

# Scientific Journey Through Borneo: Loagan Bunut

A Scientific Expedition  
on the Physical, Chemical, Biological, and Sociological Aspects

A.A. Tuen, A.K. Sayok, Toh A.N. and G.T. Noweg  
Editors



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## LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectrophotometry
ABaF	Alan Batu Forest
ABuF	Alan Bunga Forest
AN	Ammoniacal Nitrogen
BOD	Biochemical Oxygen Demand
Btg.	Batang @ Major River
cm	centimetre
COD	Chemical Oxygen Demand
DBH	Diameter at Breast Height
DO	Dissolved Oxygen
DOF	Department of Fisheries
Figs.	Figures
FO	Fruit Orchard
FRIM	Forest Research Institute Malaysia
GEF	Global Environment Facility
ha	hectare
HUMS	Herbarium Universiti Malaysia Sarawak
INWSM	Interim National Water Quality Standards
ITRI	Interpretative Trail Resource Inventory
IUCN	International Union for Conservation of Nature
KF	Keruntum Forest
kg	kilogram
km	kilometre
KOH	Potassium Hydroxide
LBNP	Loagan Bunut National Park
LOI	Loss-on-ignition
m	metre
MDF	Mixed Dipterocarp Forest
mg	milligram
MSF	Mixed Peat Swamp Forest
NCRs	Native Customary Rights
NO <sub>3</sub> -N	Nitrate
NREB	Natural Resources Environment Board, Sarawak
PAF	Padang Alan Forest
PCR	Polymerase chain reaction
PPF	Padang Paya Forest
PSF	Peat Swamp Forest
Rh.	Rumah @ Longhouse/Kampung
SAR Herbarium	Herbarium (of the Sarawak Forest Department)
SFC	Sarawak Forestry Corporation
SFD	Sarawak Forest Department
Sg.	Sungai @ River/Stream
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNIMAS	Universiti Malaysia Sarawak
WQI	Water Quality Index

## PREFACE

The 10,736-hectare Loagan Bunut National Park (LBNP), gazetted in 1990, is one of only two areas of Peat Swamp Forests that are being protected in Sarawak (the other one being the Maludam National Park). LBNP is located in the Tinjar floodplain of the northeastern part of Sarawak. Sungai Teru and Sungai Tinjar respectively form the natural boundary on the eastern and western side of the park and are responsible for inflow and outflow of water into the park. The park contains Sarawak's largest natural lake which, depending on the season, can reach a maximum size of about 650ha. The park also supports a diverse community of flora and fauna that inhabits the lake and river system and swamp, dryland and riverine forests. However, continued exploitation of the natural resources inside and outside LBNP, especially over the last 30 years, has threatened the biodiversity and integrity of the park ecosystem.

Having sufficient information on biodiversity and ecological processes that maintain it is of utmost importance in order to manage the park properly as well as to enhance its tourism and conservation value. However, such information was sketchy and more data collection was urgently required for the development and implementation of concrete management plans by the relevant authorities to ensure the sustainable management of the park's resources. This would in turn benefit the local community who are an integral part of LBNP. Such information would also be of value to the State in its effort to fulfill its commitment to manage and conserve its biodiversity, as well as its obligation to the Convention of Biological Diversity (CBD) and Ramsar Convention on Wetlands.

Recognising this need for information as well as to enhance local awareness of the adverse impacts of uncontrolled exploitation of the natural resources on the biodiversity and integrity of the park, a multidisciplinary expedition was organised in LBNP from 28 March to 12 April 2004. The expedition was jointly financed by the Peat Swamp Forest Project, United Nations Development Programme/Global Environment Facility (UNDP/GEF) Funded, the Sarawak Forests Department and Universiti Malaysia Sarawak. The aim of this expedition was to gather information and data on the physical, biological and socio-economic aspects of the park; information deemed critical for sustainable management.

As a follow-up of the expedition, a seminar involving all the researchers and relevant stakeholders was conducted in Kuching on 2–3 August 2004, during which the findings of the expedition were presented and discussed in detail. Some studies requiring a more thorough investigation were extended to 2005.

The expedition findings, including comments obtained during the seminar and results from the extended studies, have been compiled and synthesised into this monograph. This monograph is unique and informative – unique because it contains the only up-to-date information on LBNP and informative because of the depth and coverage of the subject matter. The complexity of the subject matter that defines the diversity of LBNP has been simplified by organising the 27 papers under three broad categories:

- A. Physical environment—incorporating studies on soil and water, including geology and hydrology and water quality;
- B. Biological diversity—studies on plant and animal diversity, including fish and fisheries;
- C. Socioeconomic and cultural diversity—studies on socio-economic issues affecting the natives including their use of medicinal plants, music, costumes and motifs.

The reason for the categorisation is to enable readers to identify and extract information relevant to their particular field of interest. We also believe that with this arrangement makes it easy for the relevant authorities to access and identify vital information and linkages for developing innovative management plans for the sustainable use and conservation of resources in LBNP.

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## INTRODUCTION

### Background

Malaysia possesses about 1.45 million hectares (ha) of peat swamp forest (PSF), of which over 80% is located in Sarawak. PSF covers approximately 13% of Sarawak's total land area.

The Loagan Bunut National Park in Sarawak is one of the key demonstration sites in Malaysia under a five-year project to promote the conservation and sustainable use of the highly significant and fragile ecosystem of tropical PSFs in Malaysia with the assistance from the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) launched in 1999. The project document was signed in 2001 and commenced in June 2002.

The project's primary objective is to develop and implement plans, which encourage processes to ensure the conservation and sustainable use of globally significant genetic, species, and ecosystem diversity within these forests. There are three immediate objectives towards the implementation of this project, and within those objectives are six expected overall outputs which include: setting up of information management system on biological diversity, establishment of biological diversity monitoring programme, development and demonstration of site-specific plans for Sarawak, Sabah and Pahang.

### Loagan Bunut National Park

Loagan Bunut National Park (LBNP), gazetted in 1990, covers an area of 10,736 ha area between the Tinjar and Teru rivers, in the upper reaches of the Baram River basin in Sarawak. It is some 120 kilometres (km) southwest of Miri town (Map 1) and is accessible by land as well as river transportation. It can be reached in 2.5 hours via the Bakong/Beluru-Lapok/Long Lama trunk road from the 40-km junction of the Miri-Bintulu Road or a day's journey upriver via Kuala Baram. The park is predominantly covered by logged-over PSF and a complex mosaic of wetland habitats including the Sarawak's largest natural freshwater inland floodplain lake. This lake known as 'Loagan Bunut' occupies about 650 hectares (ha) in the centre of the park. This scenic inland lake forms the main natural attraction. Though gazetted as a National Park, approximately 10% of LBNP area is under shifting cultivation, practised primarily by the Berawan. The local Berawan have been granted Native Customary Rights (NCRs) to continue using the natural resources of the area for subsistence purposes.

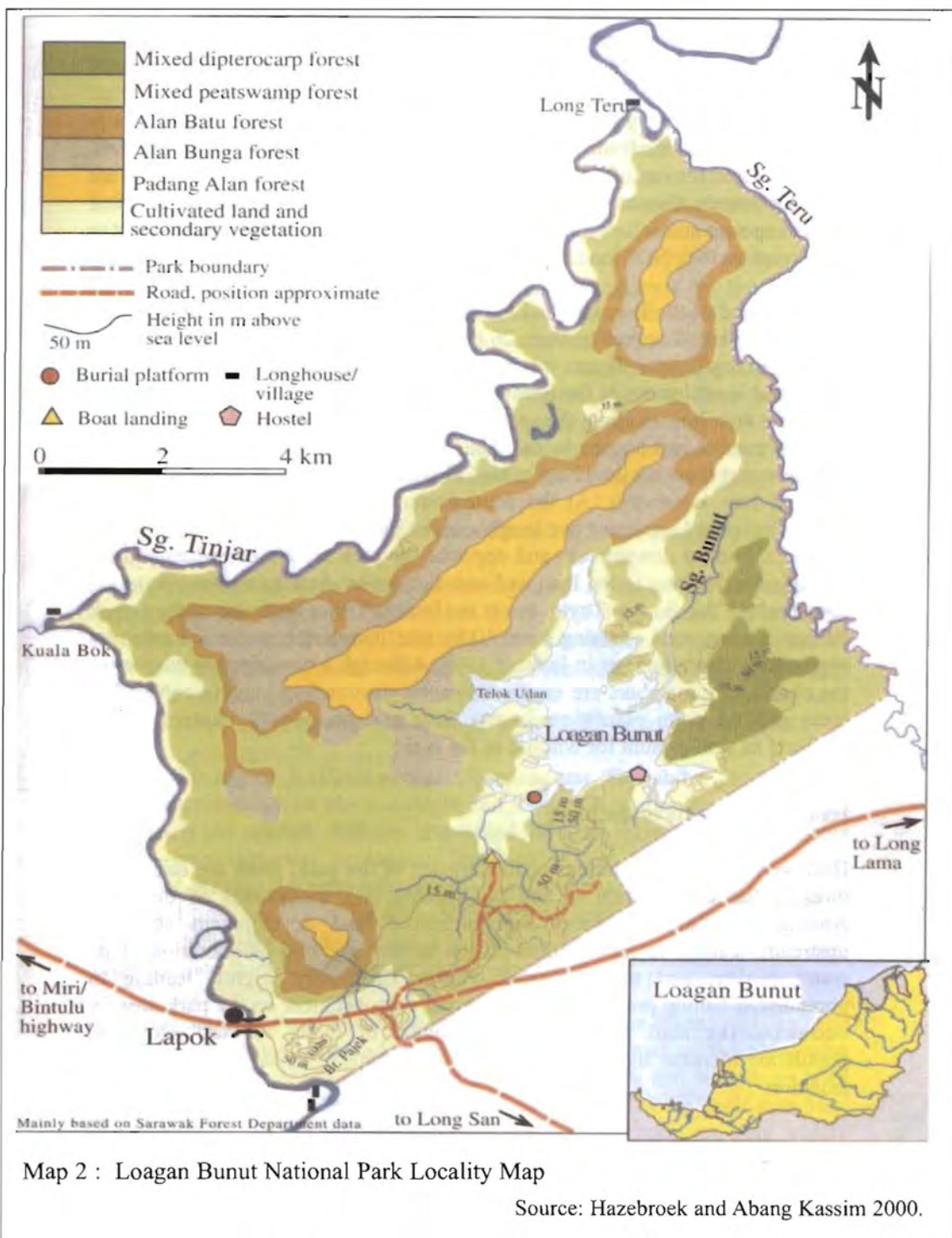
The area is generally low but with undulating hills. The tallest, Bukit Pajek, is 132 metres (m) in elevation and located on the extreme southwestern part of LBNP. To the east and south, more than half of the park boundary is bordered by oil palm plantations. To the west, the park abuts secondary forest and shifting cultivation.



This park is teeming with various species of fauna during different periods of the year. This is likely to be associated with fluctuating levels of the lake and phenological cycle of the vegetative communities. Some physical evidences of past human habitations are still intact. Because of its potential as a tourist destination, the local Berawan built tourist chalets at the southern shores of the lake. The Ministry of Cultural Arts and Tourism Malaysia has also established a RM12-million facility including a 7km tar-sealed access road and a park complex.

Loagan Bunut is an extraordinary lake with water level that fluctuates throughout the year in response to the fluctuations in water levels of the Teru River, with which the lake is connected via a narrow channel (Bunut River). Fish and birds populations also fluctuate as a result of this. The lake and its surrounding vegetation are scenic and full of life; both during high and low water levels. During extended droughts, the lake dries up to become a huge expanse of dry cracked mud. Soon after drying up, grasses and herbs would sprout in the mud cracks and Sambar deer or *rusa* (*Cervus unicolor*) have been spotted browsing on the young vegetation of the lake bottom. Insects lay their eggs in the mud cracks and caterpillars emerging from the eggs feed on the grass. When rain resumes and the lake starts to fill up, the fish will feed on the caterpillars.

A *selambau*, which is a traditional fishing implement unique to the native Berawan, is a major cultural attraction in LBNP. Another heritage is the ancient



burial platform on ironwood or *belian* poles located on the banks of the major stream (Sungai Bunan) that feeds the lake. An island, “Pulau Tengah”, located southwest of Sungai Bunut, is the ancient burial ground of the Berawan with more than 100 graveyards scattered about the island. The burial ground is still in use and it is considered a sacred place.

The Berawan from the Rumah Kajan Sigei at Long Teru, downstream of the park, are considered the native of the area. As such, under Section 14 of the National Parks Ordinance, they have special privileges to fish in the lake, hunt unprotected animals species and collect forest products from the park. They are also allowed to grow crops on their NCR land in the park.

About a third of the Berawan had moved from Long Teru to various locations within the park. The newly built 26-door longhouse known as Rumah (Rh.) Meran Surang/Loagan Bunut, some 3km from the park entrance, is the only considerable settlement of the Berawan from Long Teru. Those who fish in the lake built their houses along the eastern and southern shores while some live on semi-permanent raft-houses in the lake. Some enterprising ones even built a private resort there while others settled along the access road especially along the first four kilometres. At the southwestern boundary downstream of the Tinjar Bridge at Lapok, are two longhouses of the Iban who are the most recent migrants. Further downstream and opposite the park are six other longhouses, five of which belong to the Iban and one, the Penan. At the extreme southwest corner where the Sungai Tuyot meets the Batang Tinjar upstream of the Lapok Bridge is a log pond covering some 10-ha site. Permission to use the area was approved with restrictions in January 1994. Although a considerable number of the community members are employed in the surrounding logging concession areas and oil palm plantations, some farm and occasionally harvest forest products as well as hunt for wildlife in the park.

### **Issues and threats to the park**

However, behind the fabulous characteristics of the park, there are issues that threaten the conservation of the biodiversity and ecosystems of the area. Among them are the recent uncoordinated land development activities upstream, leading to rapid sedimentation of the lake and deterioration of its water quality, and the misuse of Native Customary Rights, leading to unregulated fishing practices and increasing encroachment on the park area by outsiders. The shift from subsistence mode of living to cash economy, population increase and rapid land development upstream have aggravated the situation.

### **Project Intervention**

The PSF Project intervention has been to work with the government agencies especially those directly related to the park and its immediate environment. The

approach taken by the project has been to investigate both the biogeochemical resources and their relationships with the socio-cultural aspects to solicit important information about the area. The data and information are then communicated and disseminated through various platforms to raise awareness on the significance of the area in terms of its biodiversity richness, its status, threats to the sustainability of the natural resources and steps forward to protect and conserve them without compromising on the socio-economic well-being of the local communities. In the process, the special privileges of the Berawan are safeguarded. Alternative or supplemental livelihoods are developed with the community to reduce dependence on the park's resources and curb encroachment. Both institutional and human capacity building and strengthening are undertaken to improve the management of the area. In addition to awareness raising, links and cooperation with local communities and other stakeholders are enhanced as they are vital instruments in instilling a sense of ownership of the park and responsibility to ensuring the conservation of the ecosystems while enjoying the benefits derived from the park. Cooperation with state government agencies and non-governmental organisations (NGOs) will ensure an integrated management of the park with the ultimate aim of conserving and sustainable use of the resources therein.

The following are some of the measures undertaken by the project:

**(a) Assessment of Biophysical Diversity and Human Environment:** A multidisciplinary assessment undertaken by the PSF Project and the scientific expedition to Loagan Bunut (LBSE2004) have provided a snapshot of the area in terms of its ecology, biodiversity and socio-economics significance. The data and information gathered form useful inputs for awareness raising and development of an integrated management plan (IMP) for implementation.

**(b) Monitoring of Environmental Components:** The above studies set a platform through which more in-depth and long-term studies can be identified particularly on species that are threatened or near threatened, components which serve important ecological functions in the area and site quality indicators. Among the parameters to be studied are patterns of distribution with space and time, quality of habitats. Various hydrological equipment had been installed in the lake, feeding streams and across the PSF for more in-depth and longer-termed studies on the water quality and movement.

**(c) Awareness of Peat Swamp Forest:** The importance of the PSF and the park as a whole has been and continued to be highlighted by the press who were invited to cover project activities such as dialogues and workshops with the locals and stakeholder agencies at the state level. During such activities, project information materials including pamphlets and brochures were widely distributed for public awareness. Media coverage of the project-related events in Sarawak has been most encouraging. Among others, the project has assisted the Park Management in establishing more interpretive trails to enable visitors to gain direct experience, explore and learn more about the unique forest environment of the park.

**(d) Capacity Building and Strengthening:** Both formal and informal training opportunities have been provided for personnel of various state government agencies especially the Sarawak Forests Department (SFD). Counterpart staff of related departments have always been invited to join experts in conducting their field studies on various aspects of the park. Students from various universities and SFD staff were involved in the LBSE04. A scholarship has also been set aside to encourage post-graduates to conduct studies in the park.

**(e) Creation/Development of Supplemental/Alternative Livelihood:** Various training programmes have been conducted for the local community to equip or improve themselves on any alternative or supplemental method of income generating activities. Among the programmes were training for boatmen, tour guides and courses in handicraft making and homestay programmes. Representatives of the local communities have also been brought on study tours to other national parks in Sarawak to enhance their understanding of the importance of such protected areas and to encourage them to develop and participate in supplemental income activities. Fish farming along the rivers and in ponds will be introduced with the support of the project.

**(f) Interagency Networking/Partnerships:** The Wetlands Management Committee (WMC), which is also the State Project Steering Committee, comprises a good representation of government stakeholders. The committee members have actively participated in meetings and dialogues, with of the state agencies even leading technical committees to resolve rising matters related to the park. Among them are the Natural Resources and Environment Board (NREB) on water pollution, and SFD on land uses and settlement issues. The scientific expedition is an example where four institutions (SFD, UNIMAS, UNDP/GEF and Sarawak Forestry Corporation) work together towards a common goal. Various training courses, workshops and dialogues conducted by the project were also the result of such an interagency cooperation. Networking has also been established with NGOs such as the Malaysian Nature Society and the private sector including Sarawak Shell Berhad and the upstream land developers.

**(g) Clear Zonation:** As the park was gazetted without much details on the land tenure and ownership, the NCRs are open to abuses. There is no restriction on the movement and activities of the locals in the park, which means that they can harvest forest products from anywhere within the park area. Zoning will eventually be made for the forest to define the different areas for different purposes. For example, a core zone will be determined strictly for the conservation of certain significant species such as ramin and alan bunga.

**(h) Formation and Activation of a Special Park Committee:** This committee comprising 12 members of the local stakeholders, headed by the Park Warden and supervised by the SFD, has been set up to deal with various issues to ensure better management of the park and its resources. The committee has looked into, among others, the establishment and enforcement of fishing

regulations, ensuring equitable distribution of opportunities for locals to participate in income-generating activities and programmes organised with the project's support particularly those related to capacity building for implementation of supplemental/alternative livelihoods such as handicraft making, tour guiding, and implementing homestay programmes.

**(i) Formation and Activation of a Fishery Management Committee:** Fishing has been carried out in Loagan Bunut for centuries. The Berawan from Rh. Kajan Sigeh and their descendants were given the exclusive privilege to continue harvesting fish from this lake when the park was gazetted in 1990. Due to exposure to market economy, subsistence fishing is no more the order of the day and the Berawan's Fishing Regulations of 1969 have been completely disregarded. This has resulted in declining catch per unit effort and depleting valuable species. In order to revive the fish population, thereby increasing the catch per unit effort, as well as to sustain fishery as a whole, a fishery management committee has been formed by the Berawan to serve as a self-regulatory body to oversee fishing activities.

**(j) Formation of a Coordinating Body:** During the recent environmental awareness dialogue with senior officials of oil palm plantations, it was suggested that a body (Integrated Resources Management Committee) be set up to facilitate a participatory decision-making and resources management at the national, provincial, and river basin levels by involving all stakeholders.

**(k) Drafting of an Integrated Management Plan:** The final product of the project is the IM to enable the park to be managed prudently so that its physical attractions and ecosystem integrity can be safeguarded, the biodiversity conserved whilst the rights and privileges of the local communities be respected. The various interests of the stakeholders including the socio-economic development around the park are considered in the IMP. The drafting of the plan follows a participatory process, involving the various stakeholders (governmental agencies, local communities, NGOs, and the private sector) and using the 5-S Framework.

### **Expected Scenario Beyond the Project Period**

The information and data compiled from the various studies are useful for the development of various awareness raising. The data will provide inputs for the promotion of a greater understanding of the PSF and associated wetland ecosystems in LBNP and form the basis for protection or conservation of selected flora and fauna species. Awareness raising activities on the importance of protecting and conserving these species particularly those targeting the local communities are crucial to inculcate a sense of belonging, ownership and hence, responsibility over the park. This will result in a willingness on the part of the locals to participate in 'co-management' efforts to ensure the conservation and sustainable use of the park resources.

The in-depth and longer-termed studies are expected to contribute more information regarding the park for the development of strategies to curb threats to the lake ecosystem and the PSF as a whole. Maintenance of a balanced lake ecosystem will ensure sustainable fishery.

The introduction of alternative/supplemental livelihoods will help create entrepreneurs among the locals. Training courses conducted for the local communities will serve to equip them with basic skills and enhance their capacity to seek employment, as well as to empower them to participate in income-generating activities that the Park Management may have for them. Such efforts may help to lessen their dependence on the park resources and reduce the area of cultivated lands inside the park, etc.

A technical committee or task force led by the Natural Resources and Environment Board (NREB) Sarawak has been formed to look into the lake and river pollution issues while the Special Park Committee consisting of local leaders and the land development estates to enable co-management of the study site. The formation of a coordinating body to facilitate a participatory decision making and resources management such as an Integrated Water Resources Management Committee will allow decisions to be made with a more balanced consideration for the socio-economic functions of the park, public benefits, conservation, equity, integration, self-reliance, openness and public accountability.

Training for local counterparts, mainly from government agencies with direct interest in the park, to develop and enhance their skills to enable them to continue performing tasks and activities required to ensure an integrated management of the park so that the biodiversity can be conserved and the resources be utilised in a more sustainable manner.

### **Concluding Remarks**

The government's initiative to conserve the fast depleting PSF and associated wetlands through the implementation of this UNDP/GEF Project should be applauded. The same goes for the Sarawak Government's efforts in protecting the sensitive and unique forest through the gazettelement of the LBNP which comprise PSFs along with complex mosaic of wetland habitats harbouring significant and threatened biodiversity. This move serves to safeguard the only biggest freshwater inland water body in the state. However, given the fragility of these wetland ecosystems, their conservation and sustainability requires not only the wise management of the park itself but also the management of development activities surrounding the protected area. The support and involvement of the local communities as 'co-managers' or 'custodians' of the park is another aspect crucial to the success of the conservation objective. It is only through the cooperation of all stakeholders in dealing with all related issues that the PSF and wetland ecosystems as well as the biodiversity richness can be conserved and managed in a sustainable manner.



## SUMMARY

This series of *Scientific Journey Through Borneo: Loagan Bunut* reports the findings of the Loagan Bunut Scientific Expedition 2004 (LBSE04). The expedition was jointly organised by Universiti Malaysia Sarawak (UNIMAS), Sarawak Forest Department (SFD), and the Peat Swamp Forest (PSF) Project Funded by United Nations Development Programme/Global Environment Facility (UNDP/GEF) from 28 March to 12 April 2004. The aim of the expedition was to study and document the physical, biological and socio-economic aspects of the Loagan Bunut National Park (LBNP) as well as the ecological processes that maintain its integrity. Among the institutions and agencies involved were the Forest Research Institute Malaysia (FRIM), Universiti Pertanian Malaysia, UiTM Sarawak, Curtin University (Miri), the Department of Minerals and Geosciences, Department of Irrigation and Drainage, Ministry of Tourism as well as Sarawak Forestry Corporation. A few foreign researchers, including geologist Dr Chris Hunt from the University of Huddersfield in the United Kingdom, also joined the expedition.

As a follow-up to the LBSE04, the Loagan Bunut Diversity Seminar was organised in Kuching from 2 to 3 August 2004 to provide a forum for the expedition members to share their findings with one another as well as with the public especially those have direct interest in LBNP. A total of 28 papers was presented under five themes: (a) Physical Environment, (b) Biological Environment, (c) Socio-economic Environment, (d) Arts, Culture and Tourism and (e) Medical and Health. The seminar, attended by 179 participants from 34 agencies, was officially launched by YB Datuk Michael Manyin anak Jawong, the Sarawak Minister of Environment and Public Health.

### Physical Environment

The studies on the physical environment of LBNP focused on geology, soil, hydrology, water quality and land use. The geology group (Hunt *et al.* – paper 1) drilled 22 boreholes up to 10m deep in the peat swamp forest (PSF) and two boreholes up to 40m deep at the lake. These core samples showed that LBNP lies on Quaternary marine deposits and had undergone repeated episodes of colonisation by mangrove swamps. The age of both the PSF and the lake is estimated to be about 7,000 years. The lake is said to have formed from the isolation of the lake in a shallow topographic depression after the most recent fall in sea level. Rice pollen detected in the deep core samples suggests agricultural activity of at least 500 years older than that recorded at Niah, and therefore, it is considered to be the earliest evidence recorded so far for this activity in Island Southeast Asia. The boreholes data also show that about 40mm of sediment are added annually to the lake bottom since the 1980's, which coincided with the period of active land development upstream. This rate is about 100 times higher than earlier

periods. It is estimated that the lake will be completely filled-up with sediment in 60 years if the current rates of sedimentation were to continue.

Exploratory studies into the soils and hydrological features of the PSF (Wan Sulaiman *et al.* – paper 2) show that despite the large water storage capacity of the PSF, there is little baseflow into the lake, probably because of the clay deposition in the outer margin of the lake and accelerated sedimentation of the lakebed. This suggests that the PSF is losing its hydrological functions of absorbing water from the lake during floods and releasing water to the lake during dry periods. Hydrodynamic studies of the lake and associated streams (Murtezda *et al.* – paper 3) reveal that the lake is fed mainly by Sungai (Sg.) Teru via Sg. Bunut. The lake will only receive water from Sg. Tinjar when the river overflows during the rainy season. The water quality of Loagan Bunut and Sg. Bunut (Lau *et al.* – paper 4) is generally poor (Class III) and characterised by low dissolved oxygen levels, relatively high ammoniacal-N and very high sediment load. The lake is still subjected to natural inputs of organic matter but anthropogenic contributions to organic and heavy metal loadings are getting more significant (Lau *et al.* – paper 6).

The land use study (Noweg *et al.* – paper 5) reports that about 60% of the area in the upper watershed of Sg. Teru had been cleared for land development and shifting cultivation. Runoffs from these newly opened plantations flowing into Sg. Teru and then to the lake via Sg. Bunut are heavily laden with sediment. Measurement made during the six-day period from 29 March to 3 April 2004 show the sediment flux into the lake was 217 tonnes. Flushing out of these sediments from the lake is not possible because the inflowing streams are too small and the current of water leaving the lake to Sg. Teru (when the level of Sg. Teru is lower than that of the lake) is too slow.

Sedimentation also causes various impacts to the lake and the surrounding environment. The sediment, laden with some agrochemical (fertilisers), forms a good substrate that encourages the growth of the sedge, *Cyperus halpan*, which further impedes water flow and facilitates sedimentation (Isa Ipor *et al.* – paper 10). The sediment also smolders substrates for various aquatic organisms depriving them of their spaces for breeding and food resources.

## **Biological Environment**

Most of the flora studies focused on the PSF. Sepiah *et al.* (paper 7) collected a total of 131 macrofungi samples from the PSF of LBNP. Almost all are saprophytes to dead wood and other plant materials—five species are edible and one species has medicinal value. The family Polyporaceae seems to be most common fungus associated with wood decay. Checksum Tawan *et al.* (paper 8) recorded 97 species of flowering plants and ferns from the peat swamp and riverine forests of Sg. Bunut, including seven species of Dipterocarpaceae which are important commercial timber species. A rare fern, *Platynerium ridleyi*, was declared as a new record for Sarawak. Four genera of orchids were found with a species from genus *Dendrobium* as a potentially new species. Four genera of pitcher plants, along with two hybrids, were found including the endemic peat

swamp species of *Nepenthes bicalcarata*. Regeneration of the PSF after disturbance by logging activities has been generally good (Ismail Jusoh *et al.* - paper 9). However, ramin (*Gonystylus bancanus*) are scarce. In contrast, the riverine forest of Sg. Bunut is considered to be very important with significant occurrence of pudau, *Artocarpus glaucus*, and several species of *Ficus*, which are important food resources for wildlife (Isa Ipor *et al.* - paper 10). The fruits of many plants have fleshy pericarp and seeds containing high protein and fat which are important nutrient for fish and wildlife (Bulan *et al.* - paper 11).

A total of 70 species of fish from 22 families was found in the lake and the stream within the park and its surrounding areas (Nyanti *et al.* - paper 13). The exotic ikan biawan (*Helostoma temminckii*) is the dominant species in the lake. A survey of riverine fishery in LBNP (Nyanti *et al.* - paper 14) reveals that the park is an important fishing ground and the people living in the immediate vicinity of park are dependent on the fish from the park as a source of protein and income. The lake and associated rivers are important spawning, nursery, refuge and feeding areas for freshwater fish. The major threats to fisheries come mainly from changes in land use and unsustainable fishing methods.

Assoc. Prof. Dr. Fatimah Abang (paper 15) recorded 231 species of macromoths from 10 families with Noctuidae and Geometridae being the most dominant. *Leucoma impressa* (Lymantridae), which made up 78% of the individuals captured, is considered the most abundant. Some species, either in their immature stage or adult stage, are important food sources for insectivorous birds and other animals such as lizards, snakes and fishes. Statistical tests show significant differences between the peat swamp and mixed swamp forests in terms of moth diversity.

A rapid survey of LBNP reveals the presence of 18 species of amphibians and 27 species of reptiles, with a few species co-existing in the PSF and lowland forest (Das and Jensen - paper 16). Globally threatened species recorded include the false gharial (*Tomistoma schlegelii*), reticulated python (*Python reticulatus*) and the biawak (*Varanus salvator*). Some of the streams sampled did not have any tadpoles that graze on algae on the rocks as silt covered these rocks. With the absence of the tadpoles, a generation of the stream-dwelling frogs is believed to be extinct.

A total of 92 species of birds, including totally protected and threatened species such as hornbills, great argus pheasant (*Argusianus argus*), lesser fish eagle, and Bornean bristlehead, was recorded at LBNP. The park is home to all the eight species of hornbills found in Borneo, with the black hornbill (*Anthracoceros malayanus*) being the most common. Comparison of mist-net data shows that the diversity of birds in the PSF is significantly lower than that of the fruit orchards or mixed swamp forest (Laman *et al.* - paper 18).

Meanwhile a study led by Assoc. Prof. Dr. Tajuddin (paper 19) encountered nine species of bats and two species of rodents. The single individual of black-capped fruit bat, *Chironox melanocephalus*, found is the fourth record for Sarawak with the last one being a decade ago. Flying foxes are abundant with a conservative estimate of 20,000–

25,000 individuals flying southeastwards in the evenings and northwestwards in the early morning to their roosting site somewhere near an ox-bow lake, Loagan Ibu. Dr. Melvin Gumal of the Wildlife Conservation Society Malaysia states that this roosting area is among the few remaining sites in Sarawak. A salt lick is located near the park Headquarters. Camera traps installed in the area by biologist Mohd. Azlan Jayasilan captured shots of the sambar deer visiting the area. A rare banded civet and a family of pigeon were also caught (by the camera traps) along the Belian Trail while a macaque was captured along the Hydrology Trail.

### **Socio-economic, Arts, Culture, Medical/Health, and Tourism Environment**

The three dominant ethnic groups—the Iban, Berawan and Penan—were co-existing peacefully for generations and able to maintain social, cultural, economic and even political stability in the area. The paper by Dimbab *et al.* (paper 20) suggests that the long-standing resource-use relationship among the Berawan, Iban and Penan communities has been disrupted by the establishment of the Park. Resource conflicts surfaced when what was previously their farmland became part of the park area and thus inaccessible to the communities. The problem was aggravated when the Berawan were given rights to exploit the resources within the park boundaries while the other communities were not. The Penan seem to be the worst-affected and the rapid economic development in the area (eg. Establishment of plantations) does not seem to have improved their livelihood (Mohamad Suhaidi *et al.* – paper 21). They are found to have a high school-dropout rate, with only a few among their community completing their primary education. The majority of families are earning a monthly income of less than RM300 and living way below poverty level even by rural standards.

The ethnobotany group (Noweg *et al.* – paper 22) recorded 70 plant species with medicinal values. The plants were divided into 25 categories of ailments and diseases for which the local communities used them. Among the medicinal plant species were kacid fatimah (*Labisia pumila*) found in the PSF and bintangor, a close cousin of the species used for treatment of AIDS, in the mixed dipterocarps forest. Twenty-five plants were screened for cytotoxicity and six were found to exhibit high level of cytotoxic activity.

In terms of exposure to the soil-borne disease Melioidosis caused by *Burkholderia pseudomallei*, the rate was high among the farming community of LBNP because of their more frequent contact with the soil. There were more among the Penan with seropositive response to *B. pseudomallei* compared to the Berawan (Karim *et al.* – paper 23).

The group studying the art, culture and tourism potentials of LBNP show that the local communities seem to have a varied culture in terms of songs, dances, music, beliefs, handicrafts, livelihood, housing as well as musical instruments. The study by Jussem *et al.* (paper 26) reveals that the Berawan's costumes appear to be influenced by their exposure to the Brunei Malays while their jewelries by the Chinese traders. Their musical instruments and dances follow closely that of the other Orang Ulus (Ng *et al.* –

paper 25). The various natural components of the park and the local culture form potential ecotourism products that are yet to be explored and promoted (Wan Jamarul *et al.* - paper 24). This group believes that the maintenance of these varied cultural elements is crucial as the younger generations are more susceptible to the influences of modernisation especially in their clothing and musical taste. Finally, Manohar *et al.* (paper 27) identifies the natural resources that can be highlighted for tourism interpretive products. These include the Tapang Trail, the Hydrology Trail, thematic boat cruise through the lake and rivers; as well as homestay at Rh. Kajan Sigeh.

## **Recommendations**

The Loagan Bunut Diversity Seminar in August 2004 revealed interesting findings not known earlier such as the formation and estimated age of the PSF and the lake; some rare and/or endemic plant and animal species; as well as the unique culture and traditional practices of the local communities. The researchers believe that the flora and fauna diversity may be richer than what they discovered during the two-week expedition. As such, the seminar recommended that more detailed studies on the various biological and socio-cultural diversity of LBNP be undertaken to unveil and document the richness for the purpose of promoting a better understanding of the unique ecosystem as well as for promoting eco-tourism in Sarawak. With regard to the impact of land use on LBNP, the data obtained may need verification through more detailed and longer-termed studies. It was also recommended that mitigation measures be carried out to reduce sedimentation from land development upstream, thereby prolonging the life of the lake.

## LANDSCAPE DEVELOPMENT AROUND LOAGAN BUNUT, SARAWAK

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### *Abstract*

*Loagan Bunut or the Bunut Lake in the Loagan Bunut National Park (LBNP) is an important geomorphic feature being the largest freshwater body in Sarawak. It is located on a low-lying flat land mostly below 10–12m. An investigation of the terrain accommodating the lacustrine environment determined it to have formed as a back-basin lake that was eventually hemmed in by peat swamp forest (PSF). Its sensitivity to perturbations arises by its shallow depth. Investigations indicate a sudden acceleration of sedimentation. The continuation of which suggests that the lifespan of Loagan Bunut will be shortened considerably. The general water level will also be affected by the destruction of the swamp forest peat. The threat is real and immediate action is required.*

### INTRODUCTION

Loagan Bunut is one of the most important natural features in Sarawak, Malaysian Borneo, since it is the only large freshwater lake in the country. The National Park contains an enormous wealth of important organisms, landscapes and human phenomena, many of which are, in direct or indirect ways, dependant on the continued health and well being of the lake. An assessment of the past history of the lake and its setting, and an evaluation of its future prospects were thus seen as an important part of the overall Peat Swamp Forest Project, UNDP/GEF Funded, at the LBNP.

This chapter describes the geological setting of Loagan Bunut and the evolution, over the last 10,000 years, of the present day shallow lake. It thus provides the natural context for all the other studies documented in this monograph. It also predicts future trends in landscape development and the prognosis for this important lake if current land-use patterns continue.

This chapter contains the results of a multidisciplinary survey and laboratory work by a team of scientists from UNIMAS, the Geological Survey of Sarawak, and the Huddersfield University. The team had the following objectives:

1. To understand the formation and history of the Loagan Bunut and the evolution of its unique ecosystems.
2. To be able to predict the likely future history of the lake and its ecosystems.

## GEOLOGICAL BACKGROUND

The Loagan Bunut basin is a fault-controlled area of subsidence. It is bounded by terrain developed in the Setap Shale and Belait Formations (Banda, 2001). The Setap Shale Formation is of Oligocene-Early Miocene age. The Belait Formation is of Middle Miocene-Pliocene age. Both consist of marine shales with occasional thin sandstones deposited in a Tertiary-Neogene Basin. Banda (2001) describes the dominant fold axes in the region striking NE-SW with structural movements giving rise to faults. The latest folding occurred in the Pliocene followed by major two-phase faulting after which the area is described as stable. The space for Quaternary deposition was most probably formed as a result of erosion of the plunging ends of the synclines, with faulting paralleling the synclinal axes, giving rise to the current valley system.

### GEOMORPHOLOGICAL BACKGROUND

Loagan Bunut occupies part of a flat-floored trough-like valley in locally steep, rugged terrain. Geologically, the valley is a graben and its floor is thus prone to subsidence. Slopes around the basin are most probably landslide-limited, as are most steep hill slopes in Borneo (A.P. Dykes, pers. comm., 2004).

Geomorphologically, Loagan Bunut can be classified as a back-basin lake. These form at the back of the river floodplain as the result of low relative sedimentation rates and general water-table rise. This happens because most sediment laid down by the river is deposited alongside the course of the river during floods where it is trapped by bankside vegetation, which acts as a natural filter. Consequently, comparatively little sediment is deposited further away from the river, even if the flood extends a long way. Areas further away from the river therefore do not accrete as fast as the riverbanks. In time, the level of the river builds up sufficiently that the water table rises above the ground at the edge of the floodplain. This is the origin of most back-basin lakes. They are inherently unstable because during major floods the river may move its course into these low-lying areas. In the case of Loagan Bunut, the formation of peat domes close to the river channel makes this eventuality rather unlikely.

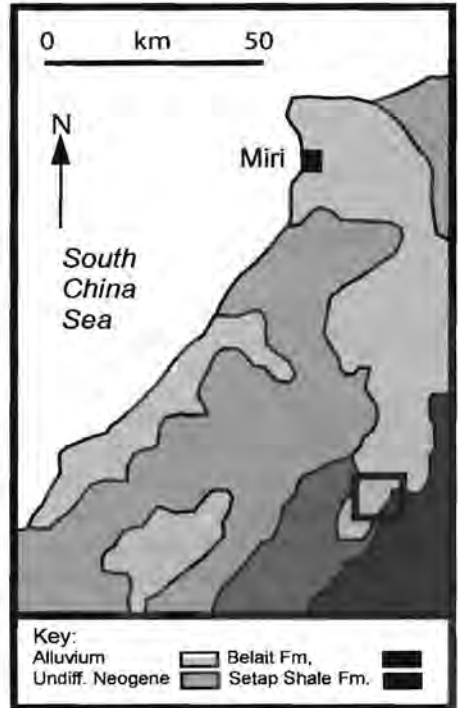


Figure 1: Regional geology of Loagan Bunut.

## PREVIOUS RESEARCH

Very little is known about the vegetational history of Sarawak, or the sequence of landscape development. The only good-quality record of the stratigraphy and palynology of an ombrogenous peat swamp in Eastern Sarawak was produced by Anderson and Muller (1972), who described a single profile from Marudi, which passed down into 4270-year-old mangrove clays at a depth of about 11m from the surface of the peat dome. More recently, Hunt and Rushworth (in press) described the stratigraphy and palynology of boreholes in the lowlands around the Great Cave at Niah. Here, mangrove swamps were replaced by freshwater peat swamps around 7600 BP. The peat swamps were overwhelmed by sediments derived from early agricultural development shortly afterwards.

At Loagan Bunut, two short cores were drilled in the *Cyperus* beds near the new Rest House in 2000 (Hunt *et al.* 2000). The following year, an 11m core was drilled near the middle of the lake at Location A on Figure 2 (Hunt *et al.* 2001). The lake centre core provided an interesting sequence that has subsequently been rangefinder dated and analysed for stable isotopes by Professor M. Bird (pers. comm., 2004). This sequence can be summarised (thicknesses and calendar dates rounded) as:

1. 0.0–1.7m Pale grey-brown dense mottled clay: this clay is the result of inwash of sediments liberated by recent logging around the lake.
2. 1.7–3.7m Dark brown organic detritus mud: this is the deposit of a clearwater lake in a stable forested ecosystem. It dates from c.6500 to c.50 years ago.
3. 3.7–4.3m Dark brown clayey detritus mud. This layer dates from c.6500 to c.7000 years ago. It relates to the lake formation.
4. 4.3–11.0m Grey silts, poorly bedded, with occasional wood. This layer dates from c.7000 to c.8500 years ago.

The sediments of layer 2 were expected, but layers 3 and 4 were unexpected and at the start of this project there was no convincing explanation for them.

The two boreholes in the *Cyperus* beds gave about 4m and 5m of unconsolidated diatomaceous clay, which dates to the last few years and contains ample microscopic evidence of logging in the catchment and consequent algal blooms.

## PROGRAMME OF RESEARCH

It seemed important to commence this research by linking what was found in the centre of the basin with the ombrogenous peats beneath the swamp forest. Two auger transects were made, one from the margin of the raised bog on Transect 2 towards the middle of the lake along the northeast side; and a second to run parallel to the first on the south and west side of the lake (Figure 2). A series of shallow boreholes was drilled near the National Park Administrative offices to evaluate the impact of development on sedimentation. Two deep mechanical boreholes were drilled in the deepest part of the lake basin provide the earlier history of Loagan Bunut.