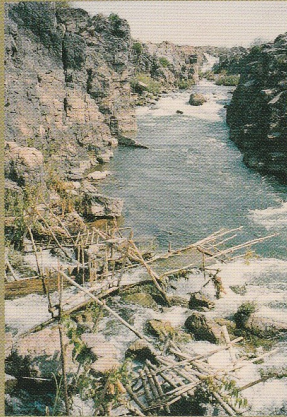
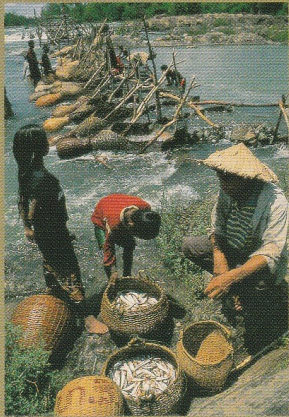


Siphandone Wetlands



Edited by
Giuseppe Daconto



Environmental Protection and Community Development in Siphandone Wetlands

Project supported by the European Commission



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With contributions from:

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Chapter 4

Vegetation in the Siphandone Wetlands

J. F. Maxwell

The Siphandone Wetlands area is characterized by its complex of channels, rapids, and waterfalls with numerous sandbars and islands, many of which are submerged during the rainy season (May-October) (Daconto, herewith). The highest points are Phou (mountain) Louang-Phou Khong at *c.* 239 m on Khong Island in the northern part of the study area and a hill *c.* 150 m high at the southern tip of Khone Island at the southern tip of the research area. Lowland elevations range from *c.* 75 m on the plains of Khong Island to *c.* 60 m in the southern part of the area. The area has been settled for a long time and there is evidence of an ancient civilisation on Khone Island where the remains of a Buddhist temple is found on the top of the hill on the southern part of the Island. This temple must be hundreds of years old and would indicate that a town of some permanency and size was in the area to support the temple. Large scale exploitation of the natural resources in the area was done by French colonialists from the latter of last century until 1941 when the Japanese took over up to 1945. The impact of settlement and long history of exploitation in the region has resulted in the presently devastated condition of the forest.

This chapter⁷ summarises the findings of surveys carried out by the author during the following periods: October 1997--end of the rainy season, Mekong River water level high; late January--early February 1998--dry season, river level falling; late April--early May 1998--driest and hottest time of the year, river level lowest; and Mid-September 1998--peak of the rainy season, river level high (Maxwell, 1999). The surveys enabled the collection of plant specimens which were carried to Chiang Mai University Herbarium for identification, while duplicates were also kept at the Biology Department, National University of Lao (Vientiane). 731 species (134 families) were identified (Appendix 2).

The climate in southern Lao is monsoonal with two distinct seasons, *viz.* rainy and dry. The rainy season is from late May-October, followed by a cool, dry period from November-February, and a hot, dry season during March-early May. The average amount of annual rainfall on Khong Island during 1979-1997 is 1753 mm. Records indicate that the amount of rainfall in Champasak Province has declined since 1980.

⁷ The findings of this study have been published in the Natural History Bulletin of the Siam Society, 48:1 (2000).

MIXED EVERGREEN + DECIDUOUS, SEASONAL, HARDWOOD FOREST (MXF)

A MXF was the original forest in most of the area without riverine (fluvial) vegetation. Remnants of this MXF are now scattered throughout the area and range from being more evergreen to more deciduous in composition. Centuries of cutting and burning have left some MXF areas so degraded that they merge with other forest facies and village/ cultivated areas. This is vividly seen on several hills on Khong and Khone Islands as well as on the Cambodian mainland during January-May when the deciduous components of the MXF are either leafless or with new leaves. This provides a distinct contrast with the evergreen members of this association. The most intact lowland remnants of MXF are found on the northern part of Khong Island, east side of Sahong Island, and the southern parts of Xang and Tholati Islands. MXF areas have the highest canopy, densest understorey and ground flora, richest soil, and are shadier and cooler than surrounding areas. Some tall evergreen trees in the MXF are: *Pterospermum diversifolium* Bl. (Sterculiaceae), *Sandoricum koetjape* (Burm. f.) Merr. (Meliaceae), *Dipterocarpus alatus* Roxb. ex G. Don and *Hopea ferrea* Pierre ex Lanes. (both Dipterocarpaceae), *Homalium tomentosum* (Vent.) Bth. (Flacourtiaceae) *Irvingia malayana* Oliv. ex Benn. (Irvingiaceae), *Knema conferta* (King) Warb. (Myristicaceae), *Calophyllum inophyllum* L. (Guttiferae), *Lepisanthes tetraphylla* (Vahl) Radlk. (Sapindaceae), *Carallia brachiata* (Lour.) Merr. (Rhizophoraceae), and *Diospyros bejardii* Lec. and *D. malabarica* (Desr.) Kostel. var. *siamensis* (Hochr.) Pheng. (Ebenaceae). Deciduous members include: *Anogeissus acuminata* (Roxb. ex DC.) Guill. & Perr. (Combretaceae), *Chukrasia tabularis* A. Juss. (Meliaceae), *Terminalia mucronata* Craib & Hutch. (Combretaceae), *Tetrameles nudiflora* R. Br. ex Benn. (Datisceae), and *Pterocarpus macrocarpus* Kurz (Leguminosae, Papilionoideae).

Evergreen woody climbers are: *Melodorum thorelii* Pierre ex Fin. & Gagnep., *Uvaria cordata* (Dun.) Alst., *U. dac* Pierre ex Fin. & Gagnep. (all Annonaceae), *Erycibe subspicata* Wall. ex G. Don (Convolvulaceae), *Rourea minor* (Gaertn.) Leenh. ssp. *minor* (Connaraceae), *Myxopyrum smilacifolium* (Wall.) Bl. var. *smilacifolium* (Oleaceae), *Ancistrocladus tectorius* (Lour.) Merr. (Ancistrocladaceae), and the rattan *Calamus palustris* Griff. var. *cochinchinensis* Becc. (Palmae). Some evergreen vines are: *Piper retrofractum* Vahl, *P. sylvaticum* Roxb. (Piperaceae), and *Rhaphidophora peepla* (Roxb.) Schott (Araceae). Most of the understorey is evergreen with *Glycomis parva* Craib (Rutaceae), *Memecylon amplexicaule* Roxb., *M. edule* Roxb. var. *edule* (Melastomataceae), *Rhodamnia cinerea* Jack (Myrtaceae); *Ixora finlaysonianana* Wall. ex G. Don, *I. nigricans* Wight & Arn. var. *nigricans*, and *Diplospora viridiflora* DC. (all Rubiaceae); *Lepisanthes fruticosa* (Roxb.) Leenh. (Sapindaceae), and *Pseuderanthemum latifolium* (Vahl) B. Han. (Acanthaceae) as common examples. *Desmos velutinus* (Hance) Ast (Annonaceae), *Eurycoma longifolia* Jack (Simaroubaceae), and *Clerodendron godefroyi* O.K. (Verbenaceae) are some deciduous representatives.

Marginal sandy and rocky areas between the MXF and the high water level of the river include some species which distinguish this habitat. *Quassia harmandiana* (Pierre) Noot. (Simaroubaceae), an evergreen tree; *Sampantaea amentiflora* (A.S.) A.S. (Euphorbiaceae), an evergreen treelet; and *Mallotus thorelii* Gagnep. (Euphorbiaceae), a deciduous shrub, are typical representatives.

The ground flora is diverse and includes both evergreen and deciduous members. Some evergreen species are: *Hedyotis nodiflora* Wall. ex G. Don (Rubiaceae), *Begonia yunnanensis* Lev. (Begoniaceae), *Gomphostemma lucidum* Wall. ex Bth. (Labiatae) and the ferns *Bolbitis hookeriana* K. Iw. (Lomariopsidaceae) and *Tectaria impressa* (Fee) Holtt. (Dryopteridaceae). Deciduous perennial herbs include: *Boesenbergia rotunda* (L.) Mansf., *Curcuma longa* L., *Globba schomburgkii* Hk.f. var. *schomburgkii*, *G. thorelii* Gagnep., *Kaempferia harmandii* Gagnep., and *Zingiber zerumbet* (L.) J.E. Sm. (all Zingiberaceae), *Alocasia odora* C. Koch and *Typhonium roxburghii* Schott (both Araceae), and *Habenaria trichosantha* Lindl. (Orchidaceae).

The ferns *Adiantum philippense* L. and *A. zollingeri* Mett. ex Kuhn (Parkeriaceae), and fern ally *Selaginella repanda* (Desv.) Spr. (Selaginellaceae) are also present. *Aeginetia indica* Roxb. (Orobanchaceae), a leafless root parasite, is also found in shaded MXF places.

DECIDUOUS DIPTEROCARP-OAK, SEASONAL, HARDWOOD FOREST (DOF)

Severe degradation or destruction of MXF areas has resulted in the development of DOF which is a secondary, fire-climax, kind of facies which differs considerably from MXF. DOF areas are open, have thin and rocky soil, and survive burning during the dry season (January-May). This kind of forest is dominated by several members of Dipterocarpaceae, viz. *Dipterocarpus obtusifolius* Teijsm. ex Miq. var. *obtusifolius*, *D. intricatus* Dyer, *D. tuberculatus* Roxb. var. *tuberculatus*, *Shorea obtusa* Wall. ex Bl., and *S. siamensis* Miq. var. *siamensis*. The oak component, *Quercus kerrii* Craib var. *kerrii* (Fagaceae) is now rare due to exploitation. The DOF is typically leafless from about January to April and lacks bamboo. Other common, but not dominant, deciduous trees there are: *Cratoxylum formosum* (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog. and *C. maingayi* Dyer (Guttiferae/Hypericaceae), *Terminalia alata* Hey. ex Roth, *T. chebula* Retz. var. *chebula*, *T. corticosa* Pierre ex Gagnep., and *T. mucronata* Craib & Hutch. (Combretaceae), *Xylia xylocarpa* (Roxb.) Taub. var. *kerrii* (Craib & Hutch.) Niels. (Leguminosae, Mimosoideae), *Sindora siamensis* Teysm. ex Miq. var. *siamensis* (Leguminosae, Caesalpinioideae); *Vitex limoniifolia* Wall. ex Kurz and *V. peduncularis* Wall. ex Schauer (Verbenaceae), *Spondias pinnata* (L.f.) Kurz (Anacardiaceae), *Schleichera oleosa* (Lour.) Oken (Sapindaceae); *Haldina cordifolia* (Roxb.) Ridsd., *Gardenia sootepensis* Hutch., and *Morinda tomentosa* Hey. ex Roth (all Rubiaceae), *Bombax anceps* Pierre var. *anceps* (Bombacaceae), *Diopyros ehretoides* Wall. ex G. Don (Ebenaceae), *Tristaniopsis burmanica* (Griff.) Wils. & Wat. var. *rufescens* (Hance) Parn. & Lug. (Myrtaceae), *Strychnos nux-vomica* (Loganiaceae), and *Careya arborea* Roxb. (Lecythidaceae). There are a few evergreen trees in the DOF, viz. *Mammea siamensis* (Miq.) T. And. (Guttiferae), *Wendlandia tinctoria* (Roxb.) DC. ssp. *orientalis* Cowan (Rubiaceae), and an occasional *Irvingia malayana* Oliv. ex Benn. (Irvingiaceae). *Irvingia* and *Pterocarpus macrocarpus* Kurz (Leguminosae, Papilionoideae), a deciduous tree, are often also found in MXF.

Aporosa villosa (Lindl.) Baill. (Euphorbiaceae), *Gardenia obtusifolia* Roxb. ex Kurz and *Catunaregam tomentosa* (Bl. ex DC.) Tirv. (both Rubiaceae), *Indigofera wightii* Grah. ex Wight & Arn. and *Lespedeza henryi* Schindl. (both Leguminosae, Papilionoideae), *Buchanania glabra* Wall. ex Hk. f. (Anacardiaceae), and an occasional *Gardenia cambodiana* Pierre ex Pit. (Rubiaceae) are some deciduous understory species. *Memecylon scutellatum* (Lour.) Naud. (Melastomataceae), an evergreen shrub or treelet and *Phoenix humilis* Roy. var. *humilis* (Palmae), an evergreen herb, as well as *Cycas siamensis* Miq. (Cycadaceae) a very distinctive treelet, are also common. *Aganosma marginata* (Roxb.) D. Don (Apocynaceae), a deciduous woody climber and *Holarrhena curtisii* King & Gamb. (Apocynaceae), a deciduous shrub, are frequently seen. *Erianchne trisetata* Nees ex Steud. (Gramineae) dominates many areas and also readily burns along with *Apluda mutica* L. (Gramineae), which is less common.

Although the woody flora in DOF is similar throughout the wetland, there are distinct differences in the ground flora which are based on exposure and drainage factors. Hills with DOF, such as Phou Kouang and Phou Khong on Khong Island, as well as those on the mainland east of Khong Island, have more rocky, i.e. eroded, soil, better drainage, and sparse ground flora in comparison to the DOF in the Jahn-Khinak Villages area on the mainland. These areas have mostly flat terrain, thicker soil, denser ground flora, and are flooded during the latter part of the rainy season (September-October). This kind of area can be considered a savanna. Due to habitat destruction and rice cultivation, savannas are either absent or very small and degraded on the islands. The differences in well-drained and seasonally flooded habitats are manifest with the ground flora, many species of which are either more abundant in or only found in savanna areas.

These species are best seen in September-October when they are flowering. Some annual representatives in savanna are: *Polygala brachystachya* DC. (Polygalaceae), *Drosera indica* L. (Droseraceae), *Mitrasacme erophila* Leenh. ssp. *erophila* (Loganiaceae), *Centranthera cochinchinensis* (Lour.) Merr. var. *cochinchinensis* and var. *lutea* (Hara) Yama., *Lindernia viscosa* (Horn.) Bold., and *Torenia benthamiana* Hance (all Scrophulariaceae); *Fimbristylis schoenoides* (Retz.) Vahl, *Scleria neesii* Kunth, and *Rhynchospora rubra* (Lour.) Mak. (all Cyperaceae); *Coelachne perpusilla* (Arn. ex Steud.) Thw. and *Eremochloa ciliaris* (L.) Merr. (both Gramineaceae).

Deciduous perennials are also common with: *Abelmoschus moschatus* Medic. ssp. *tuberosus* (Span.) Bors. and *Decaschiata harmandii* Pierre (both Malvaceae), *Trigonostemon reidioides* (Kurz) Craib (Euphorbiaceae), *Murdannia scapiflora* (Roxb.) Roy. (Commelinaceae), *Hypoxis aurea* Lour. (Amaryllidaceae); *Habenaria apetala* Gagnep., *H. rumphii* (Brogn.) Lindl., *Liparis acutissima* Rchb. f., and *Peristylus densus* (Lindl.) Sant. & Kapad. (all Orchidaceae); *Fimbristylis disticha* Boeck., *F. globulosa* (Retz.) Kunth, *Scleria levis* Retz., *S. psilorrhiza* Cl. (all Cyperaceae); *Eriachne trisetata* Nees ex Steud. and *Mnesithea laevis* (Retz.) Kunth var. *laevis* (both Gramineae). *Aeginetia indica* Roxb. (Orobanchaceae), noted above as being present in MXF, also grows in wet savanna areas.

The herbaceous ground flora in rocky, well-drained DOF is mostly perennial, deciduous, and as in savanna areas is barren in the hot-dry season. Some common examples of deciduous perennials are: *Aphaenandra uniflora* (Wall. ex G. Don) Brem. (Rubiaceae), *Barleria strigosa* Willd. (Acanthaceae), *Amorphophallus parvulus* Gagnep. (Araceae), *Habenaria dentata* (Sw.) Schltr. (Orchidaceae), *Scleria levis* Retz. and *S. lithosperma* (L.) Sw. var. *linearis* Bth. (Cyperaceae), *Arundinella setosa* Trin. var. *setosa* (Gramineae), and *Oleandra undulata* (Willd.) Ching (Oleandraceae). *Thunbergia similis* Craib (Acanthaceae) and *Lygodium flexuosum* (L.) Sw. (Schizaeaceae), both deciduous vines, are also common. Annual herbs include: *Sonerila erecta* Jack (Melastomataceae), *Borreria brachystemma* (R. Br. ex Bth.) Val. (Rubiaceae), *Thorelia montana* Gagnep. (Compositae), *Torenia violacea* (Aza. ex Blanco) Penn. (Scrophulariaceae), *Digitaria siamensis* Henr. and *Sporobolus harmandii* Henr. (both Gramineae). *Cassytha filiformis* L. (Lauraceae), a leafless, hemi-parasitic, autotrophic, epiphytic vine is also found throughout the year on undergrowth. *Curcuma zedoaria* (Berg.) Rosc., *Stahlianthus thorelii* Gagnep. (both Zingiberaceae), *Murdannia loureiri* (Hance) Rao & Kam. (Commelinaceae), *Amorphophallus koratensis* Gagnep. and *Pseudodracontium lacourii* (Linden & Andre) N.E. Br. (both Araceae), and *Crinum wattii* Baker (Amaryllidaceae), all deciduous, perennial, ground herbs which flower when leafless in April-May, are common in DOF. *Geodorum attenuatum* Griff., *G. recurvum* (Roxb.) Alst. (Orchidaceae), and *Stemona burkillii* Prain (Stemonaceae), a vine; also flower during this time with very immature leaves. *Curcuma gracillima* Gagnep., *Globba schomburgkii* Hk. f. var. *schomburgkii*, and *G. thorelii* Gagnep. (all Zingiberaceae) are deciduous, perennial, ground herbs which flower from August to October while having leaves.

There is also another DOF habitat which is found on exposed rhyolite bedrock with patches of thin soil, especially in depressions, which only has herbaceous ground flora. The Phou Kow Gayo area on the west side of Khong Island is the best place to see this very exposed habitat which is completely dry and barren in the hot-dry season and green in the rainy season--especially September-October. Some of the species found in this kind of bedrock habitat are either sparse or absent in savanna areas are: *Polycarpaea corymbosa* (L.) Lmk. (Caryophyllaceae), *Hedyotis gracilipes* (Craib) Fuku. var. *gracilipes* and *H. tetragonalis* (Korth.) Walp. (Rubiaceae), *Heliotropium strigosum* Willd. (Boraginaceae), *Psilotrichum ferrugineum* (Roxb.) Moq.-Tand. (Amaranthaceae), and *Fimbristylis obtusa* (Cl.) Ridl. (Cyperaceae)--all annuals. Some deciduous perennial representatives are: *Leptochloa malabarica* (L.) Veldk. (Gramineae) and *Cheilanthes belangeri* (Bory.) C. Chr. (Parkeriaceae). *Salomonioia cantoniensis* Lour. var. *cantoniensis* (Polygalaceae), *Zornia gibbosa* Span. (Leguminosae, Papilionoideae), and *Rhynchospora rubra* (Lour.) Mak. (Cyperaceae) are some annual herbs which are more common in bedrock areas than in savanna. *Utricularia minutissima*

Vahl (Lentibulariaceae), *Burmanna coelestis* D. Don (Burmanniaceae), annuals, and *Hypoxis aurea* Lour. (Amaryllidaceae), a perennial herb, are found approximately equally in both habitats.

SECONDARY GROWTH (SG)

Since the area has had a long history of forest destruction there are various stages of degradation which are present in the form of secondary growth. As noted above, DOF is a kind of secondary growth, but it differs from other SG associations in that it is fire-climax. The species found in SG differ from those found in MXF and DOF, however in many places a clear distinction between these forest types is vague due to merging of forest facies. Most SG species are deciduous and grow in open, single-canopied places, while none of them can be considered dominant. Typical SG trees are: *Cratogeomys formosum* (Jack) Dyer spp. *pruniflorum* (Kurz) Gog. (Guttiferaceae/Hypericaceae), *Casearia grewiaefolia* Vent. var. *grewiaefolia* (Flacourtiaceae), *Ziziphus nummularia* (Burm. f.) Wight & Arn. (Rhamnaceae), *Microcos paniculata* L. (Tiliaceae), *Bauhinia malabarica* Roxb. (Leguminosae, Caesalpinioideae), *Dalbergia nigrescens* Kurz var. *nigrescens* (Leguminosae, Papilionoideae), *Alangium salvifolium* (L.f.) Wang, ssp. *hexapetalum* (Lmk.) Wang. (Alangiaceae), *Feronia limonia* (L.) Swing. (Rutaceae), and *Streblus asper* Lour. var. *asper* (Moraceae), which is evergreen. Typically SG areas have many spiny or thorny woody climbers and scandent species, e.g. *Capparis micrantha* DC. (Capparaceae), *Ziziphus cambodiana* Pierre var. *cambodiana* and *Z. oenoplia* Mill. var. *oenoplia* (Rhamnaceae), *Harrisonia perforata* (Blanco) Merr. (Simaroubaceae), *Acacia megaladena* Desv. var. *megaladena* (Leguminosae, Mimosoideae), and *Caesalpinia hymenocarpa* (Prain) Hatt. (Leguminosae, Caesalpinioideae). Inermous, deciduous, woody climbers and scandent species include: *Oroxylum indicum* Roxb. (Olacaceae), *Calycopteris floribunda* (Roxb.) Lmk. (Combretaceae), and *Congea tomentosa* Roxb. var. *tomentosa* (Verbenaceae). *Bridelia tomentosa* Bl. (Euphorbiaceae), a deciduous, inermous woody climber or tree, is also common. The robust grass *Thysanolaena latifolia* (Roxb. ex Horn.) Honda (Gramineae) often forms dense thickets along with deciduous shrubs, e.g. *Helicteres hirsuta* Lour. (Sterculiaceae), *Colona auriculata* (Desf.) Craib (Tiliaceae), and the evergreen *Memecylon scutellatum* (Lour.) Naud. (Melastomataceae). Common vines include: *Cayratia trifolia* (L.) Dom. var. *trifolia* (Vitaceae), *Bauhinia penicilliloba* Pierre ex Gagnep. (Leguminosae, Caesalpinioideae), *Abrus precatorius* L. (Leguminosae, Papilionoideae), *Dioscorea bulbifera* L. and *D. glabra* Roxb. var. *glabra* (Dioscoreaceae). Secondary growth herbs, many of which are also weeds, are: *Eupatorium odoratum* L. (Compositae), *Hyptis suaveolens* (L.) Poit. (Labiatae), *Crotalaria verrucosa* L. (Leguminosae, Papilionoideae), *Costus speciosus* (Koen.) J.E. Sm. (Zingiberaceae), and *Amorphophallus paeoniifolius* (Denn.) Nichol. (Araceae). *Cissus modeccoides* Pl. var. *modeccoides*, *C. quadrangularis* L. (Vitaceae), and *Smilax extensa* Wall. ex A. DC. (Smilacaceae) are some examples of vines.

Weeds, that is more ephemeral (i.e. annual) herbs, include some species which are typically found in rice fields and can be seen when these places are wet. These include: *Dopatrium acutifolium* Bon. (Scrophulariaceae), *Utricularia bifida* L. var. *bifida* and *U. minutissima* Vahl (Lentibulariaceae), *Eriocaulon quinquangulare* L. (Eriocaulaceae), and *Burmanna coelestis* L. (Burmanniaceae). *Grangea maderaspatana* (L.) Poir., *Sphaeranthus indicus* L. (both Compositae), and *Ammannia baccifera* L. (Lythraceae) are some species which flower and fruit when the fields are dry.

Some weeds found in sandy, often seasonally inundated areas, are: *Spilanthes paniculata* Wall. ex DC. (Compositae), *Glinus lotoides* L. (Aizoaceae), *Polycarpon prostratum* (Forssk.) Asch. & Schw. (Caryophyllaceae), *Polygonum plebeium* R. Br. (Polygonaceae), *Cyperus pygmaeus* Rottb. (Cyperaceae); *Digitaria bicornis* (L.) Roem. & Schult., *Eragrostis amabilis* (L.) Nees, and *Eleusine indica* (L.) Gaertn. (all Gramineae).

Oryza sativa L. (Gramineae), sticky rice, is the most common crop grown while home gardens have a variety of vegetables, spices, and fruits. Some of these plants are: *Anethum graveolens* L. (Umbelliferae, dill), *Brassica chinensis* L. (Cruciferae, Chinese cabbage), *Capsicum annuum* L. (Solanaceae, chili), *Citrullus lanatus* (Thunb.) Matu. & Nak. (Cucurbitaceae, water melon), *Ipomoea aquatica* Forsk. (Convolvulaceae, water morning glory), *Lycopersicon lycopersicum* (L.) Karst. (Solanaceae, tomato), *Nicotiana tabacum* L. (Solanaceae, tobacco), and *Solanum melongena* L. (Solanaceae, egg plant).

Cultivated fruit trees include: *Annona squamosa* L. (Annonaceae, custard apple), *Cocos nucifera* L. (Palmae, coconut), *Mangifera indica* L. (Anacardiaceae, mango), *Tamarindus indica* L. (Leguminosae, Caesalpinioideae; tamarind), and *Chrysophyllum cainito* L. (Sapotaceae, star apple). Bamboos (Gramineae, Bambusoideae) are also commonly planted for their general construction utility, edible shoots, and ornamental value. These include: *Bambusa bambos* (L.) Voss. ex Vilm., *B. vulgaris* Schrad. ex Wend. var. *striata* (Lodd. ex Penny) Gamb., *Dendrocalamus longispathus* Kurz, and *Thyrsostachys oliveri* Gamb. *Samanea saman* (Jacq.) Merr. (Leguminosae, Mimosoideae; rain tree) and *Ceiba pentandra* (L.) Gaertn. (Bombacaceae, kapok), and to a lesser and more recent extent *Tectona grandis* L. f. (Verbenaceae, teak) are also commonly seen.

EPIPHYTES AND EPILITHS

Vascular epiphytes are common, especially on older trees, and include evergreen, hemi-parasitic shrubs, viz. *Helixanthera pulchra* (DC.) Dans., *Macrosolen lowii* (King) Tiegh., and *Scurrula parasitica* L. (all Loranthaceae); deciduous ferns: *Davallia denticulata* (Burm. f.) Mett. ex Kuhn (Davalliaceae) and *Drynaria quercifolia* (L.) J. Sm. (Polypodiaceae), and *Pyrrhosia adnascens* (Sw.) Ching (Polypodiaceae) which has fronds which dry and shrivel during the dry season and become succulent and green again when it rains.

Due to extensive exploitation for cultivation and habitat destruction, epiphytic Orchidaceae are generally sparse. Some examples are: *Cymbidium bicolor* Lindl., *Dendrobium venustum* Teijsm. & Binn., and *Smitinandia micrantha* (Lindl.) Holtt.

Vascular epiliths are also found in the study area, although they are not as common as epiphytes, and are found in places lacking water. Several ferns have been observed to grow on rocks, e.g. *Adiantum zollingeri* Mett. ex Kuhn (Parkeriaceae), a deciduous species which is also a geophyte: while *Drynaria bonii* C. Chr., which is deciduous, and *Pyrrhosia stigmosa* (Sw.) Ching (both Polypodiaceae), being evergreen, are more commonly epilithic than epiphytic.

BEDROCK

The bedrock in the study area consists of rhyolite and sandstone which is often interbedded with shale and chert. All of these kinds of rocks are found above the major Sompamit-Pah Peng fault line, while only sandstone, shale, and chert are found below it. Laterite is found on top of sandstone bedrock on the mainland, especially in the Kinak Village area. The bedrock has had no effect on the vegetation in the area, that is MXF and DOF are found on all rock types there.

WETLAND AREAS

Seasonal fluctuations in the level of the Mekong River and tributary streams have resulted in a distinct riparian vegetation with a predominance of rheophytic and amphibious plants. Seven categories of habitats can be distinguished which are based on river flow, bedrock conditions, and substrate. The entire area is submerged under c. 3-8 m of fast flowing, turbid water from

about August-November and is exposed from about January-May, the time when many species flower and fruit. The bedrock is rugged sandstone with some interbedded shale.

Sand Bars

The sandy banks of the islands and sand bars have within the past 5-10 years, become infested with *Mimosa pigra* L. (Leguminosae, Mimosoideae), a deciduous shrub from tropical America which forms dense, thorny growth. This species is rapidly expanding at the expense of native vegetation and is also extremely difficult to eradicate.

Marginal, mostly amphibious, trees include *Crateva magna* (Lour.) DC. (Capparaceae), *Combretum quadrangulare* Kurz (Combretaceae), and *Salix tetrasperma* Roxb. (Salicaceae), which has been over-exploited. *Saccharum spontaneum* L. and *Phragmites vallatoria* (Pluk. ex L.) Veldk. (both Gramineae) are large, vigorous grasses found in sandy areas. *Homonoia riparia* Lour. (Euphorbiaceae), a common amphibious shrub, and *Oxystelma esculentum* (L.f.) R. Br. (Asclepiadaceae), a vine, are also found in this habitat. Weeds and home gardens are common on the exposed banks from about January to June.

Boong Area

Shallow, rocky places with permanent river flow are characterised by having dense tufts or small islands of vegetation on sandstone bedrock where there is a general absence of sand. The vegetation here is rheophytic and most of its components are not found in other places in the wetland. This area is locally known as *boong* and is restricted to an area north of the fault line and south of Tholati Island. *Telectadium edule* H. Baill. (Asclepiadaceae) dominates, while *Homonoia riparia* Lour. (Euphorbiaceae), *Rotula aquatica* Lour. (Boraginaceae), and *Xanthonnea parvifolia* (O.K.) Craib var. *salicifolia* (Pierre ex Pit.) Craib (Rubiaceae), all shrubs, are also common. The fern *Meniscium proliferum* (Retz.) Sw. (Thelypteridaceae) and *Lophopogon intermedius* A. Camus (Gramineae), a grass, are also found here.

Kai Kum Zone

Gohk kai kum is the Lao name for *Phyllanthus jullienii* Beille (Euphorbiaceae), a shrub, which is the dominant species in the region below the "boong" area and above the falls. This place is flat, rugged sandstone bedrock which is completely exposed from December to May. There are channels through the bedrock and patches of sand in some places. Amphibious herbs such as *Hygrophila incana* Nees (Acanthaceae) and delicate *Cryptocoryne tonkinensis* Gagnep. (Araceae) are also present.

Acacia-Anogeissus Zone

This is a unique area below the falls which is the deepest zone of submergence in the wetlands. It is dominated by two species of current-bent, deciduous trees up to 10 m tall, viz. *Anogeissus rivularis* (Gagnep.) Lec. (Combretaceae) and *Acacia harmandiana* (Pierre)Gagnep. (Leguminosae, Mimosoideae) which grow on seasonally dry, sandy and rocky places. *Homonoia riparia* Lour. (Euphorbiaceae) is found in amphibious places there.

Channels

I have included this as a distinct wetland zone since some of the species found in these places seem to most common in this habitat. Channels include shallow to dry, seasonally flooded, rocky (sandstone) and sandy riverine areas with scattered shrubs and treelets, mostly 1-2.5 m tall. *Morinda pandurifolia* O.K. var. *oblonga* (Pit.) Craib (Rubiaceae), *Eugenia mekongensis* Gagnep. (Myrtaceae), *Gymnosporia (Maytenus) mekongensis* Pierre (Celastraceae), and *Blachia cotoneaster* Gagnep. (Euphorbiaceae) are common here. *Vincetoxicopsis harmandii* Cost. (Asclepiadaceae), a tufted herb, is also present. *Fimbristylis aestivalis* (Retz.) Vahl var.

aestivalis and *F. brunnea* Cl. (Cyperaceae) are common, deciduous, perennial, ground herbs found in both the *Acacia-Anogeissus* zone and in channels. Most of the woody plants in this habitat have also been bent by river flow.

Seasonal Streams

Some of the larger islands, e.g. Khong and Khon, have seasonally dry drainage streams while true seasonal streams are found on the mainland. These places have rocky beds and sometimes have isolated pools where aquatic plants, e.g. *Hydrilla verticillata* (L.f.) Roy. (Hydrocharitaceae) grow. The vegetation is mostly degraded MXF without riverine facies.

Aquatics

Several species of perennial herbs requiring a constantly wet environment are found in the area. Floating aquatics include *Eichhornia crassipes* (Mart.) Solms (Pontederiaceae), an introduced species which often covers ponds and stagnant water bodies in other places. This plant is uncommon in the Mekong River since it is washed away each year during the rainy season. *Ipomoea aquatica* Forsk. (Convolvulaceae), an amphibious vine, is cultivated for its edible vegetation both on sand banks and on the surface of the water nearby.

Nymphaea nouchali Burm. f. (Nymphaeaceae) and *Nymphoides indica* (L.) O.K. (Gentianaceae/Menyanthaceae) root in substrate while its leaves and flowers float. Submerged aquatics rooting in mud include: *Hydrilla verticillata* (L.f.) Roy. and *Ottelia alismoides* (L.) Pers. (both Hydrocharitaceae), *Potamogeton crispus* L. var. *crispus* (Potamogetonaceae), and *Ceratophyllum demersum* L. (Ceratophyllaceae). These species appear to be floating when the water level is low. *Utricularia aurea* Lour. (Lentibulariaceae), *Lemna perpusila* Torr. (Lemnaceae), both floaters; and several species rooting in the bottom of ponds and wet ditches, e.g. *Cyanotis axillaris* (L.) D. Don (Commelinaceae), *Monochoria vaginalis* (Burm. f.) Presl (Pontederiaceae), and *Typhonium flagelliforme* (Lodd.) Bl. (Araceae) are other aquatic herbs found in mostly seasonally dry areas away from the Mekong River. *Hydrocera triflora* (L.) Wight & Arn. (Balsaminaceae) and *Hydrolea zeylanica* (L.) Vahl (Hydrophyllaceae) are annual herbs found in savanna areas which root in mud in both amphibious and aquatic habitats. There is also a filamentous green algae which is very dense in the Mekong River during February-March, but is absent by April-May.

Marsilea quadrifloia L. (Marseliaceae), an amphibious fern rooting in sandy substrate, is often completely exposed when the river is low. The entire plant is edible, however I have not seen it cultivated.