage for agricultural purposes have been investigated and found to be marginal at present (Mekong Committee, 1980). However, reclamation of the marshes will be given priority after construction of the Pa Mong Dam and regulation of the Mekong River.

Disturbances and threats: No information.

Economic and social values: No information.

Fauna: No information is available on the wetland fauna. The region is known to have been rich in wildlife in the past, supporting a species of rhinoceros (until 1959) and Banteng *Bos javanicus*.

Special floral values: No information.

Research and facilities: No recent studies have been carried out. Sayer (1983a) identified the site as an area in urgent need of further wildlife surveys.

References: Mekong Committee (1980); Sayer (1983a).

Criteria for inclusion: 0.

Source: See references.

Wetland name: Nam Ngum Reservoir

Country: Laos

Coordinates: 18°26'-18°47'N, 102°30'-102°55'E;

Location: on the Nam Ngum River, 60 km north of Vientiane, Muong Keo Udom and Muong Hom, Vientiane Province.

Area: 45,000 ha at maximum water level; 23,000 ha at minimum water level.

Altitude: 196-212m.

Biogeographical Province: 4.10.4.

Wetland type: 17.

Description of site: Nam Ngum Reservoir is the largest water impoundment in Laos; it was created in 1971 by the construction of a dam 75m in height across the Nam Ngum River, about three km upstream from its confluence with the Nam Lik. The reservoir was conceived primarily for the production of hydro-electric power and flood control. It is fed by five rivers, the Nam Ngum, Nam Sane, Nam Ke, Nam Pat and Nam Xi, and many smaller streams rising in the surrounding hills. It overflows into the Nam Ngum River which joins the Mekong River about 60 km to the southeast. The impoundment created numerous small islands in five major island groups varying in size from about 75 ha to 500 ha. The timber was not removed from the basin before the closure of the dam and so the entire water surface is dotted with emergent dead trees. These are expected to persist for more than 100 years. Most of

the shoreline is steep. The average depth at high water level is 19m, the level reaching its maximum in September or October and minimum in April to July. The average drawdown is about 10m and the maximum 16m. Some 4,000 ha of lakebed are exposed for six months of the year, and 11,000 ha during the three driest months. Surface water temperatures range from about 24°C to 30°C or more; a low of 19°C has been recorded at a depth of 47m near the dam. The water is soft and generally has low turbidity, with an average Secchi disc reading of 4.7m. The pH exceeds 7.0 in the surface waters, and decreases to 6.5 with depth. A pH of 9.0 has been recorded in sheltered areas with an abundant growth of aquatic vegetation.

Climatic conditions: Tropical monsoonal climate, dominated by the wet southwest monsoon from mid-May to early October and the cool, dry northeast monsoon from early November to mid-March. The annual rainfall is 2,000-2,600 mm, over 83% of which falls during the five months from May to September. The mean daily temperature for the whole year is about 25°C; the maximum at the hottest time of the year in March and April averages 33°C and the minimum in the cool season about 17°C.

Principal vegetation: The great seasonal fluctuations in water level prevent extensive growth of aquatic macrophytes, although there are occasional dense growths of floating vegetation such as *Azolla*, *Pistia*, *Eichhornia* and *Salvinia*. The submerged aquatic plant *Hydrilla verticillata* grows abundantly in shallow waters three to five metres from the shore and to a depth of four metres. Grasses appear on the exposed shoreline at low water levels. Significant changes have occurred in the phytoplankton since completion of the dam; by 1981, the phytoplankton was dominated by Desmidiaceae, Dinophyta and Chrysophyta (Mekong Committee, 1984c). Some islands support good tropical lowland forest dominated by bamboos and species of *Dipterocarpus*, *Anisoptern*, *Lagerstroemia*, *Irvingia*, *Dialium* and *Walsura*. Surrounding areas were once similarly covered in forest but much of this has now been degraded by logging, wood-cutting and charcoal production, or cleared for agricultural purposes.

Land tenure: No information.

Conservation measures taken: No legal protection. Logging on the islands is subject to concession.

Conservation measures proposed: None

Land use: Generation of electricity, flood control, water supply for irrigation and fishing. Since the completion of the reservoir in 1971, a number of people have immigrated into the area to look for new occupational opportunities. In 1981, the reservoir area had a population of 9,560 people in 31 villages (Mekong Committee, 1982c). Eight of these are primarily fishing villages and have formed their own fishing cooperatives, while the others are both fishing and farming communities. In 1980/81, there were some 2,350 fishermen using the reservoir (Mekong Committee, 1982c). Human settlements have been established on a few of the larger islands located in the central part of the reservoir, while others are used for temporary housing for fishermen and for charcoal production. Because the shorelines are steep and the soils are poor, drawdown agriculture is not extensive. The major crops grown in surrounding areas are rice, corn, vegetables and fruit.

Possible changes in land use: There are plans to increase the height of the dam in Phase 3 of the Nam Ngum Project.

Disturbances and threats: Eutrophication from decomposition of the flooded vegetation caused serious problems for fisheries until about 1980. A considerable amount of unauthorized logging occurs around the lake shore. The forested islands will be flooded in Phase 3 of the Nam Ngum Project, as also will a part of the Phou Khao Khouay Reserved Forest in the catchment area. The catchment area is affected by serious erosion problems, due to deforestation and land reclamation by inappropriate agricultural practices. The estimated rate of soil erosion in this area is 16 tons/ha/year. The eroded soil is transported by rivers and surface runoff to the reservoir, causing a serious siltation problem and endangering the viability of the reservoir, not only for hydropower generation but also for fisheries production.

Economic and social values: The hydro-electric power station has an installed capacity of 110 MW. Power from the dam supplies the city of Vientiane and the surrounding countryside. Surplus energy is exported to Thailand and is the country's largest foreign exchange earner. The total fish catch was estimated at 1,583 metric tonnes in 1980 (Mekong Committee, 1982c) and 1,470 metric tonnes in 1982, the latter representing a production of 37 kg/ha/year (Mekong Committee, 1984c). In 1986, the yield was estimated at 1,800 metric tons, worth approximately US dollar 1.4 million. However, the lake has only limited possibilities for recreational use (Sayer, 1983a).

Fauna: At least sixty-six species of fishes have been recorded in the commercial catches (Mekong Committee, 1984c). The most important are *Channa micropeltes*, *Harpala macrolepidota*, *Mystus nemurus*, *Notopterus notopterus*, *Pristolepis fasciatus*, *Oxphronemus gorami*, *Puntioplites proctozysron*, *Osteochilus melanopleura*, *O. hasselti*, *Morulius chrysophekadion* and *Puntius schwanefeldii*. Several exotic species have been introduced.

Waterfowl are said to visit the area, but no details are available. Some large mammals were present on the islands after dam closure, but most have since been killed by hunters, and the area now seems to have little value for wildlife (Sayer, 1983a).

Special floral values: No information.

Research and facilities: A considerable amount of fisheries research has been carried out at the reservoir. A fishery development and management project was undertaken between 1978 and 1983 with financial assistance from the Government of the Netherlands.

References: McNeely (1975); Mekong Committee (1970, 1976, 1981, 1982c, 1984a & 1984c); Pantulu (1986b); Sayer (1983a).

Criteria for inclusion: le.

Source: See references.

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