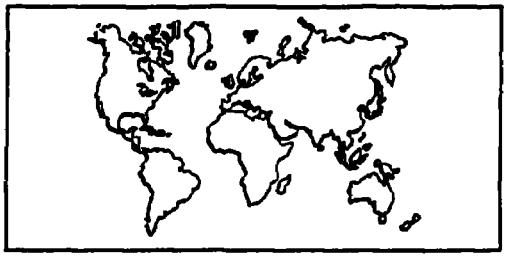
Environmental Assessment/Analysis Reports



Report E0046

Indonesia - Integrated Swamps Development Project

EA Category A

Environmental Impact Assessment

November 1992

This report has been prepared by the Borrower or its Consultant

Second Draft

ENVIRONMENTAL IMPACT ASSESSMENT

INTEGRATED SWAMPS DEVELOPMENT PROJECT

(RIAU, JAMBI AND WEST KALIMANTAN)

Prepared for the Directorate of Swamps (PU)
by
the Asian Wetland Bureau - Indonesia

1 November 1992

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1.0 INTRODUCTION

1.1 GENERAL

The Government of Indonesia, Department of Public Works, has commissioned the Asian Wetland Bureau - Indonesia, to prepare an Environmental Impact Assessment (EIA) for a Second Stage Integrated Swamps Development Project (ISDP) in the provinces of Riau, Jambi (Sumatra) and West Kalimantan, Indonesia.

BCEOM Consultants finalized the Preparation Report describing the proposed project. As a part of the Preparation Report, in accordance with Government of Indonesia Regulation No. 29 of 1986, Environmental Impact Assessment (ANDAL) reports, with Environmental Management Plans (RKL) and Environmental Monitoring Plans (RPL) were prepared. Separate ANDAL/RKL/RPL reports were presented for each of the three provincial project areas.

The World Bank would partly fund the project. The World Bank has a policy on environmental protection contained in it's Operational Directive No. 4.01: Environmental Assessment. *The World Bank has requested that the three existing ANDAL reports be revised and incorporated into a single document.* Additional information on existing environmental conditions and impacts on off-site areas and coastal resources should be included.

The purpose of this document is *to revise the three existing ANDAL reports and present an environmental impact statement consistent with World Bank OD 4.01.* This revision combines and expands on information contained in BCEOM's Preparation Report, and the accompanying Technical Reports, including the three ANDALs. A substantial amount of new information is added. Evaluation concentrates on those aspects and activities of the proposed ISDP Project where significant environmental impacts are most likely.

1.2 THE PROPONENT

The proponent for the project is:

Directorate of Swamps,
Directorate General of Water Resources Development,
Ministry of Public Works.
Jl. Pattimura No. 20
Kebayoran Baru,
Jakarta Selatan, Indonesia.

1.3 PROPOSED PROJECT

The Government of Indonesia, Directorate of Swamps essentially proposes to upgrade the infrastructure of a number of existing transmigration and swamp development schemes in the provinces of Riau, Jambi and West Kalimantan. This upgrade is a part of Stage II of

the Government of Indonesia's approach to development. The major components of the project involve construction and rehabilitation of roads, navigation canals, flood mitigation and water management structures. A number of additional agricultural and social components are also proposed but most of these are considered to have little environmental impact (see section 3.2).

1.4 LEGAL AND ADMINISTRATIVE REQUIREMENTS

The first significant legislation to be passed in Indonesia concerning the environment was Act No 4 (1982) "Concerning Basic Provisions for the Management of the Living Environment". This act included provision for compensation and penalties for environmental degradation (Article 20), a requirement that every activity likely to have an impact must have an Environmental Impact Assessment (Article 16) and provision for the involvement of non-government organizations (Article 19). Legislation specific to EIA has development further through the following legal instruments:

- Government Regulation No 29 (1986) - Analysis of Environmental Impacts states that all planned projects must go through the AMDAL (*Analysis Mengenai Dampak Lingkungan*) process.

  AMDAL is an integrated review process. It coordinates the planning and review of proposed development activities, particularly their ecological, socio-economic and cultural components. If important impacts appear likely, then a preliminary environmental report (*Penyajian Informasi Lingkungan* - PIL) and an environmental impact assessment (*Analisis Dampak Lingkungan* - ANDAL) may be required.

  The regulation also includes a parallel process, *Studi Evaluasi Mengenai Dampak Lingkungan*, or SEMDAL, which applies to projects which were already under way during 1987, but had not yet been assessed for environmental impact. These projects may require a preliminary environmental evaluation report (*Penyajian Evaluasi Lingkungan* - PEL) and an environmental evaluation study (*Studi Evaluasi Lingkungan* - SEL) if important impacts are expected.

- Often, the PIL and PEL reports are not required if ministerial decisions decree that significant impacts are expected. In this case the process moves directly to the preparation of the terms of reference (*Kerangka Acuan* - KA) for the ANDAL and SEL reports. For both AMDAL and SEMDAL process, environmental management plans (*Rencana Pengelolaan Lingkungan* - RKL) and environmental monitoring plans (*Rencana Pemantauan Lingkungan* - RPL) must be produced.

General guidance for AMDAL procedures and report preparation have been established by the State Ministry for Population and Environment and include :

- Ministerial Decree No 49 (1987) - Guidelines for the Determination of Significant Impacts.

  Significant impacts are very basic changes which are caused by any activity. Paragraph (2), Article 3 of PP No 29 (1986) states that impact significance is determined by :

  - the number of people affected by the impacts;
  - the areal extent of the impact;
  - the duration of the impact;
  - the intensity of the impact;
  - the number of other environment components affected by the impact;
  - the cumulative nature of the impact;
  - the reversibility or irreversibility of the impact.

- Ministerial Decree No 50 (1987) - Guidelines for the Analysis of Environmental Impacts of Proposed Projects. It includes the PIL, KA for the ANDAL, ANDAL, RKL and RPL.

- Circulation Letter No 3 (1987) - Procedure for the Mitigation of Pollution and Damage to the Environment. The implementation of any activity must be followed by an effort to prevent and mitigate pollution and/or the destruction of the environment.

Other general environmental legislation includes:

- Act No 5 (1990) Concerning Conservation of Living Resources and Their Ecosystems;

- Government Regulation No 28 (1985) Concerning Forest Protection;

- Government Regulation No 20 (1990) Concerning Water Pollution Protection;

- Presidential Decree No 32 (1990) Concerning Protected Areas

Specific Guidance for AMDAL procedures and report preparation have been established by the Minister of Public Works and include.

- Ministerial Decree No 531 (1989) Guidelines for Screening of AMDAL for Public Works Projects;

- Ministerial Decree No 557 (1989) AMDAL Implementation Guidelines for Public Works Projects;

- Ministerial Decree No 126 (1990) Determination of Project requiring an AMDAL;
- Ministerial Decree No 46 (1990) Technical Guidelines for AMDAL in the Ministry of Public Works; and
- Ministerial Decree No 779 (1990) Technical Guidelines for AMDAL for Swamp Projects.

In the case of the presently proposed project, the environmental requirements for the Government of Indonesia are currently at an advanced stage, with ANDAL, RKL and RPL reports already presented.

The World Bank has been involved in assisting Government of Indonesia with swamps development since the late 1970's. Guidelines for World Bank sponsored projects are outlined in the World Bank Technical Paper No. 139 (World Bank 1991). This paper contains a number of Operational Directives, policies and procedures for environmental assessment. Operational Directive 4.01 deals specifically with environmental assessment of development projects and thus, the current document conforms to the guidelines contained therein.

1.5 STUDY OBJECTIVES

The principal objectives of this Environmental Impact Assessment are:

- Provide a description of the existing natural and socio-economic environment within the area of influence of the project;
- identify the project components which might have a significant impact on the existing natural and socio-economic environment;
- identify the potential impacts of these project components on a local and regional scale;
- identify existing and ongoing negative environmental impacts of the schemes and suggest ways they may be mitigated through project design or environmental management; and
- analyze the net environmental impacts of the project and suggest mitigating measures or alternatives which might alleviate negative impacts.

1.6 STUDY SCOPE

The study encompasses the three project areas in the provinces of Riau, Jambi and West Kalimantan. Although the project administrative boundaries can be clearly defined in most cases, the boundaries of potential environmental impacts may be broad and irregular. For

this reason, the study area includes outside areas of potential impacts, especially where such areas included conservation reserves, primary forest, coastal habitats, neighbouring villages, and local fisheries.

Although the project contains a complex series of components, many of these components are likely to have little or no environmental impacts. Therefore, the study only examines in detail those project aspects and activities that might have a significant impact on the environment.

In addition to the new project components, existing and continuing environmental issues at the sites are evaluated in the light of the proposed project. Possible methods of alleviating existing problems are discussed. These issues include pest control, off-site timber harvesting, threats to endangered species and creation of buffer zones.

The revision of the existing three ANDAL reports was implemented in four months, including three-week field visits to each of the provioncial project areas by a separate team of specialist. Field work filled in most of the important gaps in the available data, and verified other data, but this report is still largely based on existing data, particularly civil-technical information, from the Preparation and Technical Reports.

1.7 STUDY METHODS

Most of the technical data on which this study is based is contained in twenty technical reports prepared by BCEOM and Associates and readers requiring more details of the project should consult these documents. To supplement these data and gain additional environmental information, Asian Wetland Bureau staff undertook field trips to each site during August/September 1992.

The field teams visited all project schemes, and inspected virtually each proposed project activity. Information on the environment at these sites was assessed through observations on vegetation and wildlife, soils, aquatic environment and the range of human activities occurring. The existing regional environment was assessed by noting the type and amount of off-site activities in the area, and the type, quality and extent of natural habitats occurring.

Because of insufficient time in the field, much additional information was gathered from local residents on and off the schemes. At most schemes, discussions were held with village heads or village secretaries about the activities on the schemes, problems and how they are dealt with, and the occurrence of native wildlife in the area. Additional information was gained while travelling through the schemes and talking to farmers, particularly those near areas of influence from the project. Transmigrants, local non-transmigrants, people in adjacent villages, forest concession workers and others were consulted in order to gain an overview of the project setting.

Because of the limited opportunity to collect primary data, much of the information presented was obtained through reports which may have varying levels of reliability. In

the case of wildlife observations, only species which the survey team felt could be definitely identified by the informant are included. To aid in identifications, books containing good colour photographs or drawings of animal species were taken into the field. The books were shown to local people, who were then asked to find the animals they had seen in the pictures. Often this involved a process of elimination, and usually included group discussions. Only when there was general consensus about a species identification and the survey team was convinced of the reliability of the observers, was the species noted as being present.

This method was reliable, as many observers spontaneously provided additional information on the species' habits, which were accurate. Many persons knew the local name of the species. This was noted in each case and verified whenever a specimen was secured. This method was particularly useful for fish identification, since most species were eventually located at markets or with fishers in the field.

In general, it was found that original residents had a far better knowledge of the fauna than the transmigrants.

Throughout this report, topics and issues common to all the project areas have been integrated wherever possible. However, since the project spans four distinct geographical areas, in many cases it has been necessary to deal with these on an individual basis.

2.0 BACKGROUND

2.1 HISTORY OF THE AREA

The wetland area of Jambi and Riau has always been sparsely populated. Only during the last few decades mainly non-Sumatran people: Banjarese, Buginese and Javanese, arrived. Until the immigration of these farmers and fishers, settlements were restricted to some *Orang Laut* villages along the estuaries, Malay settlements on river levees, and *Kubu* tribes in the swampland.

Orang Laut restricted themselves to coastal fisheries and some collection of Nypah and Nibung palms for building houses. *Kubu* collected forest products for daily needs. Only Malays cultivated rice in so-called *huma*, temporarily fields in forest areas along or close to the larger rivers: Batanghari, Berbak, Kumpeh (Furukawa, 1986), Siak Besar, Siak Kecil and Indragiri.

Reclamation of Jambi's vast swampland began with the arrival of the *Banjarese* as of the first half of this century. The first centre of Banjarese migrants was Kuala Tungkal, where they started with the digging of small canals (*parit*) along river courses for the cultivation of tidal, rain-fed rice. During low tide the parits automatically drain acid peat water from the inland swamp forests. During high tide, incoming river water irrigates the rice fields (see, *e.g.*, Tideman, 1937; Furukawa, 1986). Banjarese migrated from comparable wetland areas in Kalimantan, and therefore had experience with wetland reclamation techniques.

Buginese settlers followed the Banjarese in the nineteen fifties and later. Although essentially fishers, they had some experience with wetlands in their homeland Sulawesi, (Furukawa, 1986). They copied the reclamation of swamp forests from the Banjarese, but reclaimed areas on a larger scale. Buginese also started in the Kuala Tungkal area, but moved southward in the sixties and seventies, due to increasing scarcity of land around Kuala Tungkal (Van Son, 1991). In the late sixties and seventies they reached and occupied the coastal area of Berbak, where the ISDP schemes are located. Now this area remains essentially Buginese (Silvius, 1984; AWB Survey Team, 1991).

Land-use practices were not wholly sustainable. In the coastal areas, salination of land because tidal influences, pest problems (pigs, rats, bears, *etc.*), and invasion of grasses and sedges during cultivation have been a problem from the beginning of reclamation. Therefore, many farmers switched to less susceptible coconut cultivation after about four years of rice-cropping. This trend has turned most of the original tidal (non-transmigrant) rice-growing areas into coconut plantations. Much more than their Kalimantan neighbours Buginese see swamp cultivation as a speculative activity. Often, the required money for opening new land comes from sea fisheries and its export-related activities (AWB Survey Team, 1991). For Buginese, the speculative aspect of copra production has played a major role in adjustment of land use. Besides this, they seem less skilled in coping with the emerging environmental problems than Banjarese. Buginese have frequently

abandoned their fields and villages, while Banjarese persist over longer periods at one location.

There is a widespread understanding that in Riau, and possibly also in Jambi, Javanese gave new impetus to cultivation of abandoned fields. Allegedly this would be because of their fixation on rice cropping above all other forms of land use (see Tanaka, 1986), and their ability to turn grassy plains into *sawah* again. Field observations of AWB-teams do not support this. In Jambi's wetlands, especially Javanese often could not cope with the problems of wetland cultivation. Their inability to cope is related to the whole complex of problems associated with transmigration into wetland areas.

Next to agriculture, forest utilization took place since the area was settled. All cultural groups that lived in the area used forest. Most popular were *Jelutung* (wild rubber) for marketing, *Nypah* and *Nibung* (swamp palms) for housing purposes, firewood and (formerly) *Sago* palm (practised by the original Malay; see Tideman, 1937).

From the beginning of this century, sea fishing took place in the coastal area of Muara Sabak, practised by Malay and Chinese that newly came into the area. Riverine fish were also an export product in the first half of the century. Due to the immigration of non-Sumatran communities, (and possibly also to destruction of the freshwater fish stocks), marine and coastal fisheries dominate now.

The Siak area was under the control of the Sultanate of Siak Sriindrapura and the villages near the Siak schemes have existed since the turn of the century. The settlers were mainly Malay who planted rubber and fruit trees and cultivated rice. By the Second World War there was also a significant Javanese and Chinese population.

Most villages in the Indragiri area were in existence at the turn of the century. The market at Teluk Kiambang, the town opposite the scheme which bears its name, was built by the Dutch in 1928. A Swiss owned rubber plantation existed in Pekantua until the Second World War. Many of the labourers were Javanese and when the plantation was destroyed, they stayed in the area. Around 1940, the area near the Retah scheme was opened by Buginese, with Banjarese and Javanese soon following.

2.2 HISTORY OF THE PROJECT

During the last twenty years, the Government of Indonesia has pursued development programs in Riau, Jambi and West Kalimantan. Transmigration has been a part of these programs in both the swamp and the dry land areas. The Government's transmigration program in these areas commenced in the late 1960's and early 1970's. The program, which resettled people from the most densely populated parts of Indonesia in the areas, had two principal aims. Firstly, the program aimed to alleviate population problems by moving people to sparsely populated areas. This program would also help stimulate development in the more isolated provinces.

Indonesia's development strategy proceeds in four stages:

Stage I: An expansion of the area suitable for subsistence agriculture using low cost, simple technology. The Government's role consists of technical services, such as land clearing, construction of uncontrolled drainage systems, houses, bridges, and the provision of supporting services for agricultural extension, education and health care. This stage ends when all production factors are optimally utilized.

Stage II: When production factors established in Stage I are fully utilized, the Government intervenes with capital inputs to improve the hydraulic infrastructure and water management system. At the same time, agricultural extension is strengthened. Problems encountered in the first stage of development can be addressed during this phase.

Other Stages: After another period of consolidating agricultural production a third stage consists of irrigating individual projects by low-lift pumping from unchecked rivers. A fourth stage applies to basin-wide areas and involves the creation of fresh-water reservoirs either upstream from the tidal stretch or in closed off estuaries. At this stage optimum use will be made of land and water resources, crop diversification and the cultivation of commercial crops will reach its highest level.

The Integrated Swamps Development Project (ISDP) is a Stage II development plan, although many of the interventions, particularly the pilot components are considered more appropriate to Stage III development.

The integrated approach takes into consideration a range of project components and constraints including soils, infrastructure, agriculture, institutions and environment.

In Siak, the Siak Kiri scheme was opened in 1978, with about 2,000 households, mostly from Java and some local Malays who were already living there. In 1987, the scheme was handed over to local government, with 1,586 households. The Siak Kecil scheme was settled between 1979 and 1983 with 2,489 households. Severe flooding and problems with deep peat soil discouraged many settlers, who moved to other schemes. At hand over in 1987, only 847 households remained.

In Indragiri, the oldest scheme, Teluk Kiambang, was settled from 1971 to 1975. The other schemes were settled in 1979/80.

Construction work on the five Batanghari-Berbak deltaic island schemes took place from 1969 to 1979, but largely in the early seventies, and transmigrants settled between 1969 and 1981, but mostly in the mid seventies. Four of the five schemes are contiguous, and all are completely surrounded by agricultural land opened by Malay, Banjarese and Buginese who settled the coastal strip since the fifties. The remaining five Jambi schemes were opened between 1979 and 1986 and settled between 1979 and present. These schemes are younger, not contiguous (except Dendang I and II) and border on forest.

Originally, each transmigrant family received 2¼ hectares of land at settlement. The house lot of 100 x 25 meters, usually situated along a secondary canal, and the 100 x 100

m arable land (*Lahan Usaha 1*), directly behind the house lot, were cleared by the Transmigration Department before settlement. The remaining 100 x 100 m of land (*Lahan Usaha 2*) behind the LU 1, retained its original vegetation cover, usually forest. Transmigrants were to clear and till their LU 2 land within five years after settlement. Besides individually owned land, the design of the transmigration schemes provided for Reserve Land (*Lahan Cadangan*) and Green Belts (*Jalur Hijau*) for future development.

Because secondary canals are a standard 500 meters apart, LU 2 land from one secondary canal borders directly on LU 2 land from the next secondary canal. Because of this design, long, finger-like blocks of forest, contiguous with surrounding forest, penetrated the schemes between the secondary canals, for at least five years after settlement. In older schemes this LU 2 forest has been largely or completely cleared, but not so in younger schemes. These blocks of forests inside the schemes are at the base of the pig problem.

Since the early eighties, this standard design was abandoned for one where the LU2 land of all transmigrant families is aggregated in one or more 'corners' of the scheme.

2.3 NEED FOR THE PROJECT

The project is needed in order to address the following problems, which are presently hindering agricultural productivity:

- flooding of fields during the wet season;
- deadlocks in canals, salination and acidification of soil, ground water and canal water because of insufficient water circulation and scheme flushing;
- poor water supply for irrigation of crops during the dry season;
- poor drinking water supply;
- poor road or waterway access to schemes;
- pests, particularly pigs, rats and birds;
- lack of coordination in extension and institutional framework;
- insufficient agricultural knowledge amongst farmers; and,
- lack of manpower and capital input in agricultural systems.

2.4 PROJECT ALTERNATIVES

Project alternatives can be assessed at two levels.

The first alternative is not proceeding with the project. Without the project, the situation in the schemes is likely to deteriorate due to the diverse physical problems of flooding, excessive drainage, lack of water circulation, acidification, salination and lack of maintenance of canals and water control infrastructures. In addition, there are problems with pests and weeds, and inadequate road communications. These would all contribute to an on-going deterioration in crop production. Many transmigrants have left the schemes because of the above problems. Some schemes have declined by over 50% Many of the remaining transmigrants obtain some or even most of their income from off-scheme activities. In the absence of any environmental controls there is likely to be continued degradation of the adjacent forests and other readily available natural resources.

On a second level, there are a number of project activities for which alternatives in design or implementation may prove more efficient or environmentally sound than those currently proposed. Project activity alternatives are dealt with in detail in Section 9.

3.0 PROJECT DESCRIPTION

The complete description of the project, as formulated in the Preparation Report, consists of a one-volume Main Report with an Addendum to the Main Report and an Executive Summary. The Main Report is based on, and extensively refers to twenty Technical Reports, which in turn are based on an uncountable number of field- and other reports. Hence, the following description of the project is necessarily partial, mainly limited to environmentally relevant elements.

3.1 SITE LOCATIONS

The proposed Integrated Swamps Development Project (ISDP) would be located in three provinces: Riau and Jambi on the island of Sumatra, and West Kalimantan on the island of Borneo.

The proposed Riau project area is divided into two geographically distinct sub-project areas, Siak and Indragiri.

The Siak sub-project area comprises two schemes, Siak Kecil and Siak Kiri, located in Kabupaten Bengkalis. The schemes are approximately 90 km northeast of the provincial capital, Pekanbaru and are located along the Siak and Siak Kecil rivers. The nearest large town is Siak Sriindrapura, about 15 km south of the most southerly schemes. Road access to the area is available from Pekanbaru via the "Caltex Road", which has a gravel surface that is regularly sprayed with oil. The Siak Besar River is a major navigation route between Pekanbaru, Bengkalis and Batam Island. The river is navigable by large vessels to 1,000 tonnes. Speedboats and water taxies offer regular services to the sites from Siak Sriindrapura and Bengkalis. The total gross area of the schemes is about 22,000 ha, of which about 6,850 ha is currently cropped.

The Indragiri sub-project area comprises five schemes located on both banks of the Indragiri River between Rengat and Tembilahan, about 210 km southeast of Pekanbaru. Schemes in this sub-project area include Kuala Cinaku I (in Kabupaten Indragiri Hulu) and Kuala Cinaku II, Teluk Kiambang, Tempuling and Retah (in Kabupaten Indragiri Hilir). The schemes located on the south side of the Indragiri River are serviced by a new provincial road, which is currently asphalted as far as the Teluk Kiambang scheme. Another asphalt road on the northern side of the river links the town of Teluk Kiambang with Tembilahan. Alternative access to all schemes is available by boat along the Indragiri River. The total gross area of the schemes is about 16,800 ha, of which about 10,350 ha is currently cropped.

The proposed Jambi project area comprises ten swamp schemes located in Kapubaten Tanjung Jabung about 80 km northeast of Jambi, the provincial capital. These swamp schemes can be conveniently divided into the Batanghari-Berbak deltaic island schemes (Muara Sabak, Lambur, Pamusiran, Rantau Rasau, and Simpang Puding) and the Batanghari and Lagan river schemes (Dendang I, II and III, Simpang Pandan and Lagan

Hulu). The total gross area[1] of the schemes is 43,370 hectares of which 27,546 ha are currently cropped.

The West Kalimantan project area comprises schemes to the west of Pontianak, the provincial capital and twelve schemes to the southeast of the city. Both sub-project areas are located in Pontianak Kabupaten. In the western sub-project area the schemes are Kapuas Kecil II and III, Kalimas, Jawi, Sei Betutu and Punggur Kecil. The total gross area is about 19,000 ha of which 13,930 ha is currently cropped. The eastern sub-project area consists of the schemes of Rasau Jaya, Pinang Luar, Pinang Dalam, Sei Radak, Sei Bulan, Jangkang I, Olak-Olak Kubu, Desa Kubu, Air Putih, Arus Deras and Sei Nipah. They are located in the delta formed by the Kapuas, Punggur Besar, Ambawang, Kubu and Terentang Rivers. The closest scheme, Rasau Jaya is some 43 km from Pontianak. The total gross area of the schemes is 27,125 ha of which 17,325 is currently cropped.

3.2 OVERVIEW OF PROJECT COMPONENTS

The project would consist of eighteen[2] main components which will be implemented over a five year period. The following project components are identified (components marked with a • [filled dot] are deemed environmentally significant and discussed in some detail further in this Chapter):

- • Upgrading and rehabilitation of existing hydraulic infrastructure for irrigation and flood mitigation (canals, dikes, river channelization and various flood control devices); construction of new hydraulic infrastructure; and construction of pilot irrigation systems.
- o Upgrading of hydrometeorological network.
- • Improvements to transport and navigation systems (road and navigation canal improvements).
- • Upgrading of base camp facilities in Riau.
- o Improvement of potable water supply through provision of rainwater tanks, upgrading water treatment stations (Jambi) and piped water network (West Kalimantan).
- o Introduction of efficient Operation and Maintenance.

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1 References to the total area of the ten Jambi schemes range from 39,198 ha (TR5, Tab.3.1, p.63) to 52,687 ha (TR14, Tab.2.1, p.12).

2 The Preparation Report mentions and lists only seventeen project components. Here we include the upgrading of the Riau Basecamp, omitted in the project description.

- Strengthening of agricultural support services, formation of a Water User's Association (WUA), improvement of seed supplies, and alleviation of constraints caused by agricultural pests.

- Support to Estate Crop Production in coconut production and improvements to copra production and marketing.

- Aquaculture development.

- Support of agriculture research by the Agency for Agricultural Research and Development (AARD).

- Support of agro-industry activities to identify household and small-scale activities suited to the project area and to provide assistance to assure its viability.

- A pilot credit component to investigate alternative mechanisms for the dispersal and collection of short term production loans.

- Support for assisted supplementary settlement in selected schemes. This depends on the results of detailed studies of the potential for such resettlement.

- Non-formal education component to improve literacy, with emphasis on women.

- A rural health program throughout the schemes, with emphasis on the needs of women and children.

- A Women in Development programme.

- Institutional strengthening to improve the capability of provincial and district agencies.

- An environmental component to supervise project implementation and monitor its impacts.

3.3 ENVIRONMENTALLY SIGNIFICANT PROJECT COMPONENTS

Many of the project components are likely to have little or no impact on the environment. They are not considered in detail in this assessment. All components are designed to provide significant social benefits and thus could be regarded as having a positive impact on the socio-economic environment of the people involved.

The following project components have more or less potential for environmental impact and are therefore dealt with in detail. Four appended Maps (1A-4A) detail the significant

project activities for the four areas. Appendices 1 and 2 present a summary of the type and volume of project activities in the Jambi and West Kalimantan project areas. Table 9 in Chpater Seven shows a summary of proposed earthwork volumes.

3.3.1 Upgrading of Hydraulic Infrastructure

This aspect of the project is essentially designed to overcome the four most important environmental problems faced by the transmigrants, that of inundation during the wet season, insufficient water for cropping during the dry season, deadlocks in canals or insufficient circulation, and saline intrusion. The project proposes to either renovate existing hydraulic structure where appropriate, or install new hydraulic structures.

The following is a brief description of the design and purpose of the major hydraulic components of the schemes:

Dikes

Dikes are raised, long mounds of earth, typically 1-2 meters high and of variable width. Almost all dikes in the proposed project will be constructed from whatever soil material can be excavated at the site of construction. No earth is transported. Nor is earth excavated from any proposed canals, used to build dikes. Therefore, locally available soil material determines the quality of dikes. This method always leaves the equivalent of canal or drain at the foot of each dike. In some Indragiri schemes dikes can be built from the readily available supply of river sand.

The principal function of a dike is flood mitigation during the wet season. Dikes are located so as to protect fields from inundation from an adjacent river, the sea, or an adjacent peat swamp forest. Because of the raised design, dikes are often used for vehicular transport, usually bicycle or motorbike. Some of the proposed roads are on dikes. In some schemes, dikes and their associated canals were reported to have reduced pig numbers entering the scheme.

Canals

Canals are classified according to function, branching order and size. Based on function, navigation, supply and drainage canals are distinguished. Often the same canal performs more than one function, *e.g.*, navigation-supply or supply-drainage, or schemes lack one or two functional types. By branching order, one may distinguish primary, secondary and tertiary canals. Primary canals, whether supplying and/or draining water, usually connect to a river but often to a navigation canal. Secondary canals usually run perpendicular to the primary canals from which they stem. Primary and secondary canals are often blind (dead-ended) but may connect two rivers, respectively two primary canals. Finally, tertiary canals, again perpendicular on the parent canal, deliver water to the fields or drain them.

Six size classes seem to be distinguished, largely paralleling branching order. Yet, branches of the same order may vary greatly. Navigation and primary canals are always largest: 20-40 meters wide and 3-5 meters deep. Secondary canals are usually intermediate (but often differ little from primary or tertiary canals): 2-20 meters wide and 1-3 meters deep. Tertiary canals are usually smallest: when present or discernible 1-2 meters wide and 0.5-1 m deep.

Local usage of terms may not always conform to this terminology. In West Kalimantan, branch order names are based solely on size, and 'secondary' canals may lack: there tertiary canals connect to primary canals.

Dikes, navigation, primary and secondary canals always expose pyrite or peat when present, and then require mitigation measures.

Canals serve a dual purpose of wet season drainage of floodwaters, and dry season irrigation of fields. Apart from typical rain-fed irrigation, tidal irrigation is practised on many schemes. In this situation, the canals are filled by water from the river on the incoming tide (usually upstream of salt influence) and then are blocked off at the mouth so that the fresh water is available for irrigation.

Flap Gates

Flap gates are automatic one-way flow water control structures which are designed exclusively for flood protection at high tide and drainage at low tide. They are normally designed not to let the tide in, but can be modified to do so with the addition of a winch. Flap gates are typically placed at the entrance to secondary and primary canals.

Sluice Gates

Sluice gates are manually operated flood protection structures. They are not suitable for remote areas since they require the presence of an operator. The use of sluice gates is limited to storage of tidal or rain water during the dry season, or for semi-permanent closure of canals in the wet season. Sluice gates are usually located on primary or secondary canals. Sluice and flap gates are combined in construction in some situations.

Stop-Logs

Stop-logs are smaller, cheap manual structures consisting of a sliding gate which is removable without the help of a winch. Because of the manual operation, these gates are implemented only on small tertiary canals.

Permanent Earth Closures

Self explanatory.

Off-take Structures

Off-take structures are smaller constructions across tertiary canals for gravitational distribution of irrigation water on a rotation base. They are only proposed in the two pumped irrigation pilot projects in Pamusiran (Jambi) and Siak Kiri (Riau).

3.3.2 Improvements to Transport and Navigation Systems

Roads, Bridges and Jetties

Road upgrades range from simple earthen roads along or on existing dikes, to asphalted roads of 6 meters width. The present road network in many areas is restricted to transport by motorcycle, bicycle or on foot.

Most bridges on the sites are currently of wooden design and many are in a dangerous condition. Concrete bridges are favoured for upgrades on the various schemes. The various bridge designs are detailed in TR 12, p.33.

Jetties would be newly constructed or upgraded according to their present condition and location. TR 12, p.31 provides details on jetty designs in the schemes.

Navigation Canals

Some (primary and secondary) canals are used for navigation by boat, including sampans, speedboats and pompongs. Some canals are also built specifically for this purpose, or for the dual purposes of navigation and flood mitigation.

3.3.3 Upgrading of Base Camp Facilities in Riau

Base camp facilities at Siak Kiri would require upgrading in order to accommodate the workforce required for the project. The base camp, located at Buantan is currently in a state of disrepair.

Upgrading would consist of renovating or reconstructing the already existing buildings and facilities.

3.3.4 Strengthening of Agricultural Support Services

In this section, the main issues of environmental concern are in the implementation of pest control measures:

Perimeter Pig Fence

Wild pigs are a serious threat to the viability of the schemes because of the damage they can cause to crops. At present individual farmers protect thjeoir crops with bamboo fences around individsual fields. This increases the fence-length to protected-land ratio enormously. It is considered more efficient to look for a collective solution. The project therefore proposes that a fence be built around the perimeter of all schemes in order to

prevent access to the fields by pigs. This involves 571.5 kilometres of fence, requiring and estimated 142,875 m^3 of rock for the foundation, for all thirty-four schemes.

The pig fence would be of chain link construction in a rock and masonry foundation, or with underground sheet piles. The fencing would be integrated with the road and drainage systems, having animal grids where it crosses roads.

Rat Control

Rats are a major problem at many schemes. A research component would develop, and test in a field situation, a chemo-sterilant, and palatable bait and study rat population dynamics on ISDP schemes, all in the project's first year. Three compounds would be investigated on their suitability as chemo-sterilant: an orally active androgen[3] (methyl-testosterone), a highly potent gestagen[4] and α-fluorohydrin. The latter chemical has not yet been tested in Indonesia.

Greater coordination of eradication efforts and systematic baiting, would control rats in the second (selected schemes) and third (all schemes) year of the project. Concurrently an extension, demonstration and training programme would organize farmers. Application of rodenticide on 1.2-2 hectares (rice) farms would increase from zero in the first year, to 2.5 kilograms in the second and third years, and then gradually decrease to 2.0, 1.5, 1.0 and 0.5 kg in years four to seven.

Weed Control

Weeds are a serious problem in many schemes, primarily as a result of farming methods (no puddling) and labour shortage. Aquatic weeds in canals and rivers are also a serious problem in some schemes, because they reduce water flow and navigation. The project proposes zero tillage methods, *viz.* pre-planting spraying with a mixture of 1½ litre glyphosate (Roundup®) with one litre of 2:4-D (U-46®) or MCPA[5], instead of weeding by hand. When sprayed, weeds should be young, unwilted and growing vigorously, *e.g.*, in September-October. Optionally, heavy weed growth or weeds after flowering may be controlled by slashing (and burning) 3-4 weeks before spraying, to induce foliage growth at spraying time (TR5, p.33-34). A point of particular attention in the land development component would be improvement in the supply of agro-chemicals, including herbicides (TR5, p.93). Proposed Technical Demonstration Units would, among others, demonstrate weed control in pre-planting (TR5, p.96) and post-harvesting stage and in perimeter management. Weed research involves testing specific herbicide packages known to be cost effective, but little practised in Indonesia. Research should investigate concentrations and

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[3] The androgen, incorporated in paraffin wax, causes immediate and lasting infertility in females, and aggression in males.

[4] The -unspecified- gestagen inhibits ovulation and parturition, leading to the death of newborns.

[5] Note that other herbicides than the quoted tradenames and brands, contain the proposed active substances.

ratios of different combinations of glyphosate, 2:4-D and MCPA (TR5, p.107-108). The project does not propose specific measures to control aquatic weeds.

Insect Pests and Plant Diseases

Although insect pests and plant diseases occur in all ISDP schemes, they are not as important a problem as they are in the intensive rice producing areas of Indonesia (TR5, p.34). The preparation reports do not detail pest species, diseases, or damage levels[6]. There are no explicit references to specifically insect control or pesticides to be used, except in costing tables and farm model tables.

3.3.5 Aquaculture Development

Aquaculture is not widely practised in any of the ISDP schemes. Poor soil and water quality, the farmers' insufficient knowledge, experience and skill, inadequate capital and management, and shortage of labour and fish fry are the causes. Improved drainage infrastructure, though primarily designed for flood protection, would indirectly address poor water quality. Direct interventions would consist of (1) a technical support programme, (2) an extension and training programme, and (3) strengthening of the aquaculture support system.

Under the technical support programme one hatchery centre would be developed in Rantau Rasau (Jambi), Teluk Kiambang[7] (Indragiri, Riau) and Sei Kakap (West Kalimantan) each, to improve fry supply. A total of forty-seven demonstration ponds in selected schemes would demonstrate different pond designs, their construction, and operation (including otter control), and water quality management (liming, flushing). The technical support programme also includes research facilities in selected sites.

The extension and training programme, which will channel the results of the aquacultural research, is directed to extension workers and key farmers. The programme involves five training courses (pond construction without Potential Acid Sulphate Soils; pond management; rice-field and livestock-fish culture; fish processing; and institutional development).

Improvement of the support system involves establishment of fish farmers groups, processing and marketing, credit availability and consulting services.

3.3.6 Supplementary Settlement Scheme

The project would support the supplementary settlement of about 400 families in Jambi, about 870 families in West Kalimantan and about 600 families in Riau (Siak Kecil). In

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[6] The 'Baseline Study for Riau' (TR3) mentions a number of insect pests and plant diseases by substantive -not specific- name, as *perceived* by the farmers.

[7] Note that a dysfunctional hatchery exist in the Teluk Kiambang scheme (not town).

Jambi, about 200 families would be settled in each of Simpang Pandan and Lagan Hulu. In West Kalimantan they would be distributed as about 175 in Rasau Jaya III, 150 in Pinang Luar, 125 in Arus Deras, 120 in Pinang Dalam, 50 in Jangkang I, 175 in Air Putih and 75 in Desa Kubu.

Land suitable for settlement would be identified through Survey and Investigation of Rights (by National Land Board) and appropriate soils and topography surveys.

3.3.7 Environmental Component

This component consists of environmental management and monitoring of the project and would be implemented through the Directorate of Programme Planning. The environmental management component would be implemented during the construction phases of the project, the purpose being to reduce the environmental impacts during this critical stage. Environmental management would include:

- supervision during civil works construction to minimize the negative impact on crop production;
- assessing the need for compensation arising from any damage; and
- training of extension workers in the correct use of agricultural chemicals.

Project monitoring studies would be undertaken during the third and fifth years of the project to determine its impact and to identify any problems

4.0 EXISTING PHYSICAL ENVIRONMENT

4.1 CLIMATE

All project schemes are located on coastal plains with a tropical climate characterized by permanent high temperatures, absolute and relative humidity (always above 90%) and precipitation. Monthly temperature variations (26-27 °C) are negligible compared to daily variations. Monthly rainfall varies greatly and all project schemes experience at least one pronounced, long wet season (centred around November and December, with a second peak around April) and one mild, short 'drier' season (about June to August).

4.1.1 Riau

The Siak sub-project area has an equatorial rainfall distribution characterized by two peaks of rainfall and a weakly developed dry season. There are 7-9 consecutive months with a monthly rainfall more than 200 mm, and less than two months with rainfall less than 100 mm. Average annual rainfall in the Siak area is about 2,300 mm.

The Indragiri sub-project area is also located in the equatorial zone, but is characterized by a single rainy season and one dry season. Average annual rainfall at Rengat, near the schemes, is 2,230 mm, temperatures vary between 26.0 and 27.6 °C (Table 1 and Figure 1) and humidity is a constant 98%.

Average annual sunshine hours are about 50-52% or 1900-2000 hours. During the main wet season, October-January, they are lower at about 38-45% or 4.0-4.9 hours per day.

4.1.2 Jambi

A single, five to six months wet season and a mild dry season of less than two months characterize the Jambi project schemes. November and December are the wettest months, June to August the driest (but still over 100 mm). Mean annual rainfall is 2,202 mm. Table 1 and Figure 1 give average monthly rainfall figures over the period 1960-1989, for Jambi airport, *ca.* 80 km south-west of the project schemes.

Mean annual temperature is 26.5 °C, with monthly maxima between 32.4 °C (June) and 30.0 °C (January) and monthly minima between 22.3 °C (January) and 23.3 °C (May). Average annual sunshine hours are 52% or about 2,000 hours. During the wet season (October to April) sunshine hours are lower at about 45% or 4.9 hour per day. The growing season for both annuals and trees is about 9 months per year in the area of the schemes.

4.1.3 West Kalimantan

The Kapuas coastal swamplands have a yearly rainfall of approximately 3,053 mm with highest monthly precipitation between October and December. This is correlated with the reported floods at the project schemes in the months of December and January. However,

total precipitation increases towards the area south of Kubu. Driest months, but still with more than 100 mm, are June to August.

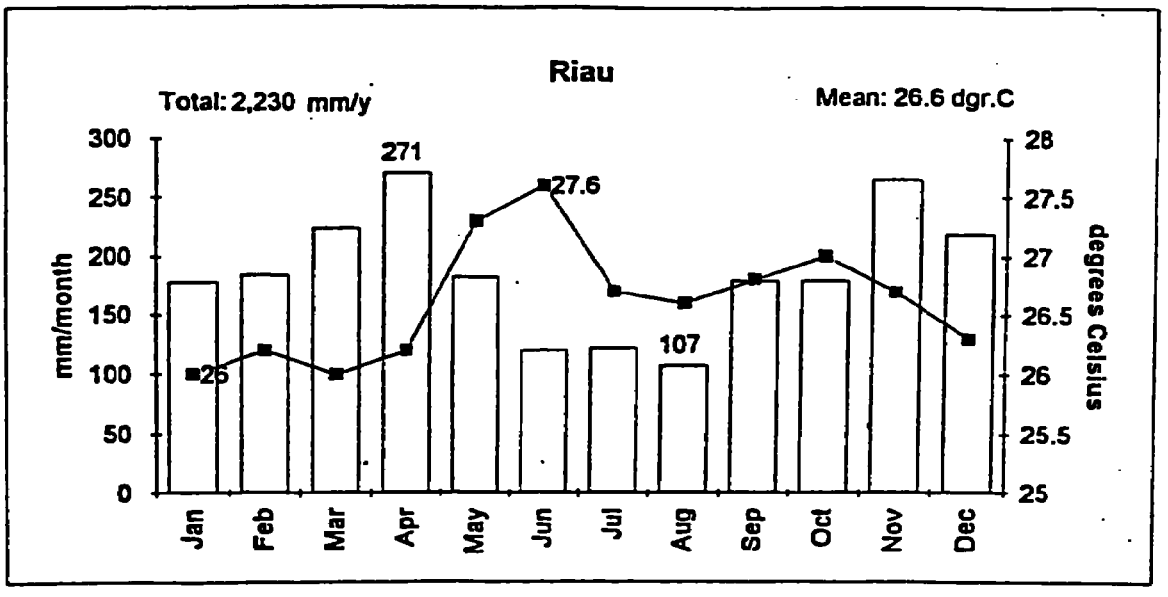
West Kalimantan temperatures vary little, with monthly maxima of 29 °C to 33 °C and mean monthly minima of 22 °C to 26 °C throughout the area. Relative humidity is high, between 83% and 91%. On average the growing season is about 8-10 months long in this coastal region.

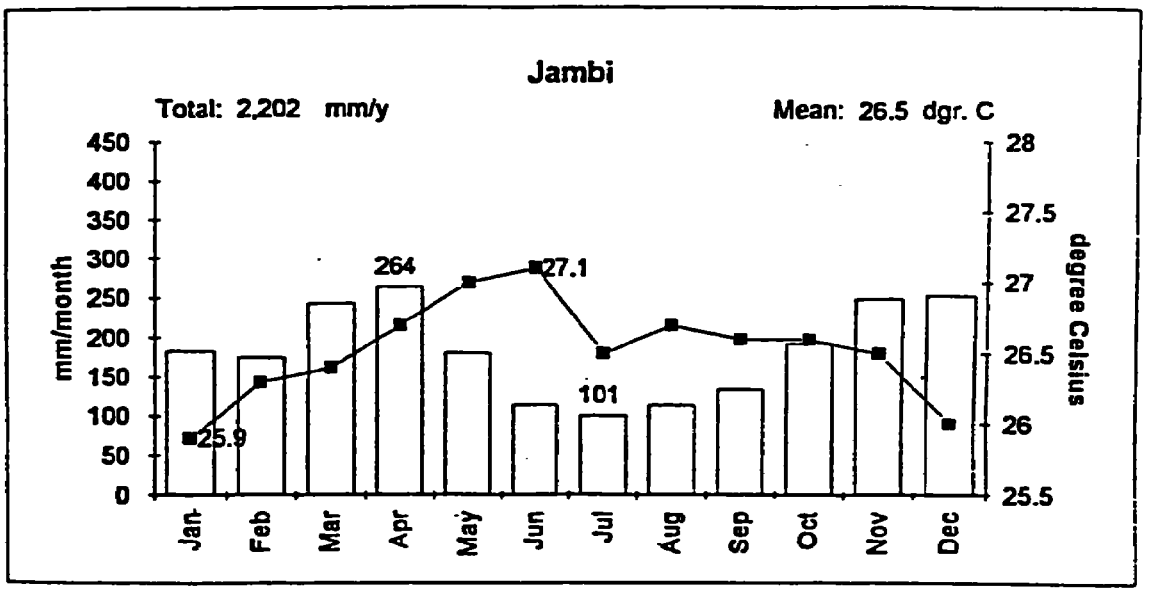
Table 1: Rainfall and temperature data for Rengat (Indragiri, Riau), Jambi (airport), and Pontianak (airport). Observation period 16-30 years.
(Source: rainfall: TR 1; temperature: RePPProT, MUN 1992)

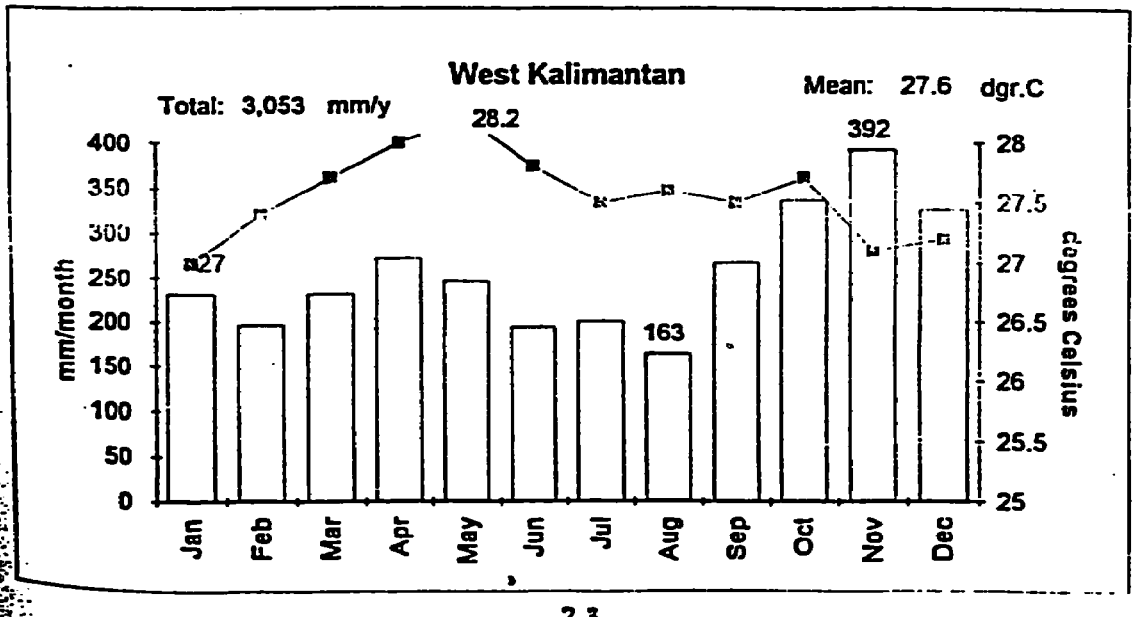
	RIAU		JAMBI		W KALIMANTAN	
	Rainfall	Temperature	Rainfall	Temperature	Rainfall	Temperature
Jan	178	26.0	183	25.9	231	27.0
Feb	184	26.2	175	26.3	196	27.4
Mar	224	26.0	243	26.4	231	27.7
Apr	271	26.2	264	26.7	272	28.0
May	182	27.3	181	27.0	246	28.2
Jun	120	27.6	114	27.1	193	27.8
Jul	122	26.7	101	26.5	200	27.5
Aug	107	26.6	113	26.7	163	27.6
Sep	179	26.8	134	26.6	267	27.5
Oct	179	27.0	193	26.6	336	27.7
Nov	265	26.7	248	26.5	392	27.1
Dec	219	26.3	253	26.0	326	27.2
Mean	-	26.6	-	26.5	-	27.6
Total	2,230	-	2,202	-	3,053	-

4.2 GEOLOGY

The Jambi and Riau Project areas are part of the extensive swampy coastal plain of Sumatra. Geologically this coastal plain is a part of the huge basin (synclinorium) lying parallel and to the north of the anticlinorium which stretches from the town of Kotatengah via Pekanbaru and Air Molek to Jambi. It is filled with volcanic tuffs and erosion products of the Barisan mountains. The synclinorium was subsequently covered with marine and alluvial deposits.


Riau
Total: 2,230 mm/y
Mean: 26.6 dgr.C
mm/month
degrees Celsius
271
27.6
26
107
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Jambi
Total: 2,202 mm/y
Mean: 26.5 dgr. C
mm/month
degree Celsius
264
27.1
25.9
101
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


West Kalimantan
Total: 3,053 mm/y
Mean: 27.6 dgr.C
mm/month
degrees Celsius
28.2
392
27
163
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

The project areas in Sumatra consist mainly of quaternary alluvial and delta deposits of the Batanghari, Siak, Siak Kecil and Indragiri rivers and their tributaries although in the northern parts of the Siak schemes and, extensively in the Indragiri schemes, thick marine deposits of mainly clays have been found under the peat layers.

Due to a slow transgression of the sea during the Post-Pleistocene era, a tidal swamp regime developed near the coast, with high tides entering the Lagan, Batanghari, Berbak and Pamusiran rivers in Jambi as well as the Siak and Indragiri rivers in Riau. Inundations took place, forming peat soils in the backswamps. In the delta areas the peat developed mainly in the depressions in the middle of the "islands", and predominantly reached a thickness of less than 2 m. In the inland areas huge peat domes with a thickness of more than 10 m commonly developed. Many of the schemes are situated on the fringes of these domes.

The West Kalimantan Project area has the simple physiography of alluvial floodplains, comprising broad but low levees, peat-covered basins and an advancing shoreline of intertidal mudflats. The floodplains consist almost completely of quaternary alluvial and delta deposits of the Kapuas River and its tributaries.

As in the other project areas, due to a slow transgression of the sea during the Post-Pleistocene era, at near-coastal sites a tidal swamp area developed with high tides entering the estuaries up to 20 km inland. Between these wide estuaries deep oligotrophic peat deposits (peat domes) have developed on top of these clay basins, reaching height of 5-10 m above mean river level, and up to 10 meters thick in the oldest and most developed swamps. Towards the coast and river margins the peat gradually becomes less thick.

Scattered as isolated hilly 'islands' protruding through the swamplands of the region are intrusive granites. Very conspicuous in the West Kalimantan area are the Ambawang mountains (412 m high) north of the Ambawang river forming an inselberg consisting of acid granite, and the source of the only non-peaty freshwater streams of importance (Air Putih, Arus Deras).

4.3 SOILS

There are three basic soil orders in most coastal swamp areas:

- Marine alluvial deposits; alluvial soils that have been acted upon by saline or brackish water for long periods of time (Inceptisols or Fluvaquepts - USDA, 1975).
- Fresh water alluvial deposits; recent and sub-recent alluvial soils from inland, not influenced by sea or brackish water (Entisols or Tropaquents - USDA, 1975),

- Peat soils; organic soils formed from partly decomposed detritus from swamp vegetation. Peat soils range from pure organic peat to soils with a high admixture of mineral material (Histosols or Tropofibrists - USDA, 1975).

In general, marine deposits occur below the two other soil orders and are more or less permanently waterlogged. After drainage marine soils become very acid and are called acid sulphate soils. Before drainage when they are not exposed, the same soils are called potential acid sulphate soils (PASS).

Acid sulphate soils come into existence after drainage and aeration of originally waterlogged soils that contain sulphur (mostly as pyrite - FeS_2). Sulphuric acid is formed which is partly neutralized by soil mineral and partly leached. The remaining acid lowers the soil pH to levels were Aluminum, Iron and Manganese dissolve causing toxicity to plants and fish.

Quantities of pyrite present in PASS soils may be in the range of less than 1% to more than 6%. Soils with more than 1.4% pyrite (sulphuric) are capable on drainage of producing high amounts of acid (up to pH 2.5) and toxic levels of metals.

Histosols (or Tropofibrists) have a high content of organic matter and usually have a CN-ratio (organic content) of more than 30% and an acidity of pH 4 or less (acid). Histosols always contain peat, and can be many meters deep in some areas. Peat has an enormous capacity to hold water, so that even in the dry season, peat soils can contain large amounts of fresh water. Peat has a low *vertical* permeability to water, but a high *horizontal* permeability.

Concave "peat domes" form in areas of deep peat soil and these become elevated above the surrounding land and rivers. Therefore, the water supply to these domes can only come from rainwater and not from rivers. Consequently, these peat domes, and the forests on them, are relatively nutrient poor, as tropical rains leached the peats for centuries.

These Histosols are usually waterlogged or inundated the whole year round. They can only be utilized for agriculture if the peat water is removed. This will, however, cause soil subsidence, which, depending on the peat depth, may amount to several meters.

Classification of soils according to their Great Soil Groups (USDA 1975) within the schemes reveals some quite distinct differences between project areas, even though they are of similar origins:

- In Jambi the major great groups are Troposaprists (about 56% of the project area), Tropoquepts (21%), Fluvaquents (9%) and Tropohemists (9%).

- In the Siak sub-project area the main great groups are Tropohemists (37%), Tropoquepts (31%), Humaquepts (17%) and Troposaprists (12%) whereas in Indragiri they are Fluvaquents (35%), Tropohemists (29%), Troposaprists (15%), Haplaquents (5%) and Sulfaquents (5%).

- In the West Kalimantan project area the main great groups of soils are Tropohemists (35%), Tropoquepts (19%), Sulfihemists (12%), Sulfaquents (11%) and Haplaquents (6%).

There is a considerable range of subgroups within each of the project areas. Swamp mineral soils typically account for about 44-51% of each project/sub-project area with the remainder of the area a mixture of peaty mineral and peat soils.

Soils throughout the project area are excessively acid and very strongly acid (pH 3.6-5.0). Peat depth is typically up to 150 cm although depths in excess of 400 cm are found to a limited extent throughout the project area.

Other than in the Siak sub-project area, pyrite layers occur throughout the project area.

In Jambi, pyrite layers within 150 cm of the surface occur in all schemes and represent 6% of the total project area.

In Indragiri, about 6% of the area has a pyrite layer within 50 cm of the surface, 24% in the range 50-100 cm. 43% below 100 cm and 27% has no detectable pyrite layer.

PASS soils occur very frequently in West Kalimantan (Map 4C, Environmental Issues), with over 55% of the project area (up to 200 cm soil depth). About 55% of the schemes soils is classified as peat soils, with a peat horizon of more than 40 cm. About 10% of the total ISDP project area has soils with peat thicker than 150 cm.

Soils are chemically moderately to highly fertile in Jambi and Siak, slightly less fertile in Indragiri and least fertile in West Kalimantan. However, throughout the project area soils were found sufficiently suitable to support production of agricultural crops.

4.4 LAND SYSTEMS

Land systems are units of land that show similarity in micro-climatic condition, land form, soils, geology and natural vegetation. The most widely used basis of land system classification in Indonesia is that proposed by RePPProT (1987, 1988). The following RePPProT land systems occur within the region of the project schemes, of which the first two land systems (Mendawai and Kahayan) are by far the most important by area:

- Mendawai (MDW): peat land with peat depth of 50-200 cm, originally covered with peatswamp forest;

- Kahayan (KHY): lowland estuarine or river plain with sandy soils, relatively close to the coast. Soils are a combination between alluvial and marine sands, while locally shallow peat may occur. The land is regularly flooded, but flooding is not usually severe. Severe flooding can be expected every 50-100 years. Originally covered with freshwater swamp forest and riverine forest;

- Gambut (GBT): deep peat land (peat layer more than 2 m deep), usually forming domes. Originally, the land was covered by peatswamp forest;

- Klaru (KLR): permanently waterlogged, peaty floodplain. Flooding may occur, but does not harm the system. Swamp forest is the natural vegetation;

- Sebangun (SBG): meander belts of large rivers with broad levees. Seasonally inundated. Originally covered with swamp forest;

- Beliti (BLI): swampy floodplain in narrow valleys with sandy or clayey soils, forming permanent lakes, or at least permanently inundated. Flooding may occur, but will not harm the system. Originally covered with swamp forest.

- Kajapah (KJP): inter-tidal mudflats with Sulphaquent (PASS) soils. The land and ground water are saline due to continuous influx of sea water at high tide. Naturally the land is covered by mangrove forest and other beach vegetation.

- Muara Beliti (MBI): undulating to rolling tuffaceous sedimentary plain, with slightly acid fine sands, without flooding (only one area between Dendang II and Lagan Hulu [around the Telur Hill], and one area on the right bank of the Berbak River opposite Simpang Puding, Jambi).

- Sungai Aur (SAR): hillocky plains on tuffaceous sediments in wet areas, with slightly acid fine sands, with some flooding (only one small area in Dendang II, Jambi).

Riau

In the Siak sub-project area, the main land systems are Kahayan along the Siak Besar River, Klaru and Mendawai along the Siak Kecil River, and Mendawai and Gambut in areas on or adjacent to the schemes.

In the Indragiri sub-project area, the principle land units are Kahayan and Sebangun along the Indragiri River, Beliti in the Kuala Cinaku area, and Mendawai in areas further away from the river systems.

Jambi

The deltaic 'island' between the Berbak and Batanghari Rivers, where five of Jambi's ten ISDP schemes are located, consists almost completely of the Kahayan land-system. There, only narrow zones of Kajapah mudflats occur along the coast (under the Pantai Timur mangrove reserve) and the coastal part of the Pamusiran River.

The remaining five schemes are located south and west of the Batanghari River, but still on the extreme fringes of the Kahayan land system, and close to the Mendawai land-system that dominates the land south of the Batanghari River. Parts of Lagan Hulu are located in Mendawai and a western part of Dendang II in Sungai Aur and Muara Beliti land systems.

West Kalimantan

The western sub-project area is completely situated in the Kahayan landsystem, with large areas of PASS soils. The coastal mangroves and Nypah formations along the Kapuas and Punggur Besar rivers is characterized by the Kajapah landsystem.

Sei Nipah of the eastern sub-project area is located in the Kahayan type. Rasau Jaya (I, II and III), Sei Radak, Olak-Olak Kubu, Sei Bulan, Pinang Dalam occur in the Mendawai landsystem with moderate peat underlain by PASS soils. Schemes like Pinang Luar and Arus Deras are on Mendawai with Gambut landsystem around the margins. Air Putih covers for about 60% the Kahayan system and for the remaining 40% the Mendawai system. A special case is the location of the Desa Kubu scheme with 50% in the Kajapah tidal swamplands and the remaining (more successful) part on Mendawai landsystem. The tidal swamps of Selat Padang Tikar and Selat Panjang are of the Kajapah type.

4.5 HYDROLOGY AND WATER QUALITY

The Siak sub-project area has two main systems, the Siak Besar and Siak Kecil rivers. There is a navigation canal linking the two rivers and another further downstream on the Siak Kecil which links a wide bend near Block A. In the dry season, saline intrusion reaches the Siak Kecil River via the main navigation canal.

The Indragiri sub-project area is dominated by the Indragiri River. All schemes are located on either side of this major waterway. The river meanders strongly in the vicinity of the schemes and flooding during December and January is a regular event. Salt does not intrude into the Indragiri schemes.

There are two major (brown water) rivers in the Jambi project area: the Batanghari and the Berbak River, the latter in fact a large branch of the former. A smaller branch from the Batanghari, the Pamusiran (Dalam) river, separates the Simpang Puding and Rantau Rasau schemes from the other schemes on the deltaic 'island' formed by the Batanghari and Berbak. A second, artificial waterway cuts through the 'island' from the Batanghari

to the coast, a little further west. There, the navigation canal through the Lambur scheme connects to the head water of the small -originally blackwater- river Simbur Naik.

The Dendang River and the Sabak Rivers are two blackwater tributaries to the Batanghari, near its estuary. A third and major blackwater river, the Lagan River, flows south to north just west of the Batanghari estuary. A navigation canal connects the Lagan and Sabak rivers.

The West Kalimantan project area encompasses the estuarine area of the Kapuas, Punggur Besar, Ambawang, Kubu and Terentang rivers. Water levels in these river sections of the project area are influenced by the tide which is basically semi-diurnal. In the dry season, saline intrusions penetrate 20 km up the Kapuas river system. The saline or brackish water does not in general migrate in underlying (peaty water) aquifers because of the predominant seaward movement of the freshwater. However, saline ground water conditions have been reported in coastal areas adjacent to Kubu and the rest of the Kapuas delta. Areas like Kapuas Kecil, Sei Nipah and Desa Kubu are negatively effected by this. This might be related to the large scale conversions of peatswamp forests and the manmade drainage system.

Water levels are also influenced by the river discharge which grows in importance inland. The Kapuas river and its adjoining rivers cover a catchment of about 85,650 km^2 and this, the longest river in Indonesia, has a mean flow of 6,214 m^3/s.

Analyses have been undertaken of tidal fluctuations during spring and neap tides for each project area and also for drainage requirements. Based on a five-year return period the drainage requirements for the Jambi project area were estimated as 14.85 l/sec/ha for village areas, 3.14 l/sec/ha for paddy fields and 7.0 l/sec/ha for tree crops. For Riau the requirements were estimated as 16.22, 3.27 and 7.13 l/sec/ha respectively and for West Kalimantan as 15.56, 3.92 and 7.78 l/sec/ha respectively.

Although most schemes have sufficient amounts of fresh water, even in the dry season, water quality is low. The amount of pollutants like ammonia (NH_3), Nitrate (NO_3^-) and Nitrite(NO_2^-) and coliform bacteria makes water in the drainage canals at the schemes unsuitable as drinking water. This is because these waters are also used for household and sanitation purposes. These waters are slightly acid on average (pH 5) but this increases in periods without much rain. This acidity and N-levels also makes it unsuitable as water for aquaculture and animal husbandry.

The water quality situation in rivers running through the ISDP schemes is slightly better, but would still need processing before attaining the standards set as drinking water (Group A, KLH: PP no. 20, 1990). Sediment levels are high, especially during the rainy season.

Ground water resources at most sites have too high levels of Iron (Fe), Manganese (Mn) and Ammonia (NH_3) because of peat and acid sulphate soils, which makes this water unsuitable for consumption.

4.6 FLOODS AND INUNDATION

Inundations are classified according to cause. They are:

- o inundation by the maximum flood occurring within the past 10 years in the scheme;
- o inundation by annual flood within the scheme;
- o inundation by spring tide (and high tide) during dry season; and
- o inundation by spring tide (and high tide) during wet season.

Maximum and annual flood data are useful for assessing the need for flood control whereas spring tide inundation can be used for assessing tidal irrigation possibilities.

Basic data concerning extent, depth, duration and date were collected from the leaders of all project villages and the results projected onto individual scheme contour maps (Technical Report No. 1). The accuracy of inundation maps was validated by comparing a limited number of flood mark elevations, which were identified with the assistance of house owners, and the inundation depths shown on the prepared maps. Table 2 shows areas inundated per (sub-)project area under various conditions. Apart from direct inundation from the major river systems, some schemes are affected by local flooding which originates from peat swamp forest inland from the major rivers.

Table 2: Areas inundated per (sub-)project area. No data available for the western sub-project area West Kalimantan (schemes are either protected by dikes or relatively higher).
(Source: Technical Report 1 "Hydrology", Tables 6.2, 6.4 and 6.6)

	TOTAL AREA		MAX. FLOOD*		ANNUAL FLOOD		TIDAL INUNDATION (spring tides) WET SEASON		TIDAL INUNDATION (spring tides) DRY SEASON	
	(ha)	%	(ha)	%	(ha)	%	(ha)	%	(ha)	%
Jambi	43,737	100%	26,681	61%	18,804	43%	11,911	27%	1,145	3%
Siak	13,643	100%	4,833	35%	847	6%	0	0%	0	0%
Indragiri	18,527	100%	11,855	64%	5,707	31%	3,048	16%	2,455	13%
W Kalimantan (eastern sub-project)	25,912	100%	4,440	17%	3,610	14%	12,110	47%	750	3%
Total	101,189	100%	47,809	47%	28,968	28%	27,069	27%	4,350	4%

* Maximum flood in past ten years

4.8 LAND SUITABILITY

Land suitability is categorized into 5 classes[8]:

S1	highly suitable;
S2	moderately suitable;
S3	marginally suitable;
N1	currently not suitable; and
N2	permanently not suitable.

Class S1 is the highest and class S3 is the lowest in productivity. This does not mean that class S1 has always higher yields than class S2. Rather, it means that class S1 can be managed more economically than class S2 to produce the desired yield. Soils in classes S2 and S3 have some limiting factors for the land uses and management practice, in which case the limiting factors are marked to help soil management.

In the Siak (sub-)project area, the higher suitability classes (S1 and S2) are dominant for all three crop categories (rice, palawija, tree/root crops). At the other extreme, the least suitable land classes (S2 and S3) dominate in Jambi. In general the soils of the project areas are mostly suitable for agricultural purpose. Table 3 summarizes land suitability for the (sub-)project areas. The main limiting factors for crop production are drainage, acidity, deep peat, and flooding. Occasionally low fertility and pyrite layer are also important.

Table 3: Summary of land suitability for the (sub-)project areas. (Source: Technical Report 4 Volume II, Tables 4.5, 4.9 and 4.13)

	SIAK		INDRAGIRI		JAMBI		KALIMANTAN	
	(ha)	%	(ha)	%	(ha)	%	(ha)	%
Total	22,040	100%	18,090	100%	41,740	100%	42,486	100%
Unsuitable for rice	5,051	23%	1,835	10%	5,496	13%	7,417	17%
Unsuitable for palawija	5,051	23%	2,319	13%	6,048	14%	7,417	17%
Unsuitable for tree/root crops	3,450	16%	1,404	8%	3,252	8%	6,054	14%
Most common classes:								
S1 for rice	11,191	51%						
S1 and S2 for palawija	13,290	60%						
S1 and S2 for tree/root crops	13,928	63%						
S2 and S3 for rice			16,255	90%			29,868	70%
S3 for palawija			14,096	78%	34,169	82%	28,851	68%
S3 for tree & root crops			15,011	83%	36,943	89%	31,581	74%
S2 for rice					29,410	70%		

[8] These definitions are given in the Main Report, Annex 3, Table 20.

5.0 EXISTING BIOLOGICAL ENVIRONMENT

5.1 REGIONAL SETTING

The Greater Sundas, to which both Sumatra and Borneo belong, are part of the Oriental zoogeographic Region, more specifically, of the Sunda Sub-region. Only recently -on a geological and evolutionary time scale- the Greater Sundas were separated from the south-east Asian mainland. The Sunda Sub-region, which includes the Malay Peninsula, Sumatra, Borneo, Java and associated smaller islands, is a very rich tropical region on both sides of the equator.

5.1.1 Sumatra - Riau and Jambi

Sumatra is the richest island in the Sub-region. Six-hundred bird (Andrew, 1992:1) and over 196 mammal species (Whitten *et al.*, 1984:44) occur on the island, many of which are limited to Sumatra: Sumatra has 24 avian and 20 mammalian endemic species. A number of species that are rare or extinct in other parts of Asia still have viable populations in Sumatra. These species include flagship species such as the Asian Elephant *Elephas maximus*, and the Sumatran Rhinoceros *Dicerorhinus sumatrensis* or sub-species such as the Sumatran Tiger *Panthera tigris sumatrae*.

East of the Jambi ISDP schemes, lies the 171,635 hectares[9] large Berbak National Park, and to the north the *Hutan Bakau Pantai Timur* Strict Nature Reserve of 6,500 hectares[10] mangrove forest. Biodiversity in the Berbak National Park is very high, and represents the richness of the project area before it was settled and the schemes constructed. The Park contains 260 wooden species, including 23 palm species (*Arecaceae*), highest of any swamp area known (Giesen, 1992:109). Further over 250 bird species and more than 30 mammal species, among which endangered animals as Sumatran Tiger, Clouded Leopard *Neofelis nebulosa*, Tapir *Tapirus indicus*, Sumatran Rhinoceros, as well as at least five primates have been recorded, while probably most of the smaller species remain un-documented.

The Berbak National Park is the first, and to date only, RAMSAR[11] area in South-East Asia.

The *Hutan Bakau Pantai Timur* Reserve gains internatic al importance for its rich avifauna, being a crucial foraging area for over 20,000 waterbirds and migratory waders on their annual journeys from north and east Asia to Aus:.lia and back. The reserve

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[9] Due to boundary and other problems, the exact surface of the Berbak National Park remains unknown, but is probably closer to 150,000 hectares.

[10] It is estimated that only 2,710-3,829 hectares remain of the *Hutan Bakau Pantai Timur* Strict Nature Reserve (GIESEN 1992:1-2).

[11] RAMSAR Convention: Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971

provides a (breeding) habitat for several endangered bird species, such as the Milky Stork *Mycteria cinerea* and Lesser Adjutant *Leptoptilos javanicus*, and a roost of Flying Fox *Pteropus vampyrus*, a large fruit bat.

A number of conservation areas surround the Siak sub-project area, of which the Siak Kecil Wildlife Reserve, some five kilometres west of the schemes is the most important[12]. There is only one conservation area in the proximity of the Indragiri schemes: the Kerumutan (Baru) Wildlife Reserve. Little is known on this reserve.

Some ISDP activities could impact the conservation areas, particularly the mangrove reserve in Jambi, and the Siak Kecil Wildlife Reserve, but none of the ISDP schemes borders directly on conservation area[13].

The major habitats occurring in Sumatra are mangrove forests, rivers and lakes, peatswamp forests, freshwater swamp forests, lowland forests and montane forests (Whitten *et al* 1984). These forests support a range of plant species and vegetation communities far richer than Java and Sulawesi, and comparable to the richest forests of Borneo or New Guinea. There are 17 genera of endemic plants in Sumatra.

The eastern lowlands of Sumatra form one of the world's most extensive peat swamp forests. Riau and Jambi provinces have the largest areas of mangrove and peat swamp forest in Sumatra. Berbak National Park, in Jambi, represents the most important freshwater reserve in South East Asia.

The ISDP schemes are located within these eastern lowlands and as such, mangrove and peat swamp predominate the natural environment. However, the areas have had a long history of agricultural settlement and timber harvesting, so that none of the areas near the schemes are in an undisturbed state.

5.1.2 Borneo - West Kalimantan

Borneo is the largest land area in the Sunda biogeographical sub-region. The island is the main distribution centre for many genera of the Indo-Malayan fauna and Malesian flora. Borneo lies within the wettest part of the Indonesian archipelago and supports the largest expanse of lowland evergreen rainforest. Forest types include mangroves, peatswamp forest, freshwater swamp forest, the most extensive heath forests (*kerangas*) in S.E. Asia, lowland dipterocarp forest, ironwood forests and various types of dipterocarps on hills and mountains.

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[12] Other conservation areas are the Danau Pulau Besar Wildlife Reserve, *circa* 25 km south-east of the southern Siak schemes, and the Bukit Baru Wildlife Reserve *circa* 30 km west of the northern schemes.

[13] In Jambi the Berbak and Batanghari Rivers lay between the schemes and the National Park. There are no ISDP activities planned east of these rivers. In Indragiri (Riau) the nearest parts of the Kerumutan Nature Reserve are 10-20 kilometre from ISDP schemes and the Reserve is relatively inaccessible from the south.

The Island of Borneo supports 483 bird species, however, only 479 occur in Kalimantan, the Indonesian part of the Island (no statistics on the province of West Kalimantan). Borneo as a whole has 4 endemic bird species, Kalimantan only one (Aandrew, 1992). The Bornean fauna further includes 221 land mammals, the West Kalimantan fauna 103 mammals (Payne *et al.*, 1985). Borneo is the richest of the Sunda islands floristically. Endemism is high through the whole flora with about 34% of all plant species and 59 genera unique to the island. In comparison Sumatra has only 12% endemic species.

Borneo is marginally less rich in fauna than the island of Sumatra, except probably for fish, amphibians and reptiles. Among Borneo's best known mammals are Orang Utang and the Proboscis Monkey (Mackinnon, 1981).

West Kalimantan is of particular significance within the island as having some of the richest and oldest forests within the island, particularly north of the Kapuas river. In addition the extensive swamp forests and valuable Ramin (*Gonystylus bancanus*) swamps are of particular interest and economic importance. The Sentarum Wildlife Reserve at the headwaters of the Kapuas river is a unique feature of the province with some of the oldest known inland peat swamps and one of the only two island lake areas in Borneo.

The ISDP schemes are situated in the Kapuas coastal swamplands large about 14,990 km2. Most of the area has been converted to other types of land-use or is strongly degraded. Primary forest in this region is restricted to coastal mangrove and nipah swamps. Considerable areas have been cleared many years ago for rubber and coconut cultivation alongside the major tidal rivers, such as the Sambas, Kapuas and the Pawan. Many of these have been removed under both Government-sponsored and local initiative schemes which aim to drain and reduce peat depth further and sufficient for construction of rice sawah. The only remaining protected forests occur on the coastal fringe between Pontianak and Teluk Batang. It was proposed by RePPProT (1989) that all intertidal forest should be designated a special kind of Protected Forest in view of its importance for coastal protection and fisheries. No conservation areas occur near the schemes in this project area.

5.2 TERRESTRIAL AND AQUATIC ENVIRONMENT

The terrestrial and aquatic habitats in the region of the schemes are dominated by coastal wetland systems. Since water plays such an important role in the functions of these ecosystems, it is inappropriate to draw a clear distinction between terrestrial and aquatic environments. This section therefore describes the environment from such an integrated perspective.

The areas can be sub-divided into two groups, those habitats with brackish-water influence along the coast and along the tidal rivers and those habitats without any saline influence farther inland. For details see appended Maps 1B-4B (Land-use /Forest Status). In general, mangroves occur along the coast, brackish and freshwater riverine formations along the major rivers, peat swamp forests on the peat-dome lands in between the rivers,

and swampy agricultural land and fallow land on the project schemes. Dominant plant species of the environments in West Kalimantan are given in Table 4.

5.2.1 Mangrove and Coastal Environments

Mangroves occur in the estuaries of most river systems of the project areas. Tidal action of the sea inundates these swamps daily, but the in-flowing freshwater from the river system results in a brackish water environment with typical dominating tree species like *Sonneratia caseolaris*, *Nypa fruticans*, *Xylocarpus granatum*, and *Bruguiera gymnorrhiza*. Unripened silty to clay soils dominate these swamps, but some locations in the estuaries of the rivers show thick river deposits of peat originating from the large peat formations inland. Characteristically, these soils are worked by Mud Lobsters (*Thalassina anomala*) which create huge mounds of soil around their burrows. This is also the habitat of the Mangrove Crab (*Scylla serrrata*) which is a highly favoured restaurant seafood.

Riau Schemes

Mangrove associations are poorly represented on the Riau schemes, due to the distance from the coast.

The Siak sites are upstream of salt intrusion, although there is a marked tidal effect. In the vicinity of the Siak Kiri project area, the river is about 500 metres wide. The depth is not known, although the river is navigable by large vessels in the vicinity of the transmigration schemes. The banks are generally fringed with mangroves, mainly *Sonneratia* spp. and are backed by secondary forest in areas not under cultivation. The river is tidal in the area of the schemes and salt intrudes upstream to the mouth of the Raya River.

Closer to the coast, the *Sonneratia* stands give way to banks dominated by *Nypa fruticans*, bamboo, and the fern, *Acrostichum aureum*, followed by a dense, fully developed mangrove community at the mouth of Panjang Strait. Most of the coastal areas at the mouth of the Siak Besar River remain in a natural, albeit disturbed condition.

The coastal areas of the Siak Kecil river are densely populated, with industries such as sawmills and brick factories lining the banks. The vegetation along these lower reaches is therefore highly disturbed, and natural vegetation is often interspersed with rubber plantations and Acacia. Along the lower reaches of the river, the predominant bank vegetation includes *Nypa fruticans*, *Pandanus helicopus*, *Oncosperma tigillarium*

Along the Indragiri river, mangroves are sparse, and mainly consist of *Sonneratia*. The schemes are located some 100 km from the coast,so mangrove habitats are not extensive. Mangroves also line the smaller rivers and some primary canals in the Indragiri area.

Table 4: Dominant plant species in the West Kalimantan project area.
(Source: field data)

I Mangroves and Coastal Environment
Sonneratia alba
Sonneratia casealaris
Bruguiera gymnorrhiza
Rhizophora apiculata
Rhizophora mucronata
Xylocarpus granatum
Hibiscus tiliaceus
Cerbera odollam
Nypa fruticans
Acrostichum aureum
Acanthus ilicifolius
Derris heterophyla coll. no 5
Brownlowia coll. no 2
Araceae coll. no 1
Oncosperma tigillaria

II Freshwater Riverine Environment
Gluta velutina
Cerbera odollam
Ficus microcarpa
Heritiera littoralis
Pandanus helicopus

II Man-Made Aquatic Environment
Salvinia natans
Hydrilla verticillata
Ipomoea aquatica
Eichhornia crassipes
Utricularia
Ludwigia adsendens
Limnocharis flava
Blyxa
Bacopa monnieri
Vallisneria natans or V. spiralis
Monochoria hastata
Acanthus ilicifolius
Acrostichum aureum
Ceratopteris thalictroides
Hanguana malayana
Scirpus grossus
Eliocharis dulcis

III Freshwater Riverine Environment
Gluta velutina
Cerbera odollam
Ficus microcarpa
Heritiera littoralis
Pandanus helicopus

IV (Degraded) Peatswamp Forest
Mabang
Shorea
Shorea teysmanniana
Dyera lowii
Koompassia malaccensis
Macaranga

V Agricultural Land and Burned Peat Land
Lygodium flexuosum
Pteridium caudatum
Nephrolepsis biserrata
Stenochlaena palustris
Dicranopteris linearis
Scleria sumatrensis
Scirpus grossus
Eleocharis dulcis
Melastoma malabathrium
Imperata cylindrica

Jambi Schemes

Extensive tracts of mangrove forest occur along the coast of Jambi. Most are protected, though far from effective, in a Strict Nature Reserve, but some is of unclear status. Along the estuaries of the Lagan, Simbur Naik and Pamusiran Rivers, the mangroves occur further inland. Giesen (1991) gives a preliminary description of the ecology and composition of this Reserve, and recommendations for management. During a visit to twelve sites Giesen's team recorded twenty-four plant species, *Avicennia alba* and *Sonneratia caseolaris* being common to (co)dominant at most sites. The mangrove belt house important roosts (and breeding colonies?) of waterbirds. The AWB team located a large Flying Fox *Pteropus vampyrus* roost in the mangroves between the estuaries of the Batanghari and Lagan River, unreported by Giesen (1991).

Large stretches of mudflats are exposed at low tide. The mudflats are a very important 'refueling' station for 20,000 waterbirds and waters annually (more than estimated for the Berbak NationalPark) on their journeys between Australia, New Zealand or New Guinea, and north, east and south Asia.

West Kalimantan Schemes

Mangroves occur in the estuaries of the Kapuas Kecil, Punggur Besar, Ambawang and Kubu/Radak rivers, respectively east and south of the West Kalimantan project sites. One area of mangroves is found in the estuary of the Punggur Besar river, on Laut Island, Karunia Island and Nyamuk Island, close to Pontianak. Typically these mangrove forests are bordered by a $\pm$50 m wide Nypa Palm zone, which merges into pure Nypa stands along the rivers further inland. This riverine vegetation indicates the saline influence of tidal water reaching at least 20 km inland up to project schemes like Sei Nipah and Desa Kubu.

Mangroves and Nypa are exploited by local people, including those from the project schemes. On some locations, such as the coastal area of Jawi and the riverine borders of Kalimas and Betutu, this exploitation has led to erosion of the banks. At Jawi a major dike along the coast has been broken because of this erosion.

Of larger extend are the mangrove and Nypa swamps south and south-east of the project schemes around Kubu (Selat Padang Tikar). This area which is richer in mangrove species than those close to Kakap/Pontianak covers about 108.000 ha (RePPProt, 1987) and represent the largest area of mangroves remaining in West Kalimantan. About half of the Kubu scheme is still mangrove swamp and has never been fully developed because of inundation and salinity problems.

The mangroves of Selat Padang Tikar have been selectively exploited some 3 - 5 years ago, in spite of its protected status (see Section 6.3 Land-use). Regeneration however, has been vigorous, resulting in a good regrowth, especially of *Rhizophora mucronata* and *R. apiculata* mangrove trees.

Both mangrove areas in the east and south of the project sites are of importance for riverine and near coastal fisheries given the large number of juvenile fish and prawns observed during fieldwork. The two mangrove sites discussed harbour a large population of Lesser Adjutant, a stork protected by Indonesian law. These forests also potentially support a population of the Storm's Stork a very rare and endangered bird occurring in West Kalimantan. Proboscis Monkey, a endemic protected monkey has been observed in these mangroves which might become the last stronghold for this species in the near future when all riverine and swamp forests have been cleared for economic development.

5.2.2 Man-Made Aquatic Environments

The project areas are intersected by the many river tributaries and canals which drain the swamp land for agriculture. These open water environments can be grouped into those with a fresh to brackish water quality, those with predominantly peaty water and those that are rain-fed.

Fresh to Brackish Water canals and streams are generally found close to the coast in areas where tidal irrigation is practised. These systems receive water from the nearby river at high tide, after which the canal is often blocked off.

In West Kalimantan, salinity levels vary depending on season and tidal inundation, and varied between 1.3 μmos and 8.2 μmos depending on tide. An average pH of 6 indicates the marine influence in these PASS soil dominated environments. River and canal border plants like *Acrostichum aureum* and *Acanthus ilicifolium* also indicate the influence of brackish tidal water. Dissolved oxygen levels measure about 4.5-6 mg/l, which is lower than the maximum level (7.5 mg/l) possible at the average temperature found (30° C).

Typical fishes of brackish water environments include species of Tetraodontidae, Gobiidae, Chandidae and Hemiramphidae. The Freshwater Prawn (*Macrobrachium rosenbergii*) occurs in high numbers in the larger canals and rivers.

At least nine species of herbaceous waterplants grow in these waters including *Salvinia natans*, *Nymphaea nouchali*, *Ipomoea aquatica*, *Blyxa* and *Ludwigia adsendens*.

Peat Water canals usually occur in those areas of the schemes which are farthest from the main river. These canals are often dug in peat swamp areas and the water they contain has drained directly from the swamp. pH values are about 3.5-5 and conductivity (salinity) is below 0.15 μmos. Also oxygen levels ($\pm$4.5 μmos) of these waters were found lower than the maximum attainable level.

Peaty waters are considerable less rich in plant and animal species than those surveyed in the brackish water environments. However, none of these peaty rivers and canals can be considered as undisturbed and in a natural state. Only about 5

species of herbaceous waterplants grow in these waters, including *Vallisneria*, *Utricularia*, and *Nymphaea nouchali*.

Rain Fed systems are commonly seen on schemes where tidal irrigation is not practised, and the fields are too far removed from peat swamp areas to receive ground water. In areas of rain-fed irrigation, these canals can become stagnant and fauna living in them can become isolated for long periods during the dry season.

Riau Schemes

The Siak schemes are serviced by a network of canals. Tidal irrigation is not practised in this area, so canals are used for wet season drainage and rain-fed irrigation in the dry season and thus, there are no fresh to brackish water habitats on the schemes. Generally, secondary canals are closed during the dry season to retain water. The dry season canal environment is quite different to that found in the adjacent rivers. Canals vary in size up to 20m wide and 3m deep and are usually in exposed situations. There is very little fringing vegetation, and often banks are bare. Canals are often choked with weeds, particularly Water Hyacinth (*Eichhornia crassipes*). Other aquatic vegetation in the canals includes Lotus Lily (*Nelumbo nucifera*). These habitats are frequently disturbed by farm animals (eg. water buffalo, ducks, etc) or by people who regularly clear the weeds.

The Indragiri schemes contain numerous tidal irrigation canals. Although these are generally fresh, mangrove plants line the banks and brackish water fishes, such as Mudskippers are common.

Peat water canals occur on both sub-projects, in most newly cleared areas away from the rivers.

Jambi Schemes

In the Jambi project area, there are no canals that contain brackish water. All schemes are intended to be irrigated by tidal forces. Therefore, water quality is very variable in all but the smallest (tertiary) canals. During outgoing and low tide, black(ish) peaty water dominates, sediment load and acidity (and probably disolved nutrients) drop, while tanines increase, as ground water from soils in or around the schemes seeps into the canals. During incoming and high tides, water from the Batanghari and Berbak is pushed into the canals, replacing the peaty water with brown(ish) water, and the reverse process occurs.

The banks of most canals are covered with the same riverine vegetation as along natural water courses. Where bank vegetation is absent, e.g., new or improved canals, bank erosion occurred in Simpang Puding (SK1), due to navigation by too large crafts.

Many of the smaller and some of the larger canals are clogged with weeds, particularly Water Hyacinth and an unidentified floating grass species, impeding water flow. The grass species seems to show a preference for waters influenced by acid sulphate soils. The clogged upper reaches of the Lagan River are an extreme example, but the grass species

occured also in the feeder canal to Block A of Simpang Pandan, the navigation canal of Lambur and upper reaches of the Simbur Naik, in feeder canal PC1 in Rantau Rasau and, until recently, reportedly in Simpang Puding.

West Kalimantan Schemes

The river water of the Kapuas estuary is a mixture of fresh water originating from the catchment area in the mountains of eastern West Kalimantan and the peaty blackish-brown coloured waters from the extensive peatswamps in and outside the project area.

Roughly all those natural and man made waters east of Sei Nipah (along Punggur Besar river) are peaty, slightly acid with pH 4-6 and Secchi values from 30 cm (larger turbid rivers) to 140 cm (slow streaming drainage canals in peatland on the project sites). During the rainy season (around December) rainwater will raise the average pH and turbidity increases because erosion of riverbanks and other flooded bare soils. Water quality data are given in Table 5.

Up to at least 15 km inland, and in particular on the project sites around Kakap (P2DR) water quality is influenced by the daily tidal regime of the larger rivers. Brackish water also enters the man made canals on the schemes, often with strong negative impact to agricultural production. Areas of particular problems with salt intrusion are Desa Kubu, Sei Nipah, Kapuas II, Kalimas and Jawi.

Table 5: Water quality parameters of schemes in West Kalimantan.
(Source: field data September 1992)

Scheme	Temperature (°C)	pH	Secchi Depth (cm)	Depth (m)	Dissolved Oxygen (mg O_2/l)	Conductivity (μmos)	Type of Water
Western Sub-project							
Kapuas II (Ampera Laut R.)	31	5-6	83	-	6	8.2	brackish
Kalimas (Block P)	31	5-6	83	-	4.5	5.7	brackish
Betutu (Nyrih R.)	31	5-6	67	3.24	4.5	2.6	brackish
Betutu (Kering R.)	31	5-6	123	3.38	3	3.26	brackish
Jawi (Jawi R.)	30	5-6	57	1.80	6	5.7	brackish
Eastern Sub-project							
Sei Pulau	29	4-5	54	1.25	4.5	0.15	black/alluvial
Pinang Luar	30	4-5	51	1.91	4.5	-	black/alluvial
Sei Radak	32	4-5	33	0.87	-	0.05	black/alluvial
Sei Nipah	31	5-6	39	1.35	4.5	1.26	brackish/alluvial
Air Putih R.	29	4-5	-	-	4.5	-	black/alluvial
Kubu	31	6	145	2.90	1 (?)	-	brackish

The canals in the schemes are particularly rich in typical brackish water fishes like, Belontiidae, Tetraodontidae (*Tetraodon nigroviridis*) and Chandidae (*Parambassis wolfii, P. microlepis*) originating from the nearby mangrove environment. Burrowing crabs and the mudlobster (*Thalassina anomala*) are particular abundant in the earthen walls of the canals undermining its stability.

5.2.3 Freshwater Riverine Environments

Two kinds of natural freshwater environments are recognisable on the schemes, those river systems which are principally sourced in areas removed from the wetlands, and those that are sourced in peatswamp forest.

"Brownwater" Rivers These rivers are usually wide, long and tidal only in the lower reaches. They are slow flowing during the dry season and carry a high sediment load. Very conspicuous are the borders of riparian vegetation along these rivers, which are frequently inundated up to 150 m width. On these sites water quality is determined by a mixture of peaty or muddy sediments which give an average pH of 6, and low to very low salinity levels. The vegetation is dominated by Rengas (*Gluta velutina*), Beringin (*Ficus microcarpa*), Pandan (*Pandanus helicopus*) and Dungung (*Heritiera littoralis*).

At undisturbed sites, the tree canopy reaches a height of 35 m (*Heritiera littoralis*) and is backed at the swampy riverside by a dense canopy of *Ficus* spp. This is the natural location where monkeys like Proboscis Monkey, Silvered Leaf-monkey and Long-tailed Macaque forage at dawn and dusk, and find shelter for the night.

"Blackwater" Rivers are characterised by a dark colouration caused by high tannin content and a low pH (3-5). These rivers drain the peatswamp forests near the schemes. They are generally fringed by a dense overhanging cover of Rasau *Pandanus helicopus* and *Hanguana malayana.*

Riau Schemes

The Siak Besar River is one of the major waterways of eastern Sumatra. It originates in the swamp and hill country of western Riau and flows through the provincial capital of Pekanbaru. It winds through low lying swamp country and eventually discharges to the sea in Panjang Strait. The Siak Besar is a muddy, brownwater river. There are a number of settlements and factories along it's length.

Smaller rivers, including the Buantan, Raya, Langsat and Tasip flow through the Siak Kiri schemes into the Siak Besar. These are all blackwater rivers which drain the peat swamps to the west of Siak Kiri. They are generally small, fast flowing streams and the banks are largely disturbed in the downstream areas where there is settlement. They are tidal in the lower reaches. Further upstream, they are fringed with dense vegetation. A pH of 4.0 was recorded in the upper Buantan River.

The Siak Kecil River originates in a series of quite unusual, dystrophic freshwater lakes on deep deats, which occur in peatswamp forest to the west of the schemes. This area is within the Siak Kecil Wildlife Reserve. In the vicinity of the schemes, this river is about 10-25 metres wide. Blackwater stretches reach to about the area of the new navigation canal, where there is influence from the Siak Besar River. The banks are generally fringed by dense stands of *Pandanus helicopus* to 3m height which overhang the river. There are also low shrubs and ferns. The areas near the river are largely cultivated, but some areas of secondary forest remain.

The river is tidal at least as far upstream as the Siak Kecil Reserve. At low tide, there are extensive areas of mudflats, many of which are vegetated by sedges. The limit of salt intrusion is reported to be in the area of the lower navigation canal near Block A1. However, salt now intrudes into the river via the new navigation canal and reaches as far as Block K during the dry season (see Map 1C, Environmental Issues).

The Indragiri River is a large, slow-flowing river which meanders through the lowlands of southern Riau province and discharges into the sea opposite Bakung Island. In the vicinity of the transmigration schemes, the river is about 500-800 metres wide, brown in colour and very turbid. All of the schemes are affected by tidal influence but salt water intrusion does not reach the area. The river has a sandy substrate and at low tide, numerous sandbars are exposed. Bank vegetation is generally low, scattered and shrubby.

There are several blackwater streams occurring amongst the Indragiri schemes, notably the Cinaku, Enok and Mumpa Rivers. Tidal irrigation is practised in many of the irrigation canals.

Jambi Schemes

The Batanghari, Berbak and Pamusiran River are (very) large, slowly flowing brownwater rivers with heavy sediment loads. The Batanghari originates in Sumatra's central cordillera, the Berbak River is a main branch of the Batangahari, the Pamusiran a minor offshoot. Only the Pamusiran and Berbak are completely under tidal influence, the Batanghari only in its lower reach, up to at least twenty-five kilometres upstream of the project area.

Other smaller, but still important rivers in the project area originate(d) in peatswamp forest and are (or were) blackwater rivers: Lagan, Sabak, Dendang and Simbur Naik Rivers. The AWB team measured pH's of 3.5-5.0 in these river. The Simbur Naik is now of mixed nature, but brownwater predominates, due to the connection of its source area to the central navigation canal through the Lambur scheme, and eventually to the Batanghari.

The banks of the Lagan, Simbur Naik and Pamusiran Rivers are vegetated with mangroves directly behind the coast and extensive belts of Nypah further upstream. The Sabak and Dendang Rivers do not debouche in the sea, but in the Batanghari, and have only minor patches of Nypah. All Nypah areas show signs of extensive exploitation by

humans. We found little or no Nypah inside schemes, most likely because of the distance to the sea.

West Kalimantan Schemes

The best remaining habitats are located along the Kubu river, in particular close to Jangkang and Pinang Dalam. On average these forests have been strongly degraded by land clearing by transmigrant sites more inland and by local people traditionally living along the river borders. Eroding river borders are a result of this.

5.2.4 Peatswamp Forests

Huge tracks of peatswamp forests dominated the ecology of the coastal swamps, but commercial logging operations (on some locations twice) have extracted all valuable logs, leaving very open stands of heavily degraded forest. Conversions to agricultural land and settlements have further reduced the remaining area of logged-over peatswamp forest.

Typically, forested peat areas form peat domes between the main rivers. Peat depth is largest in the centre of the dome reaching levels up to 10 m and thinnest at the margins, gradually being replaced by riverine sediments with a mixed swamp forest. These forests are very wet even in the dry season because of the water retention in peat deposits. Drainage water from these soils flowing in natural streams or man made canals has an average pH of 3-5 and is coffee black in colour.

Most of the settlements under this project have been located at the margins of the peatswamp forests, converting most of the mixed swamp forests. Analysis of the soil maps and the field survey indicate that there are still sections of the project sites showing the occurrence of peat layers thicker than 2m.

Riau Schemes

On many schemes, particularly those where there is insufficient labour, natural forest still occurs inside and near the scheme boundaries. The condition of this forest is variable, but is usually degraded to some extent. These areas are the most frequent targets for wood gathering by locals and transmigrants, since they are the closest areas available for harvest and they are often dissected by old canals which allow access and also tend to drain the peatswamp forest. On the other hand, many areas are in better condition than the adjacent forest which is under logging concession. These areas can be rich in wildlife because they represent refuge and ecotonal habitats.

Anderson (1975) documented the ecology of peatswamp forests in the Siak and Indragiri schemes.

The swamps in the vicinity of the Siak rivers are of immense size. Anderson recorded a total of 73 large tree species from only four plots, the dominant ones being *Palaquium burckii*, *Shorea teysmanniana* and *Blumeodendron kurzii*. There are extensive areas of

"padang" vegetation (small trees with a pole-like aspect). *Licuala spinosa* is a common understorey palm. In the Indragiri area, 82 tree species were recorded, the commonest being *Dyera lowii*, *Gonystylus bancanus*, *Knema intermedia* and *Shorea platycarpa*.

Jambi Schemes

Peatswamp forests remain on the schemes. There is more peatswamp forest affected than suggested by the reported 3,331 hectares of un(der)developed land under shrub or alang-alang. Whole sections (primary canals) of schemes were never settled after the canals were constructed (Dendang I-III, Lagan Hulu). Midway between (primary/secondary) canals of the same schemes, large tracts of (heavily) disturbed peatswamp forest remain, mostly as LU2 land, but also as unsuitable LU1 land. Such peatswamp forest is dying. One reason is the network of (drainage) canals around it that drains and dries the peat. Another reason is the frequency of (sub-soil) fires in the dried peats. Judging from their roaring 'calls' the 'chainsaw-bird' is a common form of 'wildlife' in such remnants of the peatswamp forest.

We do not know of publications for the Jambi schemes, comparable to Anderson's (1975) study on the ecology of peatswamp forest of *what is now under cultivation* in Riau or West Kalimantan.

West Kalimantan Schemes

Detailed vegetation studies (Anderson, 1975) on those locations not yet affected by the establishment of the transmigrant sites and draining these swamps by MPW reveal the species richness of the original forests. A total of 95 tree species (see Table 6) was recorded for the area between Kuala Durian and the present Raszu Jaya project site. The peatswamp forest at the centre of the dome had an average of 1,250 trees (exceeding 30 cm girth at breast height), forming a typical Padang Pole Forest with no trees exceeding 150cm girth. The Padang, with tree species like *Palaquium cochleariifolium*, *Dactylocladus stenostachys*, *Diospyros evena*, *Ilex sclerophylloides* and *Lithocarpus dasystachus* gradually increases in total number of species and tree diameters towards the margins. Here grows the mixed swamp forest characterized by trees like *Gonystylus bancanus*, *Diospyros pseudomalabarica*, *Koompassia malaccensis*, *Mezzetia leptopoda* and *Parastremon urophyllum*. In the middle storey *Blumeodendron tokbrai* is abundant.

Today about 357,000 ha (RePPProT, 1987) of heavily degraded peatswamp forest is left in the project area, including the area between the sea in the west and south, the line Pontianak - Ambawang river and the artificial boundary about 15 km east of the Sei Radak scheme. See the appended Land Use/Forest Status map (Map 4B) for more details about the remaining forested areas.

Table 6: Characteristic tree species of (peat)swamp forests of Sungai Durian and Sungai Rasau, West Kalimantan. (Source: Anderson, 1975)

Alangium havilandii	*Horsfieldia crassifolia*
Alseodaphne coriacea	*Ilex hypoglauca*
Ardisia copelandii	*Ilex sclerophylloides*
Austrobuxus nitida	*Knema intermedia*
Baccaurea bracteata	*Koompassia malaccensis*
Bhesa paniculata	*Lithocarpus andersonii*
Blumeodendron kurzii	*Lithocarpus dasystachys*
Blumeodendron tokbrai	*Litsea crassifolia*
Calophyllum canum	*Litsea gracilipes*
Calophyllum retusum	*Litsea nidularis*
Campnosperma coriacea	*Litsea resinosa*
Campnosperma squamatum	*Litsea turfosa*
Canthium didymum	*Mangifera havilandii*
Combretocarpus rotundatus	*Mezzetia leptopoda*
Crudia sp.	*Nauclea parva*
Cryptocarya enervis	*Neoscortechinia kingii*
Ctenolophon parvifolius	*Nephelium maingayi*
Cyathocalyx biovulatus	*Palaquium cochleariifolium*
Dactylocladus stenostachys	*Palaquium pseudorostratum*
Dillenia pulchella	*Palaquium ridleyi*
Diosphyros maingayi	*Pandanus atrocarpus*
Diospyros evena	*Parastemon spicatum*
Diospyros pseudomalabarica	*Parastemon urophyllum*
Diospyros siamang	*Parkia singularis*
Durio carinatus	*Payena leerii*
Dyera lowii	*Phoebe opaca*
Elaeocarpus marginatus	*Pithecellobium borneense*
Elaeocarpus mastersii	*Platea excelsa*
Eugenia elliptilimba	*Polyalthia hypoleuca*
Eugenia havilandii	*Polyalthia rumphii*
Eugenia incarnata	*Pometia pinnata*
Eugenia leucoxyllum	*Santiria rubiginosa*
Eugenia palembanica	*Shorea platycarpa*
Eugenia paludosa	*Shorea teysmanniana*
Eugenia polyantha	*Shorea uliginosa*
Eugenia puncticulata	*Stemonurus scorpio*
Fragraea acuminata	*Stemonurus secundiflorus*
Ganua coriacea	*Sterculia rhoidifolia*
Ganua motleyana	*Tectractomia holttumii*
Garcinia apelata	*Tetramerista glabra*
Garcinia cuneifolia	*Tristania grandifolia*
Garcinia cuspidata	*Tristania maingayi*
Garcinia microcarpa	*Tristania obovata*
Garcinia miquelii	*Xanthophyllum amoenum*
Garcinia penangiana	*Xerospermum murica*
Garcinia vidua	*Xylopia coriifolia*
Gomphandra sp.	*Gonystylus bancanus*

Off-site, the remaining forests have been further degraded over the last few years by the many people searching for off-farm income or new agricultural lands. Sawmills have been, or still are in operation. Transmigrants and local people have consequently logged the remaining larger trees. The logs are often sold to sawmills or wood traders along the major rivers in the area. This type of logging still occurs in all remaining forest reserves off-site, with particular activity observed around Ambawang Mountains, which harbours the least exploited wood resources.

Logs extracted belong to species like Jelutung (*Dryera lowii*), Meranti Bunga (*Shorea reysmanniana*), Madang and Meranti Batu (*Shorea* sp.). However, diameters are small and people have to enter the forests deeper and deeper to get any marketable wood.

The appended Land Use/Forest Status map (4B) depicts areas recently opened for agriculture or degraded to shrub vegetation. Large areas around the Terentang and Kapuas rivers show these developments. Transmigrant farmers from the Arus Deras scheme have been found farming on recently cleared land around the Ambawang Mountains, to compensate for bad agricultural land at the scheme itself. Clearly this development will eventually lead to the complete conversion of forest resources remaining today.

Large tracts of exploited forests are now devoid of any large diameter trees. The remaining tall trees are dying because of the yearly forest and sub-soil fires. The lower canopy is dominated by dense stands of *Macaranga*, which is a pioneer tree. Differences in exploitation levels are also expressed in the occurrence of wildlife, which will be discussed under 5.3.3.

5.2.5 Agricultural Land

Not surprisinly, land modified for agriculture dominates the landscape on most of the schemes. Four stages of development are recognisable:

Cropped Fields and Plantations: The dominant crops grown on the schemes include Rice, Soy Bean, Peanut, Maize, Pineapple, Banana, Cassava, Coconut and Rubber. Planting densities are often very thin, with a high amount (up to 40% coverage) of weeds competing with the actual crop.

Degraded Burned Peatland: Repeated burning of peatland (former peatswamp forest) results in a very dense monotonous vegetation dominated by ferns. Main species are *Stenochlaena palustris*, *Pteridium caudatum*, *Dicranopteris linearis*, *Lygodium flexuosum*, and *Nephrolepsis biserrata*. Other plants typically found at open sites are the sedge *Scleria sumatrensis* and the shrub *Melastoma malabathricum*. Biodiversity is low at these sites and forest regeneration is hampered by the yearly fires which support the very dense fern vegetation. This

type of secondary growth is particular dominant on the schemes east of Arus Deras.

Degraded Alluvial Land: Loamy to silty-clay soils occur on all schemes, often with PASS layers (Pyritic). These lands are considered more suitable for agricultural production if the hydrology is properly managed to avoid excessive formation of acid soils and toxic levels of Manganese (Mn), Aluminium (Al), and Iron (Fe). However some schemes, like Rasau Jaya II and III and those schemes around Kakap (P2DR) show PASS soils with a secondary vegetation dominated by Alang-alang (*Imperata cylindrica*) and sedges like *Scirpus grossus* and *Eleocharis dulcis*.

Secondary Shrub Vegetation: The third type of degraded land on the schemes is a dense shrub vegetation, often mixed with remaining trees from the original peatswamp forest. Degraded land is often located at the margins of the schemes merging into the open, logged-over peatswamp forest. Dominating are the stands of *Macaranga* trees, up to 10 m height and an undergrowth of *Scleria sumatrensis* and the fern *Stenochlaena palustris*.

This secondary vegetation is also the habitat where Wild and Bearded Pig like to hide or even have their young (nests). From these shelters they operate at night and constitute the pest problem as reported by the local people.

Project schemes in all areas are located along the major waterways and stretch considerably inland. Both alluvial soils, including the Potential Acid Sulphate Soils (PASS) as well as peat soils are found on the sites.

Before establishment as transmigrant sites, most of the schemes had been cleared of forest vegetation and primary, secondary and tertiary drainage canals were dug. Depending on available manpower and physical conditions of the government provided land (LU 1 and LU 2) transmigrants prepared their land for agriculture. For several reasons however people have been unsuccessful to fully utilize this land as planned.

Transmigrants as well as the local people cleared the remaining vegetation by cutting and especially by burning in order to make the land suitable for planting rain-fed rice, maize, cassava or coconut trees. Crop production was reported to be good for the first one to two years because burning the natural vegetation (including topsoil) provided the necessary plant nutrients. Burning is also considered an aid in decreasing the thickness of the peat topsoil. However, after about two years soil fertility drops sharply because only pure peat is remaining. It was also reported by the transmigrants, as well observed in the field, that repeated burning can result in the removal of up to two meters of peat. This exposes the next soil layer which includes pure silicate sands as well as PASS soils. The gradual changes in soil characteristics as well as the existing problems of seasonal flooding on the schemes forces many farmers to abandon these 'problem' lands.

Large areas of these 'agricultural' lands are consequently left fallow. It is estimated that between 30% and 40% of the total area of the schemes now consists of degraded unproductive land.

5.3 FAUNA

Table 7 shows a summary of animal species observed, or reliably reported, during three weeks of field work in each of the project areas. Appendix 3 gives a complete list of the 236 species, together with details on their status and utilization.

The absolute numbers reflect different specific expertise of team members and totals are not directly comparable. Fish and reptiles are highlighted in Riau and West Kalimantan; birds in Riau and Jambi. Moreover, the lists are a very brief snap-shots of the situation; and do not include records accumulated over time or from museums. The Riau list is probably most representative.

Nevertheless, *proportions* of significant species are reasonably comparable. Overall, more than one-quarter of the species observed is somehow significant, and one-fifth of the species is protected under Indonesia Law. Only three Endangered species occur in or near the schemes: False Gavial, Estuarine Crocodile and Sumatran Tiger.

Table 7: Summary of observed or reliably reported animal species in or near ISDP schemes, August-September 1992, and their status. Significant species are species that are *Protected* under prevailing Indonesian Law, listed in Appendix I or II of the Convention on International Trade in Endangered Species of Flora and Fauna, or registered in the IUCN Red Data Book as *Endangered*, Vulnerable, Indeterminate or Unknown.
(Source: AWB field data)

	RIAU			JAMBI			KALIMANTAN			TOTAL		
	Total	Signf	%	Total	Signf	%	Total	Signf	%	Total	Signf	%
Fishes (incl. Crustaceans)	32	2	6%	14	1	7%	31	2	6%	55	3	5%
Amphibians	5	0	0%	1	0	0%	2	0	0%	5	0	0%
Reptiles	31	6	19%	6	2	33%	10	4	40%	31	6	19%
Birds	99	28	28%	109	26	24%	32	10	31%	156	39	25%
Mammals	35	15	43%	17	10	59%	28	10	36%	46	18	39%
All	202	54	27%	147	39	27%	103	26	25%	236	66	28%
Protected	34	-	17%	28	-	19%	16	-	16%	47	-	20%
Endangered	3	-	1%	1	-	1%	2	-	2%	3	-	1%

5.3.1 Riau

The Siak region has been surveyed previously for it's terrestrial fauna, although these surveys were brief and mainly concerned with birds, larger mammals, and vegetation. Giesen & van Balen (1991a) recorded a total of five reptile, ninety bird and ten mammal species during a brief survey of the Siak Kecil Wildlife Reserve, only nine kilometres from the western boundary of the Siak Kecil transmigration scheme. Other surveys of Padang Island, at the mouth of the Siak River have been conducted by Giesen & van Balen (1991b) and Purwoko & Verheugt (1989). These surveys concentrated on vegetation descriptions, and inventories of birds and larger mammal species.

Very little fauna survey work has been undertaken in the Indragiri area although Giesen (1991b) surveyed Bakung Island, near the mouth of the Indragiri. A great deal of additional data on the region comes from surveys of the Berbak National Park, to the south in Jambi Province. Since this area is also largely peatswamp habitat, it is likely that many of the species recorded from the park also occur in the Indragiri and Siak areas.

During the course of a field visit by AWB staff in August-September 1991, a total of thirty-two fish, five frog, thirty-one reptile, ninety-nine bird and thirty-two mammal species were recorded on or near the transmigration sites (Appendix 3).

Fishes

Thirty-two species of fish were observed or reported from the Riau schemes. A number of species occur in the irrigation canals on the schemes. Common species occurring in the canals include Three-spot Gouramy (*Trichogaster trichopterus*), Striped Snakehead (*Channa striata*), Common Walking Catfish (*Clarias batrachus*), Climbing Perch (*Anabas testudineus*) and Swamp Eel (*Monopterus albus*). Most of these species are well adapted to tolerate poor environmental conditions, such as low dissolved oxygen and high turbidity, such as occurs in the canals.

A number of fish species typically occur in the blackwater rivers. All of the species that occur in the canals are also in the adjacent blackwater rivers, since this is the source of colonisation. In addition, Asian Bonytongue (*Scleropages formosus*), Bagrid Catfish (*Mystus nemurus; Kryptopterus* spp.) Giant Snakehead (*Channa micropeltes*) and Forest Snakehead (*Channa pleurophthalmus*) are found mainly in the blackwater streams.

In the larger rivers, a number of brackish water and pure freshwater species occur, even in areas where there is no salt intrusion. These species include Patin (*Pangasius* spp.), Catfish (*Mystus* spp.) and Glass Perch (Chandidae). Mudskippers (*Periopthalmus* spp.) were abundant along the banks of the major rivers, and frequently entered canals on the schemes.

There are no introduced species of fish occurring in the off-site areas of the Riau schemes. Four species, Snakeskin Gouramy (*Trichogaster pectoralis*), Giant Gouramy (*Osphronemus goramy*), Common Tilapia (*Oreochromis mossambica*) and Nile Tilapia (*Oreochromis nilotica*) are grown for aquacultural purposes in the Indragiri schemes. This is not currently operating on a large scale.

Freshwater Prawns (*Macrobrachium rosenbergii*) are common in most canals. In the tidal areas, small crabs make burrows the canal walls.

Reptiles and Amphibians

Frogs commonly occur in the man-made drainage canals of the Riau sites. The commonest species were *Rana erythaea* and *Rana limnocharis*. In the more forested areas, tree frogs (*Rhacophorus* spp.) could be heard calling.

Turtles were commonly reported as occurring in the primary and secondary canals of the schemes. The most widely occurring species is probably *Bellia crassicollis*, which was observed at Kuala Cinaku I. However, other freshwater turtles are likely to occur on the schemes and some instances of Soft Shelled Turtles (Family Trionychidae) living in the canals were reported. These turtles are quite large, and would be unlikely to spend much time in the smaller canals. The Malayan Giant Turtle (*Orlitia borneensis*) was reported as occurring in the larger rivers at many sites. The survey team observed a specimen in the Siak Kecil River.

Two species of crocodile occur near the transmigration sites. The Estuarine Crocodile (*Crocodylus porosus*) occurs along the Siak Besar River, in the navigation canal and in the lower Siak Kecil. It is reported to only enter the latter two locations late in the dry season when the water is more brackish. Although reported to be uncommon in the Siak area, crocodiles were nevertheless seen by most people, particularly in the Siak Besar. In 1992, two Estuarine Crocodiles had entered the Siak Kiri scheme (Block B) via a secondary canal and were trapped there after the flap gate had been closed. Although Estuarine Crocodiles were reported from the Indragiri River, they are now considered very rare in this area.

The main occurrence of the False Gavial (*Tomistoma schlegelii*) is in the Siak Kecil River, although it was reported to occur also in the Buantan River (Siak Kiri) and Cinaku River (Kuala Cinaku I). Mackinnon (1992) reports the Siak Kecil lakes to be a stronghold for this species, but people interviewed in this area claimed the species to be rare there, an impression also reported by Giesen & van Balen (1991a). In the middle reaches of the Siak Kecil River (near the transmigrant settlements) the species was frequently reported and the survey team saw one specimen near the junction with the navigation canal. One False Gavial was reported to have been dug up by an excavator while clearing a canal near the Buantan River.

A variety of lizards and snakes occur on the schemes. Common species include the Sun Skink (*Mabuia multifasciata*), Common House Gecko (*Hemidactylus frenatus*), Asian Water Monitor (*Varanus salvator*), Reticulated Python (*Python reticulatus*), Black Spitting Cobra (*Naja naja*) and Banded Krait (*Bungarus fasciatus*). Javan File Snake (*Acrochordus javanicus*) was reported to occur in some canals on the schemes.

Birds

Ninety nine bird species were recorded on or near the sites during the field survey. Birds such as White-headed Munia (*Lonchura maja*), White-bellied Munia (*Lonchura leucogastra*), Chestnut Munia (*Lonchura malacca*), Scaly-breasted Munia (*Lonchura punctulata*) and Baya Weaver (*Ploceus philippinus*) were commonly seen on the sites, and are regarded as pests. Some waterbirds occur along the canals within the schemes, including Cinnamon Bittern (*Ixobrychus cinnamomeus*), Lesser Adjutant (*Leptoptilus javanicus*) and White-breasted Waterhen (*Amaurornis phoenicurus*).

Forest-dwelling birds are abundant in the uncleared areas bordering the blocks. These included Pink-necked Pigeon (*Treron vernans*), Plaintive Cuckoo (*Cacomantis merulinus*) and Common Dollarbird (*Eurystomus orientalis*) and six species of Hornbill, all recorded from the schemes.

Mammals

Of the larger mammals, the most obvious group is the monkeys. Three species of monkey were recorded from the Riau sites, Silvered Leaf-monkey (*Trachypithecus cristata*), Long-tailed Macaque (*Macaca fascicularis*) and Pig-tailed Macaque (*Macaca nemestrina*). Silvered leaf-monkeys were particularly abundant in uncleared areas of the sites and in tall riverine vegetation. The two Macaque species were also common and were reported to frequently raid fruit crops on the sites.

Agile Gibbons (*Hylobates agilis*) were reasonably common in some areas of uncleared forest on the schemes. These were often heard calling from the edge of the forest adjacent to the fields.

Two pig species, the Wild Pig (*Sus scrofa*) and the Bearded Pig (*Sus barbatus*) occur in adjacent forest and scrub, and frequently in uncleared scrubland within the schemes. The Wild Pig is the more common species.

Other large mammals which occur on or near the schemes include Malayan Sunbear (*Helarctos malayanus*), the Endangered (RDB) Sumatran Tiger (*Panthera tigris*), Clouded Leopard (*Neofelis nebulosa*) and Sambar Deer (*Cervus unicolor*). Two other large species, Asian Elephant (*Elephas maximus*) and Tapir (*Tapirus indicus*) are known to occur in the region. However, these have not been seen in the vicinity of the transmigration sites for many years and the habitats in the areas surveyed are generally unsuitable for them.

The smaller mammals in the area include squirrels, such as Low's Squirrel (*Sundasciurus lowii*), Red Flying Squirrel (*Petaurista petaurista*) and Prevost's Squirrel (*Callosciurus prevosti*). Rats are numerous on the schemes. The most abundant species is Ricefield Rat (*Rattus argentiventor*), although other species including Black Rat (*Rattus rattus*) and Polynesian Rat (*Rattus exulans*) are also present.

Several species of introduced, or domesticated species live on the schemes, such as dogs, cats, water buffalo, goat and cattle. The Black Rat appears to be the only introduced species which has wild populations.

5.3.2 Jambi

There are no wildlife reports dealing specifically with the ISDP schemes in Jambi, prior to clearing and settlement. Existing reports address areas near the project sites, such as the Berbak National Park,the *Hutan Bakau Pantai Timur* Strict Nature Reserve and the Southern Sumatra Coast between South Sumatra and Riau Provinces. One can find complete descriptions of wildlife of Berbak National Parks in Silvius *et. al.* (1984 and 1986), Wulf *et. al.* (1981), Rusila (1991) and HIMBIO (1992) and of the *Hutan Bakau Pantai Timur* Reserve, in Giesen (1992). At the moment at least 286 bird species (Rusila, 1992), 38 mammal species (Silvius, *et. al.*, 1984) and 93 fish species have been identified in the Berbak National Park. In *Hutan Bakau Pantai Timur* Strict Nature Reserve, Giesen recorded at least 27 bird species plus and unspecified number of undetermined wader species. Other species identified there by Giesen: Reptiles: *Varanus spp, Python reticulatus, Boiga dendrophila* and *Trimeresurus sumatranus;* Mammalia: *Sus scrofa, Macaca fascicularis, Presbytis cristata,* and *Helarctos malayanus.*

The AWB team recorded, during a three-week field visit in August - September 1992, a total of 14 fish, 1, possibly 3 frog, 6, possibly 11 reptile, 17 possibly 21 mammal and 109 bird species on or near the ISDP - Jambi schemes.

Fish

Fourteen species of fish were recorded from Jambi ISDP sites, most of them were found in irrigation canals. Most of these species are found at and are well adapted to acid condition (pH<5.0 and down to 3.5), *e.g.*, *Osteochilus schlegeli, O. hasseltii, Mystus planiceps, M. nemurus, Belodontichthys dinema, Hemirhamphodon cf. phaiosoma* and *Rasbora vaillanti*. The last species is the commonest observed. Only one species found in neutral water pH = 6.5)

Mammals

Seventeen (twenty-two including domesticated species) species of mammals were recorded on or near Jambi schemes, including species reliably reported to the AWB team. Three species of monkeys, Silvered Leaf Monkey *Trachypithecus cristata*, Long-tailed Macaque *Macaca fascicularis*, and Pig-tailed Macaque *Macaca nemestrina* are commonly observed and/or reported wild mammals by transmigrants. The species are known to raid crops and can become a nuisance occasionally. The largest group observed by the AWB comprised 15 (mainly immature) Silvered Leaf Monkeys in riparian forest near Muara Sabak. Trained Pig-tailed Macaques are emplyed to pick coconut. Siamang *Symphalangus syndactylus* were often heard calling the peatswamp forests behind the Dendang schemes. Western Bearded Pig *Sus barbatus* and Wild Pig *Sus scrofa* were reported to be common on the Dendang schemes, and can become a pest there.

Among the carnivores, three species are also reported to occur in and near the schemes, namely Malayan Sunbear *Helarctos malayanus*, Sumatran Tiger *Panthera tigris*, and Leopard Cat *Felis bengalensis*. Malayan Sunbear reportedly often roams the settlements to look for young Coconut trees and sometimes young Jack Fruit *Arthocarpus heterophyllus*. A fresh pug mark of the Sumatran Tiger among pig foot prints was found in Dendang I, *ca.* 25 metres from the nearest house and *ca.* 1.5 Kilometres distance from the nearest primary forest. Leopard Cat is mainly reported by transmigrants in Simpang Puding (in February or March 1992, four immature cats were hunted by transmigrants' dogs in the remaining forest near Desa Simpang) and Dendang II.

Birds

Compared to the other two project areas, Jambi seems to have a somewhat higher bird species richness. A total of 109 bird species were recorded on or near the schemes, a respectable number considering the short period. At least twenty-two waterbird species observed in or near human settlement, including the Vulnerable Milky Stork *Mycteria cinerea* and Lesser Adjutant *Leptoptilos javanicus*. A flock of forty rare Asian Dowitcher *Limnodromus semipalmatus* were also found in the estuary of the Simbur Naik river. At least nine forest specialist species were still found in the remaining forest, especially in Lagan Hulu/Simpang Pandan schemes (most notably Block A), including Bushy-crested Hornbill *Annorhinus galleritus*, Asian Pied Hornbill *Anthracoceros albirostris*, Rhinoceros Hornbill *Buceros rhinoceros*, Yellow-crowned Barbet *Megalaima henricii*, and White-bellied Woodpecker *Dryocopus javensis*.

All Munia species known from Sumatra were observed in the scheme, namely White-rumped Munia *Lonchura striata*, Javan Munia *Lonchura leucogastroides*, Scaly-breasted Munia *Lonchura punctulata*, White-bellied Munia *Lonchura leucogastra*, Chestnut Munia *Lonchura malacca*, and White-headed Munia *Lonchura maja*.

In regard of predator birds, 6 species were observed in the riverine systems or in cultivation, including a large, single flock of at least 45 Black-winged Kites *Elanus caeruleus* in Lagan Hulu and 40 Brahminy Kites *Haliastur indus* in mangrove forest along the Berbak river estuary. White-bellied Sea-eagle *Haliaeetus leucogaster*, Grey-headed Fish-eagle *Ichtyophaga ichtyaetus*, Crested Serpent Eagle *Spilornis cheela*, and Black Eagle *Ictinaetus malayensis* were also seen solitary especially at the periphery of the forests. The occurrence of these predator birds could mean that the ecosystem is still going well and the utilisation of pesticides has still no significant impact on the fauna on and around the schemes. Frequent observations of Kingfishers points in the same direction.

5.3.3 West Kalimantan

The ISDP project region has a longer history of habitat conversion and degradation than the two sites in Jambi and Riau. This is expressed in the type and extend of present day wildlife habitat, and the animal species recorded during the EIA field work.

Reptiles and Amphibians

At least 19 frog and toad species occur in the lowlands of West Kalimantan, but only the commonest species like *Rana erythraea* and *Rana limnocharis* were recorded for the cultivated land on the schemes.

Soft-shelled Turtle (*Trionyx cartilagineus*) was several times recorded mainly occurring in natural rivers, but numbers have dropped through the years. Three species of monitor lizards live in West Kalimantan. Numbers were recorded to be low including those for the most common one *Varanus salvator*. No confirmed records could be obtained for the Estuarine Crocodile (*Crocodylus porosus*) and False Gavial (*Tomistoma schlegelii*), but the tidal swamps (108.000 ha) at Selat Padang Tikar south-east of Kubu provide suitable habitat for Estuarine Crocodile. Due to hunting and habitat disturbance crocodiles are considered to be extinct in the mangrove/nypah swamps in the estuary of the Punggur Besar River. False Gavial was reported to have disappeared from the Ambawang and Sungai Putih rivers south of Gunung Ambawang.

Surprisingly, snakes were reported to be rare on the schemes including the Reticulated Python (*Python reticulatus*). Hunting pressure for their skin could be the cause for this. Typical mangrove snakes, *Boiga dendrophila* and the Wagler's Pit Viper (*Trimeresurus wagleri*) were found in the forests in the eastern sub-project area. More detailed surveys, in particular in the degraded peatswamp forests will reveal more species.

Birds

At least 256 bird species occur in West Kalimantan, but this province is not known to be particular rich in waterbird and wader species.

Thirty-two bird species were observed in and around the tidal mangroves, with a large population of Lesser Adjutant (*Leptoptilos javanicus)* in the mangroves on Laut Island. Wandering Whistling Duck (*Dendrocygna arcuata*), a resident bird, occurs in large groups of up to 150 birds. Local Dayak people reported a steady decline and even disappearance of certain bird species, related to the large scale conversions of peatswamp forests for agriculture. Of the seven Hornbill species living in West Kalimantan only two, the Rhinoceros Hornbill (*Buceros rhinoceros*) and White-crested Hornbill (*Berenicornis comatus*) were recorded for the degraded peatswamp forests.

Ricebirds were reported to be a pest on some sites, with records of Chestnut Munia (*Lonchura malacca*) as most common.

Mammals

Interviews with local and transmigrant people and direct field observations shortlisted a relative small group of mammals still occurring near the schemes.

A total of twenty-seven mammal species was recorded during this survey. Of these monkeys, like Proboscis Monkey (*Nasalis larvatus*), Long-tailed Macaque (*Macaca fascicularis*) and Silvered Leaf-monkey (*Trachypithecus cristata*) were most conspicuous. Local people reported two additional species, Pig-tailed Macaque (*Macaca nemestrina*) and Red or Banded Leaf-monkey (*Presbytis*) to live in the remains of the peatswamp forests surrounding the schemes. Proboscis Monkey was abundant in the riverine forests with *Ficus microcarpa*, *Heritiera littoralis* and *Gluta velutina*, but was not observed on those sites degraded. The impression was given that suitable habitat for monkey species is declining, resulting in isolated forest remains. The Orang Utang (*Pongo pygmaeus*) does not occur in the project area.

Two pig species, the Wild Pig (*Sus scrofa*) and the Bearded Pig (*Sus barbatus*) occur in the eastern sub-project schemes (P3S) in adjacent forest and scrub. No pig pest problems were recorded for the schemes around Kakap (P2DR). Sambar Deer (*Cervus unicolor*) was often recorded for the same locations and habitat as Wild Pig, but in low numbers left. Bornean Yellow Muntjak (*Muntiacus atherodes*) has occurred on all schemes of the eastern sub-project area but is now only found on some locations like the hill forests of Ambawang Mountains and the logged-over forests between Rasau Jaya I and Sei Bulan.

Different from the Riau and Jambi schemes Polynesian Rat (*Rattus exulans*) or Malaysian Wood Rat (*Rattus tiomanicus*) are a pest in coconut and rice fields.

Frequent records were made of the Small-clawed Otter (*Aonix cinerea*) which lives around the canals, rivers and fishponds on the schemes.

In general wildlife is rare on the ISDP schemes,in particular for the coastal sites around Kakap, which is directly related to the age of occupation and few remains of 'forest' wildlife habitat. In the eastern sub-project area adjacent forest remains and riverine vegetation are the last strongholds for most of the species recorded.

5.4 SIGNIFICANT SPECIES

5.4.1 Status of Animal and Plant Species

In classifying the status of species, three reference systems have been used:

- Species that appear in the Red Data Book (IUCN, 1990) under the following classifications: E (Endangered); V (Vulnerable); R (Rare); I (Indeterminate) and K (Insufficiently Known);

- species that are listed by CITES (Convention on International Trade in Endangered Species) in the CITES Appendices I and II (Favre, 1989). It should be noted that the CITES agreement mainly deals with the regulation of trade in wildlife, and that some species listed, particularly those in Appendix II, are not necessarily rare or endangered at present; and

- species that are Protected under Indonesian law.

Riau schemes

A total of 28 bird, 15 mammal, 6 reptile and two fish species recorded from the Riau project areas fall under one or more of the above categories (Table 7 and Appendix 3). None of the bird species recorded are in the highest category of Endangered, however White-winged Wood Duck, Milky Stork and Lesser Adjutant are listed as Vulnerable.

The White-winged Wood Duck, which is also listed as an CITES Appendix 1 species, is the most threatened bird species occurring on the sites. This species was recorded only in the Kuala Cinaku I area of the Indragiri sub-project. The species was not directly observed by the survey team, but very accurate descriptions of the species appearance and habits were obtained from witnesses who were assessed to be very reliable. These witnesses also picked this species out from a bird identification book without prompting.

The most significant mammal species occurring in the areas is the Sumatran Tiger, which is Endangered. This species was reported from many schemes where there was uncleared LU2 land backing on to forest. Most recent reports of Tigers came from the Kuala Cinaku area in Indragiri, and in the western parts of Siak Kiri. The Clouded Leopard (RDB - Vulnerable) was reported to be not uncommon in the Siak area. Other species of note include the Malayan Sunbear and Agile Gibbon, both of which are quite common in some forests adjacent to the schemes.

Significant reptiles recorded include the Estuarine Crocodile and False Gavial, both of which are Endangered. Crocodiles occur along the Siak Besar River in Siak, and along the Indragiri River, where they are reported to be rare. The main areas for False Gavials are along the Siak Kecil River (Siak), and the upper Cinaku River (Indragiri).

The Asian Bonytongue is an CITES Appendix I listed fish species which occurs in the area. The main habitat for this species is in the Siak Kecil Wildlife Reserve, but it is also reported to occur all along the Siak Kecil River in the vicinity of the schemes.

Jambi schemes

Significant species in the jambi project area include 1 fish, 2 reptiles, 26 birds and 10 mammals. Only one species is listed as Endangered, namely Sumatran Tiger. This species was reported from at least 4 sites, but the AWB team observed only one pug mark.

Two bird species, Milky Stork *Mycteria cinerea* and Lesser Adjutant *Leptoptilus javanicus* are listed as Vulnerable. The first species was found locally in the estuary of Simbur Naik and along the coast near Berbak River estuary, and even on the Pamusiran and Dendang II schemes. The South East coast of Sumatra is known to accommodate more than 90% of world population of Milky Storks (Silvius, 1987).

Asian Dowitcher *Limnodromus semipalmatus* and Wrinkled Hornbill *Rhyticeros corrugatus* are the only birds listed as rare. The Dowitcher was found once during the field visit in the Simbur Naik estuary. Silvius *et.al* (1984) observed a total of 1,460 Asian Dowitcher in the same place and claimed it to be the largest single flock ever recorded of this species. So far, this Dowitcher has been reported from Indonesia only four times.

West Kalimantan schemes

Far fewer species in West Kalimantan fall under these classifications than for the Riau and Jambi project locations, totalling 5 reptile, 5 bird, 13 mammal and 1 fish species.

The most significant reptile species is the Estuarine Crocodile (*Crocodylus porosus*) which is Endangered. This species is expected to be found in the extensive mangrove/Nypah swamps of Selat Padang Tikar.

The Proboscis Monkey (*Nasalis larvatus*) is endemic to Borneo and is considered Vulnerable and listed at Appendix I. Because of declining populations Indonesia gave protected status to this species. Some populations still occur around the schemes, mainly in the riverine forests of the larger rivers. However, suitable habitat is under pressure because of land clearing and degradation. Other species traded and included in Appendix II, like Pig-tailed Macaque and Silvered Leaf-monkey also depend on the remaining forest areas close to the schemes for survival.

The Asian Bonytongue, which exhibits three colour varieties locally (including the sought after "Red Arowana"), is becoming scarce in the area.

5.4.2 Pest Species

Agricultural pests are not a problem that is unique to the transmigrant schemes. Indeed, agricultural pests are a problem faced by all farmers in the world. Most farmers on the ISDP schemes stated that even the worst pest species are (usually by far) secondary to flooding problems (unless no flooding occurred of course). Very often they stated that they are perfectly capable of handling the problem, *provided more people and more social coherence.*

A number of wildlife species occurring on the schemes are regarded as agricultural pests and thus, these species are often the target for hunting or poisoning activities.

The commonest rice crop pest species cited were birds of the finch family, particularly White-headed Munia, White-bellied Munia, Scaly-breasted Munia and the Baya Weaver. At one location in Indragiri, the White-winged Wood Duck was reported to be a pest to rice. This species (which is a Vulnerable species) systematically pulls out the newly planted padi. Similarly, the Purple Swamphen seems to cause troubles in Simpang Puding (Jambi). Although Ducks and Swamphens visit the crops in small numbers (1-5 individuals), they can do a lot of damage. Note that we do not know other instances of these two species causing trouble in Indonesia.

Most pest species reported were mammals. Of these, the Wild Pig was reported as the most destructive. The Western Bearded Pig also occurs in most areas, but this species is not regarded as a serious pest. In West Kalimantan, Wild Pigs are not a problem on all sites of the western sub-project area, but is on Rasau Jaya I, Arus Deras, Pinang Luar, Sei Bulan, Jangkang, Sei Radak, Pinang Dalam, Air Putih, Olak-Olak Kubu in the eastern sub-project area.

Pig pest problems are directly related to the occurrence of secondary shrub vegetation on-site and forest remains close to the schemes. Crops most impacted are maize, tuber crops like cassava, young coconut, peanut, soybean and pineapple.

Rats, particularly the Ricefield Rat, are seasonal pests of rice. The Black Rat reportedly can be a pest as it attacks goods and harvested crops in storage. Farmers in the West Kalimantan schemes, reported seasonal raids on coconut by the Polynesian Rat (*Rattus exulans*) or Malaysian Wood Rat (*Rattus tiomanicus*) but rats were considered a pest of less importance (impact) than those by Wild Pig (*Sus scrofa*).

Monkeys are often regarded as pests, as they raid fruit and vegetable crops in location near the forest. The main pest species is the Pig-tailed Macaque, but Long-tailed Macaques are also responsible for damage.

The Malayan Sunbear is regarded as a pest in areas where coconuts are grown. The bears cause damage by eating the crown of the young coconut, thus killing the plant. This species only occurs on the Sumatran schemes.

In areas where aquaculture is practised in the Indragiri schemes, the Common Otter is a serious pest, because they catch fish from the ponds at night.

In West Kalimantan, the Small-clawed Otter (*Aonyx cinerea*) was often recorded in large groups, stealing most fish out of the freshwater fishponds of transmigrants. It further occurs along the many natural and man-made waterways.

Large cats, such as Sumatran Tiger and Clouded Leopard are occasionally involved in taking chickens or goats from the villages, but they are generally not regarded as pests because the incidence of this happening is generally low.

6.0 EXISTING SOCIO-ECONOMIC ENVIRONMENT

6.1 REGIONAL LAND USE

Most of the schemes are located in areas which have been settled for many years, and they are surrounded by a variety of outside interests and activities. The principle land usages occurring around the schemes are:

- o agriculture, particularly rice and palawija crops, and plantation estates such as coconuts, rubber and oil palm;
- o logging concession areas;
- o fishing, usually non-commercial;
- o mining, particularly oil exploration and drilling (mainly concentrated in the Siak sub-project area).
- o large towns located along the rivers, which serve as trading ports;
- o industrial development (*e.g.*, sawmills, brickworks, pulp and paper mills, rubber factories, *etc.*)
- o conservation areas such as wildlife reserves and national parks.

Tourism in the areas is virtually non-existent as there is no support infrastructure, poor access, and very few potential attractions. The historic town of Siak Sriindrapura, near the Siak schemes currently attracts small numbers of tourists who mainly come to see the Palace, which houses a well-maintained historic museum.

Detailed Regional Land Use maps for each (sub-)project area are presented in the appended Maps 1B-4B.

6.1.1 Siak Sub-project Area

The Siak sub-project is located amidst a number of outside influences which are at present having an impact on the local environment.

The Siak Kiri schemes are located along the Siak Besar River. This is an important transport route linking the provincial capital, Pekanbaru, with major trading ports such as Bengkalis, Batam Island and Singapore. Therefore, the river is subject to constant and heavy traffic. Large ships, up to 1,000 tonnes regularly ply the river, as do a large number of smaller vessels. The potential for environmental pollution from shipping accidents, such as oil spills and loss of dangerous cargo is very high, and may well have occurred in the past. Also, wave action from passing ships has the potential to cause

serious erosion to unprotected river banks and damage to riverside structures such as jetties. This process was very apparent during the field surveys.

Along the river between Siak Kiri and Pekanbaru, there are a number of factories including plywood, rubber and palm oil manufacturers which are alleged to have discharged waste products into the river. One of these, a pulp and paper mill about 60km upstream of the project area has been alleged to have dumped industrial waste into the river which reportedly caused a fish kill (miscellaneous national newspapers, August-October 1992).

Although there are no commercial fisheries operating in the vicinity of the project area, local and non-local people utilise the area for fishing. Fishing activities are particularly concentrated on the Siak Kecil River, where, according to local reports, fish stocks have seriously declined in recent years. The widespread use of fish poisons (usually potash) in the area has reportedly also decreased fish stocks. Commercial fisheries operate along the coast near the schemes, and the city of Pekanbaru is a major port for the fishing industry in Riau.

Most of the land surrounding the Siak sub-project area is covered by forest concession, in fact, one concession has a base camp at the Siak Kecil scheme. Logging in the surrounding peat swamp forests requires the laying of corduroy log mats through the forest which are then overlaid with a rail system to gain access. Most of the forests in the area are therefore in various stages of forest utilisation. An Environmental Impact Assessment covering the Siak logging concessions is currently in progress.

The Siak Kecil Wildlife Reserve is located along the Siak Kecil River. The eastern boundary is about 9km (by river) from the Siak Kecil schemes. This wildlife reserve has been designated to protect a unique series of dystrophic lakes on deep peats, which drain into the Siak Kecil River. The Reserve supports a variety of threatened wildlife species, including Sumatran Tiger, Asian Elephant, Malayan Tapir, False Gavial and Asiuan Bonytongue (Arowana) fish. Forests in the reserve are generally in a degraded state, due to previous logging, and there is evidence that illegal logging is still going on in the reserve (Giesen & van Balen 1991). A number of brick factories are located along the Siak Kecil River near the mouth and these factories require a large amount of firewood, some of which may be coming illegally from the reserve.

There is a great deal of oil exploration and drilling going on in the region. Caltex, which is based in Rumbai, near Pekanbaru has constructed an earthen road which passes through parts of the schemes and is the main road link to Pekanbaru. This road is regularly sprayed with oil for compaction. Caltex is currently conducting seismic tests on some of the Siak schemes. Transmigrants generally had a good relationship with Caltex in the area, saying that they paid good royalties for land. They were also happy that Caltex had maintained the roads and in one instance, had built a mosque for the local community.

6.1.2 Indragiri Sub-project Area

The Indragiri schemes are located in a heavily populated area. Almost the entire region to the east, north-east and south-east of the schemes is agricultural land, while to the west, agriculture development extends all along the Indragiri river. The river itself is subject to heavy and constant traffic. Two major towns are located near the schemes, Rengat, to the west, and Tembilahan to the east. The area is serviced by good asphalt roads which are currently being upgraded.

Industries along the river are dominated by sawmills, sand mining and logging base camps. There is a great deal of fishing activity, although most is on a small scale.

To the north of the river, lies a huge expanse of peat swamp forest, extending some 75km to the Kampar River. Most of this area is covered by logging concession. Within this area, commencing about 20 km north west of the westernmost schemes lies the Kerumutan Wildlife Reserve, Riau's largest conservation reserve. This reserve extends northwards from the north side of the Indragiri River near Rengat to the Kampar River and covers an area of 120,000 ha. Little data are available on the condition of this reserve, as it is extremely inaccessible.

To the south of the schemes, there are also large expanses of relatively undisturbed swamp forest, although these areas are continually being opened up for agriculture, particularly oil palm plantation estates.

6.1.3 Jambi Project Area

The Batanghari and Berbak Rivers are large rivers navigable by sea vessels up to the provincial capital and further. Upstream of the project area, untill the capital Jambi, there are ten or eleven medium to large sawmills active. Huge barks are towed over the Batanghari and Berbak to suppply these mills of logs. Tankers ply the waters to provide the province with petrol and oil.

Near the coast, on the banks of the two estuaries are the project area's two regional centres: the small Nipah Panjang town in the east along the Berbak, and Muara Sabak (after which one scheme has been named) in the west along the Batanghari. A minor centre is located at 'pasar SK 17' in Rantau Rasau. The land on the 'deltaic island' is largely cultivated, particularly with coconut. Little natural cover remains there, except for a patch between Muara Sabak and Lambur, a stand between Pamusiran and the Batangahri and along the coast and the lower reaches of the Lagan, Batanhari, Simbur Naik, Pamusiran, and Berbak Rivers (mangroves). These mangroves either have the status of Strict Nature Reserve or are proposed as Protection Forest (RePPProT 1988).

The younger western and and southern schemes (Simpang Pandan, Lagan Hulu, Dendang I-III), are 'pushed' into extensive stretches of peatswamp forests, often on a peat dome. The forest south of the three Dendang schemes has been logged. The peatswamp forest south and west of Simpang Pandan and Lagan Hulu seems not logged and still largely undisturbed. All these peatswamp forests have the status of either Normal Production Forest (most), Convertible Forest (some; a portion bordering on Lagan Hulu, another

portion on Dendang III) or is Unclassified Forest (some; bordering on Simpang Pandan). See also the appended Land Use/Forest Status for Jambi (Map 3B). These forests together form a *corridor connecting* the Berbak National Park (and further east the proposed Sembilang conservation area) with forests in Riau, *(still) valuable* for movements of large wildlife (notably Tiger). All these forest are under logging concessions.

The land north of the Simpang Pandan scheme, between the estuaries of the Batanghari, Lagan and Mendahara[14] Rivers, is also virtually completely under cultivation, again, dominated by coconut.

There are two sawmills in the vicinity of the Dendang I scheme. The mills absorb important numbers of workers from the Dendang schemes. We do not know where the logs sawn in the mills originate, presumably from outside the region. Large barks were seen unloading logs at the mills.

No mining or oil exploitation is reported from the project area, though it seems that exploration has taken place several years ago.

6.1.4 West Kalimantan Project Area

There are two plywood mills near Rasau Jaya II and many small sawmills scattered through the area. These mills provide considerable employment opportunities both in terms of direct employment and for supporting services such as providing poles for making rafts for transporting logs. However, resources of larger logs have run out in the forests around and most of these are now extracted from far inland along the Kapuas Catchment Area.

Settlers around Kubu are involved in the processing of charcoal from mangrove logs taken from the swamps of Padang Tikar. An important product extracted from these same coastal swamps is Nypah thatch, which is sold at the local market. Some sites like Arus Deras and Sei Bulan subsist mainly on their logging activities and other schemes obtain additional income at a seasonal base or from remittances from family members working outside the site. However, large scale logging operations (HPH) are now something of the past as all primary forests have been logged.

Many small scale rubber plantations managed by local people are found along the river banks in the area.

6.2 POPULATION AND DEMOGRAPHY

Population statistics were derived from the October 1990 census which was executed in the 1990/91 planting season. According to these data the population of the ISDP areas was 187,865 persons (96,779 males and 91,086 females) in 40,244 households.

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[14] This -large- Mendahara River should not be confused with the -small- river of the same name that runs through Block A of Simpang Pandan. See there.

The distribution of population and its composition by project area is shown in Table 2.2, 2.3 and 2.4 of the Technical Report No 10 (Socio-Economics). Within individual schemes, local villages with a high proportion of non-Javanese population have larger household sizes than transmigrant villages.

Tables 2.5, 2.6 and 2.7 of the Technical Report No 10 (Socio-Economics) show estimates of the rate of population growth for each of the schemes in the Jambi, Riau and West Kalimantan project areas. Only Rantau Rasau (Jambi), Kuala Cinaku I & II, Delta Retah, Siak Kiri (Riau), Rasau Jaya and Desa Kubu (West Kalimantan) showed significant growth since handover. In most others, population has declined, often dramatically.

The total population at the West Kalimantan project schemes amounts to 82,206 persons (Appendix 4) At least another 63,755 persons live around the schemes, mainly along rivers (Buginese, Chinese and Malay people), or in the original villages like Kubu, Terentang, Teluk Pakedai, Ambawang settlements and Kakap.

Appendix 4 also gives estimates of the total land available per person for the villages recorded. It can be seen that the Teluk Pakedai district, with Sei Nipah as project scheme, has only an average of 1.2 ha land available per person. Even lower amounts of land are available for Sungai Kakap district with an average of 0.7 ha per person. This coastal district with schemes like Rasau Jaya I, II, III and those of the western sub-project area might get problems with the availability of agricultural land in the near future if the population will develop further.

Sei Radak and those schemes of the Kubu district have much more land available per person with an average of 5 and 4 ha respectively.

6.3 LAND TENURE

From the time of first settlement to the present, household status and land tenure has been changing. Some reasons are that households have:

- aged and passed land on to their children;
- bought land in whole or partial plots from departing families;
- sold land in times of hardship; and
- actively cleared and exploited good land in unallocated areas.

Virtually all land is owner cultivated: very little is rented or share cropped. However, land status is difficult to quantify since the number of original transmigrants remaining on the schemes is not known, there have been significant movements of people into and out of the schemes and very few farmers equate the concept of ownership solely with the issue of Hak Milik titles. Available information suggests that land certificates have been issued to most current households who are entitled to them.

Originally, transmigrant farmers were granted 2.25 ha of land under a system of housclots, LU 1 and LU 2 (see Section 2.2). In practice, however, farmers tended to use the better of their plots more frequently and have tended to trade plots without regard to their status as LU 1 or LU 2. This has resulted in the utilisation of the best contiguous blocks for agriculture, leaving large areas (usually on the periphery of the schemes) uncleared.

6.4 LAND-USE ON THE PROJECT SCHEMES

6.4.1 Riau

Land under agricultural use in the Riau schemes amounts to about 27,800 ha (10,300 ha in Siak and 17,500 ha in Indragiri). Monocropped rice fields amount to 8,540 ha (5,700 ha in Siak and 2,800 ha in Indragiri). Rice fields occupy about 31% of the land under agricultural use.

In Siak, the remaining area is made up of 21% predominantly cleared unused land of scrub and alang-alang, 11% of house lots including garden crops and 11% of tree crops such as coconut.

In Indragiri, the remaining land includes 10% mixed coconut/rice/scrub, 10% house lot gardens, 7% coconut plantation and 7% cleared fallow land of scrub and alang-alang.

Land under natural vegetation, usually degraded peat swamp forest is about 11,000 ha over both sub-project areas.

6.4.2 Jambi

The total area of cropped land within the schemes amounts to 27,546 hectares (64% but possibly between 52% and 70% depending on which total surface is taken as a base) plus 3,331 ha of un(der)developed land, uncleared or under *alang-alang* and scrub, within the schemes, thus totalling 30,877 hectares (59-79%). (Moderately) good soil is given as 31,409 ha. This close agreement between potention and reality could indicate that farmers avoid less suitable soil (deep peats, acid sulphate soils). The more fully developed schemes on the 'deltaic island', Simpang Puding, Rantau Rasau, Pamusiran, Lambur and Muara Sabak, show cropping intensites of 74-95%; on the less developed schemes on the margin of peat domes, like Dendang I, II, III, Lagan Hulu and Simpang Pandan, cropping intensities vary between (33-)69-73%

Rice cropping intensity, here defined as land under rice with up to 12.5% coconut relative to *suitable* soils available, varies in the opposite way: developed schemes 54-73%; less developed schemes 59-91%

The mean area cropped per household varies from 1.97-2.34 ha/hh to 1.71-2.13 ha/hh respectively.

Though large areas of Rantau rasau are supposed to be destined for wood crops, notably fruit trees, because of peats, only Lambur is reported to have 400 ha of fruit trees. Some pineapple sultivation is attempted on less developed schemes (Dendang I-III).

Existing fishponds are negligible: a mere 14.37 hectares for the Jambi project area. Fishery does not play an important (commercial) role on the schemes[15], but off-scheme (non-ISDP farmers) seem to make considerable use of fish resources for subsistence purposes.

Table 8: Summary of land use aspects for the Jambi project area.
(Source: Technical Report 5 *Agriculture*, Table 3.2, p.64)

	Rice (with up to 40% coconut)	Total Cropped Land	Cropped + Un(der)-developed	Cropping Intensity	Rice Intensity	Mean Area Cropped
Simpang Pandan (6,500 ha)	1,435	2,710	3,516	73%	65%	2.13
Lagan Hulu (4.030 ha)	585	1,885	2,885	33%	91%	2.03
Dendang I & II (6,500 ha)	2,673	3,293	4,393	69%	59%	1.71
Dendang III (1,940 ha)	?	?	?	?	?	?
Muara Sabak (1,950 ha)	1,480	1,480	1,655	74%	54%	1.97
Lambur (6,440 ha) + Pamusiran (4,140 ha)	4,815	8,165	8,415	95%	55%	2.34
Rantau Rasau (9,110 ha) + Simpang Puding (2,760 ha)	5,868	10,013	10,013	90%	73%	2.01
JAMBI SCHEMES (43,370 ha)	16,856	27,546	30,877	?	?	2.10

6.4.3 West Kalimantan

The total area of the project schemes is 46,114 ha of which 31,255 ha is presently cultivated. Large areas degraded by clearing, burning and unsuccessful agriculture are now under alang-alang, dense fern vegetation and shrubs up to a total of 5,225 ha. Other degraded semi natural vegetation types like degraded peatswamp forest and mangroves measure about 2,835 ha.

In most West Kalimantan schemes the areas of cropped soils conform closely to the areas of good rice soils (mineral and shallow peat without PASS). Because of problems with flooding, salt intrusion and PASS/peat soils, farmers selected the best available lands. This means that present land use pattern has no correlation any more with the original classifications like LU1, LU2 or reserve lands.

[15] With the exception of people in Block A of Simpang Pandan, that claim that on-scheme is a rich, albeit their only source of protein.

Areas fully under cultivation (settled) are Kapuas II and Rasau Jaya I and II. The database presented in Appendix 2 gives the ratio between cultivated and total area of land for all schemes. Most schemes are for more than 60% cultivated but schemes like Rasau Jaya III, Kapuas III, Pinang Dalam, Sei Bulan, Jangkang I, Desa Kubu and Sei Radak fall short in this aspect.

The main cropping systems are rice paddy (18,015 ha or 57%), mixed rice/coconut (8,940 ha or 29%) and coconut/treecrops (4,300 or 14%), the latter mainly in Punggur Kecil.

Many people living in schemes close to the sea, in particular Kapuas III, Jawi, Betutu and Sei Nipah are involved in near coastal fisheries and catches in the (brackish) canals to supplement their income during the periods that no rice can be grown. Many of the families living in Kakap village are entirely restricted to fisheries and to providing transport services at the sea and to the schemes. The rivers in the eastern sub-project area provide some fish to the inhabitants, but chiefly the Malay and Chinese people living along these waterways are specialised in river fishing.

Most aquaculture activities in the West Kalimantan project area are traditional, non-intensive and carried out particularly to supply fish to the family in addition to the normal agricultural income. Major problems for aquaculture is the bad quality of the water (peat and PASS) and drying out of ponds during the dry season. Fishes bred are adapted to this kind of environment like Jelawat (*Leptobarbus hoevenii*), Betutu (*Oxyeleatris marmoratus*), Tambakan (*Helostoma temmincki*), Sepat Siam (*Trichogaster pectoralis*), Betok (*Anabas testudineus*) and Udang Galah (*Macrobrachium rosenbergii*). *Trichogaster pectoralis* has been introduced in Indonesia for cultivation in ponds and ricefields.

Forestry activities are lacking on the project schemes though some initiatives have been taken to plant trees for future firewood supply like on Sei Radak.

As mentioned before many of especially younger people find a living in off-farm work. This includes work at sawmills along the rivers, rubber and wood-processing factories in Pontianak, and even jobs in Malaysia.
A unique type of harvesting is the collection of old *damar* (resin) reserves in the soils around Rasau Jaya I, Arus Deras and east of Sei Nipah. The *damar* which is actually a forest product is sold to a factory.

7.0 ENVIRONMENTAL ISSUES ARISING FROM PROJECT COMPONENTS

7.1 INTRODUCTION

The main project components with potention to cause environmental impacts are described in section 3.3. This section analyses the potential impacts they may cause along with mitigation measures or alternatives which may reduce these impacts. These impacts are treated in a general sense, in that they may occur over a range of sites where the project components are implemented. Site specific impacts are dealt with in detail in Section 10.

7.2 UPGRADING OF HYDRAULIC INFRASTRUCTURE

7.2.1 Dikes and Canals

The construction and rehabilitation of dikes and canals involves the excavation of 8.2 million cubic metres earthwork, summarized in Tabel 9.

Heavy equipment is only operated during the dry season to avoid too soft swampy soils. No special precautions are taken to minimize the impact of excavations to existing environments like agriculture or aquatic habitats.

Potential Impacts

The Physical Chemical Component:
The main environmental factor related to these dikes is the type of soil being used for construction. Potential Acid Sulphate Soils (PASS) occur on large areas of the ISDP project schemes, including those with high levels of pyrite. The amount of pyrite found in the different soil layers is the key factor in the evaluation of potential impact of these soils when being exposed to the air. Pyrite content of soils classified as PASS varies between 1.4% to up to 7%. Soils with an average pyrite content of 2.4% and higher are known to release prodigious quantities of sulphuric acid up to a soil depth of 4 m (AARD & LAWOO, 1990).

Typically, soil acidity builds up quickly during the first 30 days after exposure to the air (digging), after which a long process starts in which toxic levels of Aluminum ion (Al^{3+}), Ferrous ion (Fe^{2+}) and other metals are released from the soil matrix. This process stops when soil acidity has dropped to about pH 2.5 after about 4 months (TR4, Chapter 2). The above mentioned soluble salts are leached into drainage water during rain and in high concentrations are toxic to plant and fish life.

Direct toxicity by dissolved acid and aluminum will be greatest in those inland schemes further from the sea where waters are weaker buffered (Dent, 1986). Also, in contrast to the salt-water zones their is little or no tidal effect to assist drainage and the removal of acid affluent.

The location of the new dikes and canals involves the destruction of existing agricultural lands like coconut groves and rice paddies. However the most profound impact is the pollution of these fields with effluent from the freshly excavated soils, which depending on topography will extent much further from the actual site of activity.

Table 9: Summary of proposed earthworks (in 1,000 m³).
(Source: Main Report, Annex 4, Table 4; Technical Report 6 Volume II *Upgrading of Existing Infrastructure* App. 7)

	Rechannelization existing rivers/canals and exacavation new canals				Dikes	Total
	Primary	Secondary	Tertiary	River		
JAMBI						
Rantau Rasau	0.0	0.0	0.0	0.0	171.8	171.8
Simpang Puding	0.0	0.0	0.0	0.0	191.7	191.7
Lambur	0.0	16.0	24.0	50.0	0.0	90.0
Pamusiran	450.0	8.8	42.0	0.0	0.0	500.8
Dendang I, II	752.1	596.5	0.0	0.0	260.5	1,609.1
Dendang III	121.2	57.1	0.0	0.0	168.4	346.7
Simpang Pandan	125.0	162.0	0.0	40.0	32.2	359.2
Lagan Hulu	0.0	0.0	0.0	586.5	0.0	586.5
Sub-Total Jambi	1,448.3	840.3	66.0	676.5		
		Sub-Total canals/rivers		3,031.1	824.5	3,855.7
RIAU						
Siak Kiri A	174.8	30.0	0.0	36.0	112.8	353.6
Siak Kiri B, C, D	6.0	22.0	0.0	0.0	313.6	341.6
Siak Kecil	66.0	67.6	0.0	465.0	0.0	598.6
Kuala Cinaku I	0.0	81.6	135.1	0.0	212.2	428.9
Kuala Cinaku II	0.0	6.4	0.0	0.0	16.0	22.4
Teluk Kiambang	0.0	0.0	3.4	0.0	80.0	83.4
Tempuling	36.2	33.8	0.0	200.0	150.5	420.5
Reteh	59.7	0.0	0.0	160.0	0.0	219.7
Sub-Total Riau	342.7	241.4	138.5	861.0		
		Sub-Total canals/rivers		1,584	885.1	2,468.7
WEST KALIMANTAN						
Western sub-project	0.0	0.0	0.0	0.0	294.5	294.5
Rasau Jaya	0.0	0.0	0.0	0.0	0.0	0.0
Pinang Luar	121.8	0.0	0.0	0.0	4.2	126.0
Pinang Dalam	0.0	0.0	0.0	0.0	21.7	21.7
Sei Bulan	0.0	0.0	0.0	0.0	155.4	155.4
Air Putih	0.0	0.0	0.0	0.0	0.0	0.0
Sei Nipah	297.0	0.0	0.0	0.0	296.0	593.0
Arus Deras	0.0	0.0	0.0	0.0	23.2	23.2
Desa Kubu	160.0	0.0	25.0	0.0	0.1	185.1
Olak-olak Kubu	0.0	0.0	79.5	0.0	67.8	147.3
Jangkang I	0.0	0.0	121.3	0.0	0.0	121.3
Sei Radak	0.0	0.0	121.0	0.0	175.7	296.7

Sub-Total West Kalimantan	578.8	0.0	346.8	0.0		
		Sub-Total canals/rivers		925.6	1,038.6	1,964.2
Grand-Total	2,369.8	1,081.7	551.3	1,537.5		
			Total	5,540.3	2,748.2	8,288.6

Biologicasl Component

The construction of new dikes and canals in areas of peat swamp forest would destroy the natural vegetation. The main impact, however, would be the fragmentation of wildlife habitat. Canals and collector drains along the would pose an obstacle to smaller terrestrial mammals and reptiles. It has been learned that canals and dikes located on and around schemes are the prime access routes for inhabitants to the adjoining forests to collect wildlife and logs.

Canals established in moderate to deep peat also drain the adjoining swamp forests result in the dying of trees and increase in risk of forest and sub-soil fires during the dry season. The dikes located in pure mangrove forest in West Kalimantan (Kubu) hamper free flow of tidal water, which may lead to dying of this productive forest. That this is not the case yet is because present dikes are damaged at three locations, leaving a free tidal flow.

These on and off-site forest resources should be managed more wisely. Especially in Riau sites have still important forests resources which act as bufferzones between nature reserves and development areas.

Socio-Economic Component

Many of the proposed dikes and canals will cut right through land being used by inhabitants for settlements and agriculture. No proper consultation has been sought by the departments of PU with those local people being impacted. Although people were positive about the infrastructure plans friction will develop when actual excavation work will start.

Also most dikes and canals are solely planned to assist the agriculture of scheme inhabitants and leave neighbouring farmers out. This is certainly not to the advance of the integration of local development with transmigrant schemes.

Project Alternatives

Two aspects have to be evaluated in relation to the earthworks proposed.

- the location of the dikes and canals, and
- the PASS soils effects.

Some of the works on dikes and canals proposed are to be located on existing forest land, not being used for agriculture. These lands are not cultivated for reasons like lack of manpower, seasonal flooding, too deep peat or saline intrusion by the sea. In most cases these forests also have an important function as a wildlife refuge (Riau) and as breeding and nursery site (mangroves of Kubu, West Kalimantan).

The most obvious alternative would be to relocate these dikes inland in such way that they directly border productive land and exclude as much as possible unproductive sections of the schemes and forests off-side.

Canals entering valuable wildlife habitat or forests to be protected could be closed off from river transport by physical structures.

PASS soil related problems as discussed above can be minimized or avoided by the following measures:

- o construction of earthworks only during the rainy season,
- o bring non-PASS soil in from other locations,
- o liming of PASS soil, and
- o reducing the depth of excavation for dike materials.

During the rainy season oxidation of PASS soil material will be slowed down because soils are constantly wet and effluent will be better diluted. The increased flow in canals will transport most polluted water to the larger rivers were buffer capacity is higher. This means that Public Works has to change its season of operation.

Presently only in some cases of structurally unsuitable peat materials better soil material is brought in from other nearby locations.
This should also be considered if local soil materials have high amounts of pyrite (>2.4%). This considers in particular the soils classified as 'moderate' and 'high' regarding their pyrite content. For an overview of risk classes of these critical soils see the Appendix 5.

Liming of acid sulphate soils has been proposed by many consultants, but excessive amounts of lime (100-150 mton/ha in the first year, and 20-30 mton/ha during two to five years thereafter) are necessary to only neutralize the top soil layer of dikes and canal diggings. Given the fact that oxidation of pyrite after drainage or excavation can continue up to a depth of 4 m, all excavated soil material should be mixed with lime. This is even more labour and capital intensive than transport of suitable soil from adjacent locations. Also experiments with liming on agricultural lands revealed that this is only successful if the soils were low in reserves of pyrite or jarosite (Dent, 1986).

A lot of negative impact by PASS soils can be minimized if only the upper soil layers are being used as construction material for dikes. Most ripened soils do not have high amounts of PASS within 30 cm depth. However, this method would require that much larger surfaces of land would be cleared (10-15 times), resulting in higher levels of surface erosion and loss of agricultural crops.

7.2.2 Flap Gates, Sluice Gates and Stop Logs

Although most of these water control structures will be located in tertiary canals, some will be constructed in secondary canals.

It was learned from the inhabitants at the sites that those structures keep them from using these canals for transport by boat, and often did not function as they would like them to keep water in or out their fields. Often these gates had been removed as a result.

Also presently free flowing canals (in both directions) will be transformed into on-way streams by flap gates, which might give circulation problems when soil water levels drop in the dry season. Lack of flushing possibilities will result in building up of unacceptable levels of acid and other effluent from peat and PASS soils.

7.2.3 Weirs

Two weirs are planned for Riau, but no exact data could be obtained about the design and operation related to the hydrology of the area.

7.3 IMPROVEMENTS TO TRANSPORT AND NAVIGATION SYSTEMS

7.3.1 Roads, Bridges, and Jetties

The upgrading of the road and navigation system will be done by repair of existing earth roads and paving some of the main transport roads. Though the same physical and chemical environmental aspects apply for this project component as for hydrological earthworks (section 7.2.1) much less volumes of earth will be moved. Also no new road sections will be developed. The conclusion is that environmental impact if any is small, and this will be discussed in the detailed analysis per scheme (chapter 9).

7.4 STRENGTHENING OF AGRICULTURAL SUPPORT SYSTEMS - PEST CONTROL

It should be stated at the outset that agricultural pests are not a problem that is unique to the transmigrant schemes. Indeed, these agricultural pests are a problem faced by almost all farmers in Asia and a large amount of research data exists on the various methods of controlling them. While agricultural pests are indeed a serious inhibiting factor to crop yields in many schemes, it should be noted that, in general, these pests are of secondary importance to the more serious problems of wet season flooding and dry season crop irrigation.

In most cases there is a strong correlation between the severity of pest problems and the amount of available labour on the schemes able to effect controlling measures.

7.4.1 Pig Control

On many schemes, pigs are cited as the single most destructive pest species affecting production. The pig problem usually occurs in areas where there is uncleared forest or scrub adjacent to or in the central areas of the fields. Another factor is that on many schemes there is insufficient labour to clear the pig habitat or effectively control pigs by other means.

The present methods commonly implemented for pig control include:

- guarding of affected fields at night;
- hunting of pigs with dogs, spears and occasionally, guns;
- poisoning, usually with "Temic";
- setting of snare traps;
- construction of locally made fences around individual schemes; and
- construction of perimeter dikes and canals which are said to reduce pig numbers on some schemes.

The proposed project would attempt to solve the problem by construction of a pig proof fence around the perimeter of the schemes. This system may be impractical on some schemes and this solution would likely be implemented only on schemes where it is a realistic option.

Positive impacts of the pig fence would include.

- possible solution to the pig problem;
- clear delineation of scheme boundaries; and
- encouragement of farmers to clear remaining areas of the blocks.

Negative impacts of the pig fence include:

- difficulty of maintenance, particularly as it would be built in areas far away from farmer's residences, often in areas where the deepest peat soils occur;
- disturbance to vegetation and soils in outlying locations;

- o isolation of populations of native wildlife on the schemes. While many species, such as leopards, bears and monkeys would have little difficulty in climbing the fence others, including deer, pangolin and porcupine would have no way of escaping; and

- o trapping of large numbers of pigs within the schemes.

Project Alternatives

The most obvious alternative to solving the pig problem, and one often suggested by the farmers, was assistance in clearing the remaining uncleared land on the schemes and hence removing the pig habitat. This solution, however is not without problems.

Typically, the uncleared land in which the pigs occur backs on to degraded swamp forest which, in some cases is included as forest concession. In effect, the uncleared land is presently acting as a buffer zone between the forest concession and the transmigrant's fields. Removal of this area could result in conflicts with the forest concessions, particularly in some cases where the forest concession claims that the area is available for logging. Secondly, this "buffer zone" effect was emphasised by several farmers who stated that endangered species, such as Sumatran Tiger were driven into their uncleared land because of heavy logging activities in the adjacent forest. The high population density of pigs in these areas is also a likely attraction for tigers. Many of these areas are currently acting as wildlife refuges because they are not being systematically logged.

Clearing of this land is also unlikely to really eliminate the pig problem, but rather, move it to another location - the newly cleared fields. Further, unless supplementary transmigration is implemented on these schemes at the same time, there will be insufficient labour to maintain the area in a cleared state, and it will eventually revert to alang-alang and secondary scrub - prime pig habitat.

Safeguards or Mitigations

The perimeter pig fence as proposed by the project could be adopted in some small, sparsely populated schemes where there is clear evidence that it would be viable, and where it has the support of the local farmers.

Any clearing of land should be undertaken by the resident farmers, with assistance from P3S, and should be integrated with a supplemental settlement program if necessary to ensure the land can be maintained and cropped.

A co-operative agreement with the neighbouring land users (typically forest concession holders) should be reached such that the adjacent land be managed in a way that will be environmentally sound and not detrimental to either party. For example, a suitable use of this land was seen in some schemes where co-op schemes for rubber or oil palm plantations had been implemented.

7.4.2 Rat Control

Rats of several species frequent the schemes and are considered to be pests. The most serious pest species are the Ricefield Rat (*Rattus argentiventor*) which a pest to rice crops, the Polynesian Rat (*R. exulans*) and the Malaysian Wood Rat (*R. tiomanicus*) both impacting coconut and palawija crops. Rats are currently controlled by the following methods:

- o poisoning. An enormous variety of poisons are available in and near the schemes. The most widely used is Klerat. A list of available poisons is presented in Appendix 6.
- o hunting with dogs
- o smoking out rat burrows
- o setting snare traps

Rats have a number of natural predators, including snakes (*e.g.*, Black Cobra, Reticulated Python) and raptors, such as Black-winged Kite (*Elanus caeruleus*), Barn Owl (*Tyto alba*), Shrikes (Laniidae) and some Kingfishers (Alcedinidae). The occurrence of birds such as owls, eagles and hawks on the schemes is often related to the availability of nesting habitat, such as large trees. In schemes where all large trees had been cleared, few raptors were observed and these schemes frequently reported the worst rat problems.

Project Alternatives

Alternative methods of rat control which involve lower usage of poisons could include:

- o retention of a significant number of large trees whenever blocks are cleared so that available raptor breeding habitats are not destroyed;
- o artificial introduction of Barn Owls and followed by nestbox program. This method has met with success in North Sumatra and Malaysia (Lenton 1984, Toumey 1986);
- o co-ordination of rice planting such that all fields are harvested simultaneously. This method deprives rats of a continuous supply of food on the fields, so that when the rice is ready to harvest, they do not have the opportunity to quickly build up in numbers.

7.4.3 Weed, Insect and Plant Disease Control

A serious problem affecting agricultural production is the high level of weed infestation on the fields. Often these weeds cover more than 40% of the vegetation competing for light and nutrients with the actual crop species. Although insects and plant diseases don't

seem to be a serious problem, and the project description is not very clear on what is going to happen, insecticides and other pesticides are treated here too.

Availability of Pesticides

In 1991, 535 pesticide formulations were licensed in Indonesia for agriculture and forestry (PTP 1991). Contrary to conclusions by BCEOM, availability of pesticides does not seem a problem in the project areas[16]. One hundred and one formulations were found in shops retailing pesticides in Jambi, Riau and West Kalimantan. At least 5 formulations are *not or no longer permitted for use* in Indonesia. Table 10 summarizes commercial availability of pesticides.

Pesticide usage in the Asia-Pacific region is dominated by insecticides (76%), followed by herbicides (13%) and fungicides at 8%. Thus it is not surprising to note that insecticides constitute 53% of the formulations available. For some reason (aggressive marketting, particular swamp environments ?), the number of fungicides available in West Kalimantan is disproportionately high.

Shops investigated were the shops that farmers on the field refered the AWB team to, mostly in the local commercial centres, *i.e.*, Reteh (Indragiri, Riau), the market at secondary canal 17 of Rantau Rasau, Nipah Panjang and Muara Sabak (Jambi) and Pontianak (West Kalimantan). In addition, a variable number of smaller, to tiny window 'shops' in hamlets were inspected. Search effort is not comparable between project areas, largely explaining the differences in total numbers of formulations found.

Table 10: Type and number of formulations per project area. Dual purpose formulations are tabulated twice, but counted once in the totals.
(Source: AWB field data, August-September 1992)

	Riau	Jambi	West Kalimantan	Total
Acaracide	0	1	5	5
Bactericide	0	0	2	2
Fungicide	1	5	19	24
Herbicide	3	7	9	15
Insecticide	8	22	51	54
Nematocide	2	1	3	3
Rodenticide	2	0	2	2
Total	14	35	87	101

[16] Although pesticides may be under reach of any farmer in the project areas, their purchase power my still preclude application.

Appendix 6 gives details on the actual formulations's agent in Indonesia, full trade names, active substances, and permitted uses. It should be noted that these data refer to *availability* of pesticides in the free marketplace, not actual *usage*.

Discrepancies or imbalances noted from the Table and the Appendix include:

1 No rodenticides were found in Jambi.

2 Only one fungicide (**Fujiwan 400ec**), with only one permitted use (rice), was available in Riau.

3 One (**Vitigran Blue**) of the five fungicides found in Jambi is only permitted on cocao, coffee and tea, which are not major regional crops.

4 Three single use fungicides for minor, or possibly nonexisting, crops (**Tiezene** for tobacco; **PP Zineb** for potato; **Nimrod** for apple) are available in West Kalimantan.

5 **Rogor L40** (carbamate) is available, but not licensed and **Diran 950** (diuron), **Sevidol 4/4G** (carbaryl + lindane), **Harcos Malathion 50ec** (malathion), and **Temik 10g** (aldicarb) are available but are no longer licensed.

6 Another formulation (**Physan**) that is apparently not registered was found in West Kalimantan.

Problem Chemicals/Situations

Most pesticides do not present major problems if used correctly by trained personel. However, in the project schemes pesticides will be selected, diluted and applied by individuals who are likely not only to be untrained, but sometimes also illiterate and thus unable to read directions on the label. These individuals are at risk of poisoning themselves, their livestock and their environment.

Therefore, there is concern regarding the availability of certain pesticides *i.e.* those with:

1 extreme toxicity to man and other non-target organisms (*e.g.*, aldicarb);

2 persistence, or resistance to degradation (*e.g.*, organochlorines);

3 potential for bioaccumulation in the food chain (*e.g.*, organochlorines);

4 potential for abuse (*e.g.*, for deliberate poisoning and suicide).

The WHO has classified pesticides into four hazard classes, based on the likelihood that a pesticide will cause injury under conditions of use. Of the pesticides available in the free market in the study sites, only two are categorized as Extremely Hazardous (IA), six are Highly Hazardous (IB), twelve are Moderately Hazardous (II) and the rest are Slightly Hazardous, or are unlikely to present acute hazard in normal use (Table 11).

With respect to the Extremely Hazardous (IA) and Highly Hazardous (IB) pesticides, the World Bank (1985) has stated: "*All these materials are unsuitable for use by other than highly trained and skilled operators under strict supervision. In no circumstances should they be made available for use by small farmers or the general public.*" Indonesian government policy restricts the distribution of these products to liscenced pest control companies in minimum containers of ten kilogrammes or litres. Government regulations to restrict the availability of IA and IB pesticides are not entirely effective, since eight of these were found in west Kalimantan, three in Jambi and three in Riau.

In Jambi, "popularity" of formulations was probed by asking four keepers of the larger or specialized shops to name the top-three sales products in herbicides and insecticides. Of six trade names consistently mentioned, only **Roundup** does not show up in the hazardous substances Table 11 below (bold-faced, underlined trade names).

Table 11: Extremely to moderately hazardous formulations found in the project areas. Active substances banned for use on rice in Indonesia due to adverse effects on Brown Planthopper predators, are marked with an asterix (*).
(Source: AWB field data; ADB 1987)

IA	Extremely hazardous			
	aldicarb	I	Temik	No longer licensed in Indonesia.
	phosphamidon *	I	Dimecron 50scw	Toxic to fish, bees and wildlife.
IB	Highly hazardous			
	carbofuran	I	Dharmafur 3g	Very toxic to fish, birds and wildlife.
		I	Furadan	
		I/N	Curaterr 3g	
	fenthion *	I	Lebacyd 550ec	Harmful to fish.
	methamidophos *	I	Monitor	Toxic to fish and bees.
	monocrotophos *	I	Azodrin 15wsc	Toxic to fish, birds and bees.
		I	Gusadrin	
	oxamyl	N	Vydate 100as	
	triazophos	I	Hostathion 40ec	Toxic to bees.
II	Moderately hazardous			
	2,4-D	H	Rilof H	Toxic to fish.
		H	DMA-6	
		H	Indamin 720hc	
		H	Ronstard D83/83ec	
	BPMC	I	Baycarb	
		I	Hopcin 50ec	
		I	Kiltop	
		I	Bassa 500ec	
		I	Dharmabas 500ec	
		I	Indobas 500ec	
	carbaryl *	I	Sevidol 4/4 G	Toxic to honeybees.
		I	Sevin 85s	
	chlorpyriphos *	I	Dursban 20ec	Fairly toxic to birds. Toxic to shrimp, crabs and other aquatic invertebrates.
		I	Petroban 200ec	
	diazinon *	I	Basudin 60ec	Toxic to fish and bees. Highly toxic to birds.
		I	Diazinon 60ec	
	dimethoate	I	Perfekthion 400ec	Toxic to bees and birds.
	endosulfan *	I	Thiodan 35ec	Highly toxic to fish. Toxic to some birds.
	fenitrothion *	I	Agrothion	Toxic to bees and fish.
		I	Sumithion 50ec	
	lindane	I	Sevidol 4/4 G	No longer licensed in Indonesia.
	paraquat	H	Para-Col	Can cause human death when ingested.
	phenthoate *	I	Dharmasan 60ec	Toxic to fish and bees.
		I	Elsan 60ec	
	tridemorph	F	Calaxin	

Only one organochlorine, Thiodan (endosulfan), is presently permitted for agricultural and forestry applications. Although endosulfan is one of the least persistent organochlorines, residue levels of concern have been reported in Indonesia (Indraningsih *et al.* 1990). Sevidol 4/4G, which contains the more persistent organochlorine, lindane, was recently delisted but remains for sale in West Kalimantan. Residues of other non-permitted persistent organochlorines, such as aldrin, endrin and DDT have been reported in Indonesian agricultural products (Indraningsih *et al.* 1988).

The more toxic pesticides, especially aldicarb, have potential for abuse, particularly for deliberate poisoning, for example, of trespassing or nuisance livestock. In addition, various formulations have been employed for suicides.

Conclusion

The following issues are identified as needing monitoring in project sites:

1 availability (and likely use) of non-compliant (unlicensed, restricted) pesticides;

2 the most popular formulations seem to be more hazardous than average;

3 misuse by untrained personel (need for training);

4 effects on non-target organisms;

5 human health effects;

6 the emergence of pesticide resistance;

7 identify and promote environmentally acceptable pesticedes.

7.5 AQUACULTURE DEVELOPMENT

The major environmental constraint affecting aquacultural development is the exposure of pyritic soils during construction of ponds, stucturally instable peat soils and the resultant poor water quality of the pond. Also lack of surface water in the dry season hamper the proper development of aquaculture.

The operation of brackish water fish ponds (Tambak) involves the use of pesticides like Thiodan to kill off predator fish at preparing new ponds or before stocking with new fish fry. These pesticides are very harmfull to birds and other wildlife.

The placement of fish cages in secondary canals could affect water circulation, and lead to local pollution problems. However, As the proposed project would only be developed at a demonstration level, these impacts would be minor.

If future success arising from the demonstrations appears likely, then management and monitoring of aquacultural projects would need to be implemented in order to ensure environmental protection.

7.6 SUPPLEMENTARY SETTLEMENT SCHEME

The proposal for supplemental settlement of schemes would be implemented in locations where there is clear evidence that additional people are required to make the scheme viable. Settlers would not be placed in areas of abandoned schemes, or in areas identified as having marginal agricultural potential.

To ensure that supplementary settlers do not compound existing environmental problems, they should be kept well informed of the existing problems of the scheme and the environmental objectives of the project.

8.0 ENVIRONMENTAL ISSUES ARISING FROM EXISTING AND CONTINUING OFF-SITE ACTIVITIES

8.1 INTRODUCTION

As part of the study, an evaluation of the existing and continuing off-site impacts of the transmigration sites was made. While these impacts are not directly related to the proposed project components, the project must also examine these processes and attempt to reduce any adverse existing impacts through technical design, social and institutional interaction and implementation of appropriate environmental management and monitoring. Overall, the project is designed to reduce off-site impacts by improving agricultural productivity and therefore creating a more successful on-site economy.

8.2 WILDLIFE EXPLOITATION

A number of native wildlife species are exploited by both transmigrants and local people living in the schemes. The level of exploitation varies greatly from scheme to scheme depending on the availability of valuable species and the market demand. The following wildlife species are exploited to some degree.

8.2.1 Exploited Species

Sumatran Tiger

Tigers occur in the vicinity of many of the schemes, especially in Riau and to a lesser extent, Jambi. They are not found in West Kalimantan. The level of exploitation of this species on the schemes is generally low, as the species is somewhat uncommon. Most transmigrants rarely saw tigers and no evidence was found of any transmigrants actively engaged in tiger hunting.

At one scheme in the Indragiri sub-project area, there is a local non-transmigrant who is a semi-professional tiger hunter. This person traps tigers using a snare trap made of bamboo. The line used is made from bicycle brake cable. This person had caught about five tigers in the Kuala Cinaku area during 1992. One had been caught a few days prior to the survey team arriving and had escaped earlier that day.

Tigers are caught for their valuable skin and bone. They are sometimes sold live, especially if they are young. In the Indragiri area, tigers are sold to a dealer in Tembilahan, who then sells them in Singapore. In the Siak area, they are sold in Siak Sriindrapura. The skin and bones of an adult tiger are worth about Rp 2,000,000. The bones alone are worth about Rp 800,000 per kilogram. It is likely that Chinese traders are involved in buying tiger products.

Most tigers sold by transmigrants are caught incidentally in snare traps set for wild pigs. They are left to die in the trap, and can take three days to do so. Several transmigrants reported that tigers entered their land because they had been forced off adjacent logging

concessions because of the level of disturbance to these areas. This opinion, however, is difficult to substantiate. The uncleared land on these schemes is also attractive to tigers because of the abundance of pigs, a favoured prey item. Tigers occasionally enter villages at night and catch goats and chickens.

In general, transmigrants are not interested in catching tigers, but if one is accidentally caught, then it is sold through the widely known trade routes.

Malayan Sunbear

his species occurs in the Riau and Jambi schemes, but not in West Kalimantan. It is common enough on some schemes to be regarded as an agricultural pest, as they attack young coconut crops. This species is infrequently caught in pig traps. Bears are not usually sold, but the tiger hunter in Indragiri sometimes sells them. They are worth about Rp 180,000 each.

Sambar Deer

Sambar deer are occasionally caught in pig traps and are usually either eaten on site, or the flesh is sold locally in the market. They are hunted on most schemes in West Kalimantan where there is surrounding forest. The level of deer exploitation is generally low.

Lesser Mousedeer

Mousedeer are occasionally caught for food or are sold live. They are worth Rp 4,000-5,000 each. People sometimes come from outside the areas to catch mousedeer.

Otters

Otters, which are regarded as a pest to aquaculture, were caught by transmigrants in the Indragiri scheme. The skins were sold in Tembilahan for Rp 50,000 each. The day before the survey team arrived at this site, seven skins had been sold. A mounted skin was produced as proof of this. Small-clawed Otter frequently occur on the coastal schemes of West Kalimantan, but is seldom hunted for.

Pythons

The Reticulated Python is a very common species on most schemes. They are occasionally caught for their skins, which fetch about Rp 70,000 for a large snake. There is a professional snake hunter in Siak Kiri who is a non-transmigrant. Snake hunters regularly visit the schemes from outside the area, particularly from Medan. A group of transmigrants in the Indragiri area sell python skins to a dealer in Tembilahan. Another species, the Short Python (*Python curtis*) is also collected sometimes, but this species usually occurs in the forest and most people had not seen them.

Monitor Lizards

Monitor lizards (mainly *Varanus salvator*) are caught on most schemes, and sold for their skins. At Indragiri, some transmigrants were mounting monitor skins for sale in Tembilahan. However, in many areas, the skins were not sold, but just kept as curios.

Hunters organised from Pontianak visit the schemes to catch monitor lizards for their skins. The main catching areas are around Kubu, Sambas and Ketapang. An inventory made in 1988 indicated that large numbers of lizards are caught (up to 85,400), but numbers were about double ten years before this inventory (KPSL UNLAM, 1988).

Estuarine Crocodiles

Transmigrants are generally not involved in crocodile hunting, presumably because the species is generally uncommon. At Siak Kiri, two crocodiles were trapped in a secondary canal which had been closed off for the dry season. The transmigrants had no interest in catching these animals, even though this would not have been difficult. Local people and outside hunters were occasionally reported to catch crocodiles. Crocodiles were regarded on some schemes as having magical powers.

False Gavials

This species was reported to be caught in the Indragiri area by a collector from Palembang. They are generally not caught by transmigrants, even though in the Siak Kecil area they were often seen.

Birds

Hornbills were occasionally hunted with air rifles and sold, dead or alive. They are worth Rp 30,000 - more for live birds.

A group of transmigrants at Siak Kiri were actively engaged in bird hunting. They hunted Oriental Pratincole, Watercock, White-breasted Waterhen, Lesser Whistling Duck, Pintail Snipe, Gallinule, Javan Pond Heron and Milky Story (Milky Stork were caught on the coast). One hunter could catch 19kg per day from their fields during the migratory season.

The bird hunters at Siak Kiri were transmigrants from Indramayu, Java. This area is well known for bird hunting activities. These hunters had specialist nets and equipment, which they had brought from Java.

Asian Bonytongue

The Asian Bonytongue is a highly prized and extremely valuable aquarium fish, particularly amongst the Chinese communities throughout Asian. It is said to bring good luck to the owner.

This fish is heavily hunted in the Siak Kecil area, although the evidence obtained suggests that few transmigrants are engaged in this activity, and it is mostly local Malay fishers or people from outside the area.

Asian Bonytongue occurs all along the Siak Kecil river, but the favoured hunting grounds are upstream of the transmigration schemes, in the lake systems of Siak Kecil Wildlife Reserve. Fish are usually caught during the wet season. The lakes are more accessible at this time of year and it is the breeding season. This species is a buccal incubator (eggs are retained in the mouth of the females) and the young tend to stay close to the mother after they are born. At this time they are vulnerable to capture.

Fish are located by spotlighting at night from a boat, and are scooped up in a dip net.

Asian Bonytongue fetch between Rp 50,000 and Rp 200,000 each depending on size and colour variety. They are usually sold in Pekanbaru or Duri. However, collectors often come to the lakes by road and buy fish on site. Dealers are otherwise contacted by radio and then travel to the area to buy the fish. They are not kept in holding ponds, but are usually just kept in bamboo cage traps until the dealer arrives.

Transmigrants have little involvement in this trade. If a fish is caught, it is usually sold, but transmigrants rarely visit the lake system and showed little interest in developing this fishery. Very few people realised that the species is protected, or that the lake system is within a Wildlife Reserve.

Asian Bonytonque occurs in three color varieties in West Kalimantan, including the precious 'Golden Red'. This fish is caught in the Terentang, Sei Radak and Kapuas rivers. The common 'Silver' variety which fetch up to Rp 200,000 is also eaten.

Wildlife Kept for Agricultural Purposes

In the Lambur scheme, Jambi, one former farmer kept a Pig-tailed Macaque *Macaca nemestrina* to pick coconut from the tree, for a 20% share in the harvest. In this way the farmer could obtain a net profit of about 50-100 coconuts per day. The animal, a female, was trained when the man bought it two months earlier for Rp 120,000 in Muara Tungkal.

Wildlife Kept as Pets

Wildlife pets are commonly seen on the transmigrant sites, but there is no evidence of any organised local trade in desirable species. Species observed as pets included various birds, particularly doves and parrots, Long-tailed and Pig-tailed Macaques, Slow Loris and Reticulated Python. Appendix 3 details all pet species observed on the sites.

In West Kalimantan, the impression was given that Proboscis Monkey is not hunted; but local people have often tried to keep this monkey in captivity, always leading to the immediate death of the animal.

8.2.2 Mitigations

Many species which are exploited on the schemes are rare, endangered or protected by Indonesian law. Indeed, the very act of legally classifying a species as such no doubt increases its value and thus, its likelihood of exploitation. There seems little point in actively policing the fauna protection laws at a local level because of the tremendous difficulties in obtaining evidence and maintaining field staff. Further, this is likely to provide only a temporary solution.

The only real way of stopping the trade in these species is to attack the problem at the dealer level and thus stop the market opportunities. This problem is far beyond the scope of the present study and requires an effort on the part of the relevant law enforcement authorities.

In general terms, however, it is apparent from the field studies that the transmigrants are only remotely involved in these activities, and then only on an opportunistic basis. The transmigrants have a far greater interest in developing a successful agricultural economy on the schemes than in developing a wildlife trade.

The incidence of accidental capture of potentially valuable wildlife is very low, and can be further reduced by alternative methods of pig control and better management of adjacent uncleared lands, as proposed in this project.

8.3 OFF-SITE HARVESTING OF FOREST PRODUCTS

Forest resources play an important role in the daily lives of Indonesian people in agricultural societies, to supplement their income or to provide new agricultural land (mostly slash and burn). This also accounts for transmigrants who harvest several forest products from their uncleared lands and forest areas adjacent to the ISDP schemes.

During the first years of the development of the schemes people relied heavily on off-farm income because their agriculture investments (clearing, planting, drainage system, etc) had not fully given results. People burned their lands to clear it of vegetation and to decrease the peat depth. Crop production on these lands appeared to be only successful for the first one to two years after which production levels dropped strongly. New lands were opened as a result.

It can be concluded that even today after many years of cropping available labour and capital input are too restricted to optimally develop the agricultural system at the schemes. As a result income of the farmers is low and the need to find off-farm income high.

This has led to the situation that on many schemes up to 50% of the families have one or more members working outside the scheme. Especially the young men, who are involved in logging.

Before and during the establishment of the ISDP schemes, logging companies had often already extracted all valuable timber from the swamp forests on and off-site. However, still suitable logs could be extracted on a small scale basis by local people and transmigrants, who sell these logs to local wood traders and sawmills.

People firstly utilised resources at the schemes itself. On some schemes in Riau, transmigrants however have been stopped by logging companies from clearing their own (LU 2) land, claiming that it was covered by forest concession.

A closer look at these swamp forests located around the schemes reveals that most of these lands have the status of Conversion Forest for West Kalimantan but Production Forest in Riau and Jambi (see appended Land-use/Forest Status maps, Map 1B-4B). Nature reserves like Siak Kecil (Riau) and Berbak National Park (Jambi), are located further away but still within the potential impact zone of the schemes. These three main types of forest land status implies that these are managed by the government in line with their respective status. Spontaneous developments like extraction of logs by inhabitants of the project schemes, operation of sawmills and extraction of secondary forest products certainly are not under control and have led in many instances to the degradation of Production Forest's. Conversion Forests are planned to be converted to productive types of land-use which does not include the observed destruction of swamp forests on deep peat, which leave only unproductive shrublands unsuitable to agriculture.

In Riau and Jambi this process is still fully going on, but in West Kalimantan were exploitation of the forests started earlier these resources are running out of logs.

In West Kalimantan Jelutung (*Dryera lowii*) is of particular interest because it is one of the main tree species being extracted as logs from the surrounding peatswamp forests by a high number of farmers originating from the project schemes.

Also Meranti Batu (*Shorea*), Mabang (??) and Meranti Bungga (*Shorea teysmannicana*) are processed as logs. However, all wood resources are becoming scarce because of the long history of exploitation.

In Riau transmigrants generally do not travel far into the forest to collect timber. Most people interviewed did not usually travel more than one or two kilometres into the forest, although they sometimes went further for rattan. There are two principle reasons for this more restricted travel into the forests than at the West Kalimantan project area.

Firstly, the forests in Riau are still relatively undisturbed, are densely vegetated and the entrance routes are limited.

Secondly, as most transmigrants are Javanese, often originating from city environments, they have an inherent fear of the forest and prefer to stay on their cultivated blocks.

Local people, on the other hand, readily enter the forests to harvest timber. Most local people interviewed claimed that they never saw transmigrants in the forest.

9.0 ENVIRONMENTAL ISSUES AND CONSTRAINTS OF INDIVIDUAL SCHEMES

9.1 INTRODUCTION

In sections 7 and 8, the impacts of project components and off-site pressures which are common to all, or most of the project schemes were assessed. This section analyses significant project components or environmental pressures which are unique to particular schemes.

9.2 SIAK KIRI (Riau - Siak Sub-project)

9.2.1 Upgrading of Base Camp, Siak Kiri

The project proposes to upgrade the existing Base Camp, located at Buantan to the south of the Siak Kiri schemes. The Base Camp is currently in a state of disrepair and the proposed upgrading would be necessary in order to accommodate the workforce needed for the civil works program.

The base camp is located next to the Siak Besar River. At the site, there are exposed banks which have been disturbed through works activities. Wave action from passing ships is presently causing serious erosion to these banks. The vegetation in the area of the base camp is highly disturbed secondary scrub which has no conservation value other than protection of the soil.

There is an historic site located only a few metres from the buildings at the base camp. This site is a pond and mound built by the first King of Siak, Sultan Abdul Jalil Rachmatsyah. Five metres from the pond lies the grave of Panglima Emping Barantah. The Sultan himself is buried at a site about 1km south of the base camp. It is protected by an elaborate shelter which was built probably by the Ministry of Tourism, Post and Telecommunication.

The pond, mound and grave at the base camp are presently in the process of being fenced off.

Project Alternatives

There are no feasibly alternatives to the location of the Base Camp. Since this work is an upgrade to the existing camp, it is more environmentally sound to limit disturbances to an area that is already disturbed.

Safeguards or Mitigations

Erosion of the banks near the base camp should be brought under control, through the laying of bunds and revegetation of the banks. Destruction of the vegetation cover around

the base camp should be kept to a minimum, and rehabilitation of disturbed areas be initiated.

There is likelihood that fuels and other chemicals would be stored at the site, and these should be maintained in a secure compound area which is located at some distance from the river.

The historic site at the base camp should be protected by fencing, as is currently being done. A sign explaining the significance of the site should be erected.

9.2.2 Weir and Dike Construction

The project proposes to construct a 26.2 km long dike surrounding blocks B, C and D (see appended Project Activites map, Map 1A). The dike would follow the north bank of the Buantan River, cross the back of block D to the Raya River, then to the Siak Besar. A second dike, 9.4 km long would be built on the opposite side of the Raya River, in block A. In addition to these dikes, weirs would be built on both the Buantan and Raya Rivers. These weirs would be used to supply water for a pilot irrigation scheme in the dry season. The dikes are to prevent flooding in the wet season from the peat swamp to the west.

Both the Buantan and Raya Rivers are "blackwater" rivers which drain from an extensive peat swamp. In the vicinity of the schemes, the river banks have been largely cleared of natural vegetation, but in the upper reaches there is some remaining. The False Gavial (an Endangered species) is reported to still occur in the Buantan River, but populations are likely to be very low.

Most of the western parts of block D are uncleared and consist of degraded primary and secondary forest which covers at least 6 sq km within this scheme, mostly on very peaty soils. Most of the commoner wildlife species in the area probably live on this site. It was reported that tigers occasionally come in to this area.

Potential Impacts

The environmental impacts likely to occur at this site due to the proposed project include:

- loss of vegetation and bank habitat along the Buantan and Raya Rivers;
- isolation of a fairly large area of peatswamp forest within the scheme through construction of the dike;
- inability of aquatic animals such as fish and turtles to move up and down the Buantan and Raya Rivers during the dry season, due to the weir obstructions.

- o likely lowering of water levels in the two rivers concerned and draining of the source area which is in peatswamp.

Project Alternatives

Most people interviewed in the Siak Kiri and Siak Kecil schemes felt that the proposed solution would not solve completely the problem of dry season irrigation. The proposed weir and dike system would be supplemented by pumped irrigation to distribute water to the fields but even then, some areas would not be serviced.

An alternative solution has been proposed by a local consultant which involves digging a direct connecting canal from the Siak Kecil River at the Pesinsim River junction to the Siak Besar River near the Langkat River, a distance of about 12 km (Map 1A). From this canal, a series of secondary and tertiary canals would provide irrigation to blocks in both Siak Kiri and Siak Kecil.

This project has widespread support in the schemes; almost everyone interviewed in Siak Kiri and Siak Kecil had heard of it and wanted it to go ahead. There is a popular misconception about where the canal actually originates. Many persons believed that the canal would come from a large lake (probably Lake Airhitam) in the Siak Kecil Wildlife Reserve. This view is also presented in BCEOM (1991- Vol 6; Vol 14). However, this lake is dry during the dry season and may be at a lower elevation than the schemes. The most feasible starting position of the canal is at the junction of the Pesinsim and Siak Kecil rivers, as represented in BCEOM (1991- Vol 7, App 4-1) and in Map 1A

There are several ecological problems associated with this project alternative. Contrary to BCEOM (Vol 6; Vol 14) the route does not pass through the Siak Kecil Wildlife Reserve. Nevertheless, the consequences for the Reserve are still alarming. The canal is likely to significantly increase drainage from the reserve and thus lower the level of the stream and also of the lakes. Since the lakes are already quite shallow (<2m generally), the canal could cause many of the lakes to dry completely. This would have serious consequences for the populations of aquatic species living there, especially the rare False Gavial and Asian Bonytongue.

It should also be remembered that the proposed deepening an widening of the Siak Kecil navigation canal is also designed to decrease water levels in the Siak Kecil River and thus would compound the problem.

The proposed route of the canal crosses a large peat dome. The peat depths in this area are not known, but may be in excess of 10 metres. The canal will have an effect of draining and slowly killing this peat swamp forest (and subsequent subsidence of peat) and therefore threatening the wildlife species which live there, including Tiger and Clouded Leopard. The canal would also create a fragmentation of habitat and open up the area to possible exploitation.

While the proposed "Pesinsim Canal" is not a part of the currently proposed project, it has widespread support in the local community and at the District level and may be built independently.

This canal cannot be justified on environmental grounds. If it is built, the proposed ISDP project for this area will have to be modified or abandoned, as it may be unnecessary. As such the project should take up this matter with the provincial authorities, including the Department of Forestry.

Since there is some question as to the effectiveness of the proposed scheme, there seems little point in constructing the northerly portion of the dike through an area of uncleared peat swamp, particularly as the soils in this area are likely to be very marginal for agriculture. Integration of the dike with the proposed new road along the centre of the scheme may be more effective, although this would mean continued and perhaps increased flooding of areas outside the dike. These areas are at present sparsely populated, and the people on this part of the scheme may have to move inside the dike system if this alternative is realised.

9.3 SIAK KECIL (Riau - Siak Sub-project)

9.3.1 Upgrading of Navigation Canal

In 1987, in order to alleviate a series of severe flooding events in the Siak Kecil area, a canal was constructed which links the Siak Kecil to the Siak Besar rivers. The canal has also greatly improved water access to the Siak Kecil area.

The existing canal is 4,600 metres long, with an average width of 20 metres (26 metres at the surface) and an average depth of 5 metres. In order to further improve flood mitigation, and also to solve serious problems of erosion due to turbulent flows in the canal, the project proposes to deepen the canal to an average 8 metres and widen it to 30 metres average and 40 metres at surface. Details of the modelling for this project are contained in BCEOM (TR no 7).

The construction of the navigation canal has created an unusual aquatic environment. During the dry season, the tide flows up the canal and into the Siak Kecil River before it flows up from the Siak Kecil mouth. This has led to reported salinity problems in block A' from upstream. Through most of the dry season, salinity intrudes part way into the navigation canal from the Siak Besar River.

Two endangered species live in the canal, the Estuarine Crocodile, which reportedly comes up from the Siak Besar River during the dry season, and the False Gavial, which enters the canal from the Siak Kecil end. The survey team observed a False Gavial about 500 m down the canal from the Siak Kecil in September, 1992. Another rare aquatic species which occurs in the Siak Kecil River is the Asian Bonytongue fish.

Potential Impacts

The widening and deepening of the canal will double the current daily discharge of the Siak Kecil into the Siak Besar and increase flows by 20% (TR 1991 no 7). There is a predicted change in the water levels of the Siak Kecil River of plus 3cm at high tide and minus 60cm at low tide. Another consideration during the dry season is that salt intrusion into the Siak Kecil is likely to be greater due to the higher volumes of water entering the system from the Siak Besar.

The effects of the general lowering of water levels in the Siak Kecil River during the dry season could include:

- o changes in the bank habitats along the river, and thus possible changes in fish populations.
- o reduction in navigability of the river and access to jetties and landings.
- o premature dry season draining of lakes in the Siak Kecil Wildlife Reserve and thus a reduction in available habitat for aquatic species.
- o widening of the canal will involve loss of land and crops in some villages which are close to the canal.

Project Alternatives

Most persons interviewed in the Siak area were pleased with the operation of the existing canal. Nobody spoken to had heard of the proposal to widen and deepen the canal and the general opinion was that it was currently functioning well.

There has been no serious flooding in the area since the canal was constructed and the river rechanneled. Further, most of the Siak Kecil blocks in the flood prone upstream areas are now abandoned and this area is planned for a buffer zone (Section 9.3.2). Those blocks that are still populated are included in other flood mitigation proposals.

It is suggested that very few schemes would really benefit from this project component. The ecological consequences of such a change in hydrology are unclear, but it is possible that populations of rare aquatic species in the Siak Kecil River may be affected. It is also possible that the protected lake system of Siak Kecil Wildlife Reserve could be adversely affected.

This component should therefore be excluded from the project until it can be justified in terms of agricultural benefits and ecological safeguards.

The proposed "Pesinsim Canal" discussed in Section 10.2.2.2 would likely have a similar effect in lowering water levels in the Siak Kecil River and if this canal is built, then the navigation canal upgrade would be superfluous.

9.3.2 Buffer Zone for Siak Kecil Wildlife Reserve

The Giam - Siak Kecil Wildlife Reserve, gazetted on 6 June, 1986, covers an area of approximately 100,000 ha of swamp forest, peat swamp forest and floodplain lakes (called "*tasiks*"). In the south western part of the Reserve, dryland forest occurs. According to Mackinnon (1982) the reason for protection of the reserve is to ensure protection of breeding habitat for the False Gavial, as well as protection of endangered species such as Tiger and Elephant.

The main features of the Reserve are a series of dystrophic lakes covering an area of about 8,000 ha, which drain into the Siak Kecil River. Forests in the area are very degraded due to past logging practices. Giesen & van Balen (1991a) report that the Reserve is currently subjected to a considerable amount of illegal logging.

Few transmigrants interviewed in the Siak Kecil schemes were aware of the existence of the Reserve, and none had actually been there. Local people use the Reserve extensively for fishing, especially during the wet season when access to the lakes is better. Local fishers interviewed inside the Reserve reported never seeing transmigrants in the area.

The principles of buffer zone management are well established, and usually involve a low intensity type of land usage, such as plantation estate which has minimal impact on the adjacent conservation area while allowing limited production capabilities.

The project proposes to utilise 5,000 ha of abandoned schemes in Siak Kecil as a buffer zone to protect the Siak Kecil Wildlife Reserve, which is located about 5km to the west of these schemes (9km by river).

These schemes were abandoned after a serious flood in 1984. There has been no major flooding in the area since then, and the water flow has been improved through rechannelisation of 8km of the Siak Kecil River and the construction of a canal linking the Siak Kecil and Siak Besar Rivers. These works were undertaken in 1987.

The present situation is that almost all schemes on the north bank of the river (blocks F', E, D, C, A, and B') are abandoned. The remaining inhabited schemes are blocks B, A', and C'. Most of the abandoned blocks occur in the western part of the scheme, nearest to the Wildlife Reserve. The buildings on these blocks have been pulled down and taken away for construction material elsewhere and the area is now a vast expanse of alang-alang grass. A few Malay fishers have established houses and small transient villages along the river in this area.

The suggestion for the area to be a buffer zone is presented in TR14 but no detail has been provided. Giesen & van Balen (1991) also suggest the area be used for this purpose. The establishment of a buffer zone would require a cooperative effort with all parties concerned including transmigrants, local people, forest concessions, PHPA and Caltex.

In the strictest sense, this area cannot really be called a "buffer zone" since it does not directly abutt the conservation reserve and the intervening land is forest concession. However, a less intensive usage of the land is nevertheless desirable, particularly since it would appear unsuitable for intensive agriculture.

A suitable, low intensity form of land use for the area would need to be agreed upon. Already, the villagers at block B have formed a co-op with a logging concession which plans to use part of the land for rubber plantation, and possibly also coconuts.

9.3.3 *Supplementary Settlement*

The project proposes to resettle approximately 600 households in the Siak Kecil schemes.

This part of the project would have a very positive impact on the economy of the remaining schemes, since the lack of manpower was often cited as a major problem on these schemes.

Since the abandoned schemes on the north bank of the Siak Kecil River are destined to become part of a buffer zone development (Section 9.3.2) there is little sense in resettling these areas.

It is therefore proposed that the resettlement scheme be concentrated on reinforcing the population of existing schemes, particularly blocks F', I, B, and A'.

As an example, in Blocks I/H only 76 families are present, and half of these are locals. Originally, 415 families were settled there but most moved out after the 1984 flood. The main problems facing these people are the limited workforce to clear land and control the pig problem. If these schemes were resettled, particularly in conjunction with the proposed hydraulic system upgrades, they would very likely be successful.

9.4 KUALA CINAKU I (RIAU - INDRAGIRI SUB-PROJECT)

9.4.1 Canals and Dikes

The project proposes the installation of 20.7 km of new dikes on the Kuala Cinaku I scheme. In Blocks C0 and C1, the dikes would completely surround the southern boundary, including about 3 km along the north bank of the Cinaku River and 1 km of the Ampat River.

In Block D, on the north bank of the Indragiri River, about 6 km of new dike is proposed, chiefly along the Indragiri River. Overall, the project would also include 42 km of new secondary and 25 km of new tertiary canal construction. There is also a proposed upgrading of the main road between Blocks C and D, on the north bank of the Indragiri.

The new provincial road (asphalt) dissects the southern bank section of this scheme. The road is on a raised section and thus acts as an additional dike. The new road is reported to have caused flooding in the area near the Indragiri River.

Potential Impacts

The main environmental issues at this scheme are the reported occurrence of several species of rare wildlife in the area, including White-winged Wood Duck, False Gavial, Estuarine Crocodile and Sumatran Tiger.

Most of the land in the southern parts of Blocks C1 and C0 is uncleared secondary and primary forest which is in good condition and supports a variety of wildlife. The construction of a dike along the southern boundary would isolate about 2-3 sq km of forest on the block if it remains uncleared.

The Cinaku River was reported to contain nesting habitat for Estuarine Crocodile and a small tributary, the Ampat River was reported to be a significant area for False Gavial. The construction of a dike along the banks of these rivers may cause disturbance to these habitats or affect nesting sites. More importantly, it would open access to these areas which at present is difficult.

White-winged Wood Ducks were reported from fields in Block C1. These birds may come from the forested area in the upper Cinaku River. They were also reported to fly across from the north bank of the Indragiri.

Project Alternatives

A local consultant has proposed dikes along both banks of the Indragiri River, but this may not be a feasible option because of the instability of the banks.

An alternative which would relieve pressure on the upper Cinaku River area would be to construct the dike along the boundary of the currently cropped fields, rather than along the Cinaku and Ampat rivers. If this is not feasible, then location of the dike at least 100 m away from the river banks would reduce impacts on this potentially sensitive area.

This would involve the loss of some land on the schemes, but this land is currently uncleared and may be less suitable for agriculture, and thus unlikely to be cleared in the near future. This alternative is also likely to relieve the current pig problem on the scheme, and offer protection to the wildlife of the area.

Safeguards and Mitigations

This scheme has the greatest amount of civil works proposed in the entire Riau project area. Therefore, considerable attention should be given to proper environmental management and monitoring.

There is a need to verify the reported occurrence of White-winged Wood Duck and False Gavial in the Cinaku River area. A fauna survey of this and the Ampat River should be conducted in order to assess the conservation value of the site, and to determine the impact of the proposed project. Particular attention should also be paid to potential crocodile nesting sites. A survey team currently investigating the status of the White-winged Wood Duck in Riau has been informed of these observations and may be able to verify the conservation value of this area.

There appear to be no significant areas of PASS soil on this scheme.

Materials for dike construction would come from the sandy bed of the Indragiri River. This would ensure minimal disturbance to peat soils, and would also provide a sounder base than the on-site materials, which are often very peaty. Removal of this volume of sand from the river is unlikely to have a significant impact, but this part of the operation should be monitored. In addition, the survey team heard several independent reports of young False Gavials being dug up from the river during these sand excavations. These reports seem strange, since the Indragiri River appears to be an unsuitable habitat for this species. If this is the case, then care needs to be taken during these excavation activities.

9.5 KUALA CINAKU II (RIAU - INDRAGIRI SUB-PROJECT)

Most of the infrastructure for the Kuala Cinaku II scheme involves installation of stop logs, gates, etc. on the existing tertiary canals. There is 0.8 km of new secondary canal proposed. There are some areas of PASS soil on this scheme, and thus control measures would need to be taken where earthworks occur.

There is a 5.8 km long dike proposed for the north bank of the Indragiri River.

Potential Impacts

There are no significant local impacts on this scheme other than disturbance to bank vegetation which is already badly degraded or cleared.

9.6 TELUK KIAMBANG (RIAU - INDRAGIRI SUB-PROJECT)

The project proposes a 10 km long dike along the Indragiri and Pengalian Rivers in order to control flooding which occurs between the river and the main road. Additional rehabilitation and upgrading of gates, etc is also proposed. The system of canals in this scheme has been duplicated, such that some canals run alongside others and are separated only by a shoulder. It is proposed that these canals be joined.

Most of the land on this scheme is cleared, or in the process of being cleared.

Potential Impacts

There are areas of PASS soil on this scheme which may be exposed during canal upgrading and subsequently oxidate to pollute water with sulphate acid. The proposed dike would have little localised impacts since most of the site has already been cleared of vegetation. Along the Pengalian River, there are some fringing mangrove areas.

The combined effects of dike constructions along the Indragiri River may cause off-site flooding in new areas, particularly the small local town of Teluk Kiambang which is located on the northern side of the river from the scheme of that name.

Dikes are proposed for about 10 km along the north bank upstream of this area and a dike is proposed to completely surround the Tempuling scheme which would redirect water into Teluk Kiambang town area along "Parit 8". In addition, the new road on the southern side of the river effectively acts as a dike and has already caused some flooding. With all these factors combined, there would be few places left along the river where floodwaters could disperse. Examination of Map 2C shows that the area in the vicinity of Teluk Kiambang township is the most likely location where this event would occur. See also under the Simpang Puding scheme in Jambi (section 9.1) for a similar problem.

Safeguards and Mitigations

The proposed dike for this scheme would probably be unnecessary had coordination with the provincial road construction been established; the main road should have been built along the proposed dike route.

Similarly, the construction of duplicate canals is perplexing. This has also meant that for every crossing along the main road, two bridges have been built. This apparent duplication of projects should not continue.

The combined effects of multiple dikes along the Indragiri River on local towns and settlements should be assessed and monitored. If flooding occurs in these areas, then some form of compensation or redesign of the project might have to be implemented.

9.7 TEMPULING (RIAU - INDRAGIRI SUB-PROJECT)

The project proposed 10 km of dike surrounding the northern part of the scheme in order to protect it from flooding which comes in from the peat swamp to the north. There is also some rechannelisation of the Simpang Kiri River.

Road construction at this site includes 5 km of connecting roads within the scheme and the reconstruction of the connecting road between Teluk Kiambang and Tembilahan, including the construction of several new bridges. The scheme is presently serviced by a network of narrow asphalt roads.

Most of the land in the northern part of this scheme is uncleared peatswamp forest. Soil surveys for the area report the occurance of PASS soils, including those of the Sulfic Flu/aquents type (average pyrite: 2.8 %). Field observations by the survey team indicated

also deep peats in this area. There is a lot of logging currently going on to the north of the scheme and the uncleared land within the scheme has also been logged (against the protests of the transmigrants).

The entire Tempuling scheme is reported to have been built on a significant Estuarine Crocodile nesting site, and the species has become rare in the region since. It still occurs (and perhaps breeds) in a swampy area to the north of the scheme. False Gavials are also reported to occur in the area, as are bears and occasionally tigers.

Potential Impacts

Clearing of the forest for dike construction along the northern boundary will cause disturbance to wildlife and also create a fragmented environment.

Rechanneling of rivers will adversely affect aquatic wildlife, including Estuarine Crocodile and False Gavial. This impact would be temporary.

PASS soils uncovered during earthworks could cause crop damage and present problems for aquaculture development.

Project Alternatives

Two alternative routes have been proposed for the road; one which follows the existing road along the Indragiri River, with replacements for unsafe bridges, and the other connecting the upper Mumpa River to the existing road to the west of the scheme (see Map 2A).

During the field survey, however, it was noticed that the first option, that of upgrading the existing road along the river, had been already completed except for one remaining bridge, where work appeared to be at an advanced stage.

9.8 RETEH (RIAU - INDRAGIRI SUB-PROJECT)

The only civil works activities proposed for Reteh scheme are the rechannelisation of a deadlock along the Enok River (in order to improve wet season drainage), and a series of stop logs and gates on the existing canals to improve irrigation.

These activities are unlikely to have a significant impact on the environment. Almost all of the Reteh scheme has been cleared and any remaining natural vegetation is very degraded.

9.9 SIMPANG PANDAN and LAGAN HULU (JAMBI)

Simpang Pandan Block A.

The project activities focus on flood protection and drainage of the northern Block A of Simpang Pandan, which is completely isolated from the remainder of the scheme. The existing perimeter dike, built in 1982, is too low[17] and the project proposes to raise the perimeter dike (6 km rehabilitation). The project also proposes to restore the original course of the small Mendahara River, *i.e.* through the Block. To that end, the current secondary canal SK6[18] should be impounded on both banks (5.8 km of new dike), effectively dividing Block A in two separate protected areas. The (improved and new) impoundment will require 32,200 m^3 earthwork, all of local origin. Four new water control works in the dikes regulate water level and flow.

To improve drainage of the restored Mendahara River, the secondary canal SK6 of Block A, would be rechannelized (6 km) and connected to an unspecified *parit* to the east, which would be rechannelized until the Lagan River (5.8 km). Also, 2 km of the Simpang Pandan river would be rechannelized to upgrade drainage of Block A (and C and D). Rechannelization will produce over 183,000 m^3 of soil material, predominantly peat, to be disposed off locally.

It should be noted that the largest part of Block A is still uncleared, under-developed or abandoned and bears extensive stands of disturbed primary peatswamp forest. These remaining forest stands are contiguous with the forest that surrounds the Block. Uncleared and abandoned land largely coincides with very deep peats. In fact only the southern 30-40% (up to secondary canal SK7) is still inhabited and marginally cultivated. The northern protected area would consist almost entirely of deep to very deep peats. All dikes and the vast majority of rechannelization work will be in very deep peats or in soils with moderate to high pyrite risk (*Hemic sulfihemists*, *Sapric tropofibrists*, *Terric troposaprists*, with 3.9-12.5% pyrite in the first 120 cm).

The majority of the original transmigrants have abandoned the Block and many of those who persevere complained "*to do the same within the coming two years unless the Government will help us with the floods*" The Block definitely gives the poorest impression of all schemes visited and reportedly off-farm, off-scheme activities are indispensable to subsist. Indeed more than half a dozen chainsaws were active in the surrounding peatswamp forest when the AWB team visited the Block. There are no problems with pigs, rats or wildlife, "*because there is nothing for them to get because of the flood.*"

Simpang Pandan Blocks B-D, and Lagan Hulu.

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[17] Judging from the difference between the soil surface and the two existing flap gates' surfaces, the dike subsided about 30-40 cm in 10 years, aggravating the situation. Farmers complained to the AWB team that in fact the dike extended the period that their land was flooded, because the dike hindered drainage after the wet season. For this reason, the existing flap gates at both ends of the primary canal (where new ones are proposed by the project) had been cleared of their flaps and are essentially non-functional.

[18] Note that secondary canal SK6 of Block A is close to Mendahara's original course, but is not the same.

Flooding of Blocks C and D of Simpang Pandan would be caused by water weeds clogging the Lagan River[19]. Therefore, the project proposes to rechannel the Lagan River (again!) over 8 km, and improve drainage *to* the river by rechannelization of the navigation canal[20] (6 km between Blocks B, C and D) and secondary canal SK6 (5.8 km between Blocks C and D). This rechannelization exercise will produce a total of 684,000 m^3 earthwork (78% from the Lagan River), and to be disposed of locally.

All rechannelization work will be in deep peats or in soils with moderate to high pyrite risk (see above), particularly the rechannelization of the Lagan River.

Finally, the important navigation canal between the Lagan and Sabak Rivers, would be deepened by at least 1 meter over the central 3.5 km, producing *c.* 46,500 m^3 earthwork, to be locally disposed of. There are no details on the soil around this canal.

Potential Impacts

Impacts (very) likely to occur in or around Simpang Pandan Block A:

- o further isolation of fairly large stands of (partly degraded) peatswamp forest within Block A, particularly the northern protected area, because of the raised perimeter dike;
- o water tightness and stability of the perimeter dike will be low, and flooding risk remain high, because locally available soil material is only peat;
- o considerable amounts of excavated soil of moderate to high pyrite risk will release toxic exudates in the newly impounded SK6 and on to the unspecified *parit* in the east. Agricultural (non-ISDP) land downstream, along the Lagan River, may be affected;
- o unless instant dramatic improvements in the living conditions of the current inhabitants are achieved, off-farm, off-scheme income from illegal logging will remain the main source of income. (Partly degraded) primary peatswamp forest in and around Block will be (further) degraded.

The effect of the normalization/rechannelization of the Lagan River on its discharge has not been studied in the hydraulic report. Presumably it is hoped that increased discharge will purge the river from the water weeds. Earthwork on the Lagan River almost completely coincides with extremely acid *Sulphic tropaquept* soils with pyrite between 50 and 100 cm (and more?). It seems unavoidable that:

- o a large volume (maximum 540,000 m^3) of potential acid sulphate soils will be exposed and subsequently oxidate to produce toxic exudates.

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19 Though the Lagan River is indeed heavily clogged with an unidentified floating grass species, this obstruction is completely upstream of the scheme, viz. upstream of Zone I or Block H of the Lagan Hulu scheme. Weeds in this section probably cause drainage problems to the Lagan Hulu scheme.

20 Whole or part of the navigation canal between Blocks B, C and D of the Simpang Pandan scheme has been improved this year. It is not known whether the improvement fulfils the specification proposed by the ISD Project.

The impact of rechannelization of the navigation canal (Blocks B, C and D) and SK6 (Block C and D) is not further discussed, because they have been implemented already.

Alternatives and mitigation

The two alternatives for Simpang Pandan Block A are:

- o much higher investments to import mineral soil from outside the scheme to built the perimeter dike (this would leave the problem of subsidence, and add the problem of mass transportation); unrealistic high amounts of liming of excavated material and farm land.
- o completely abandon the Block, persuade the few remaining inhabitants to re-settle in other schemes under the resettlement component of ISDP, and restore the natural environment around the kernels of remaining primary peatswamp forest, blending the former scheme into the surrounding forest. This would require some investments to create gaps in the exiting perimeter dike and control restoration.

If the main objective of the normalization/rechannelization of the Lagan River is improved drainage through riddance of water weeds, then:

- o initial mechanical clearing of the water course and subsequent weed management, should be considered as an alternative to normalization/rechannelization. This section of the Lagan River has been subjected to normalization twice before, and is now about 40 meter wide.

If nevertheless it is decided to continue as proposed, then:

- o transportation of excavated soil over the Lagan River to the sea[21] should be considered, to prevent acid sulphate problems on the banks and schemes.

9.10 DENDANG I and DENDANG II (JAMBI)

Annual floods inundate 6,140 hectares or 90%, more likely *c.* 64%[22] of the twin-schemes Dendang I (eastern part) and Dendang II (western part). Maximum floods in the past ten years inundated no less than 7,380 ha (114%-77%). Therefore, in these schemes the project focus is on flood protection, and drainage. Although the schemes are completely isolated from the rest of the province the project also proposes roads for within-scheme transportation.

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21 Sea water buffers the effect of acid sulphate soils.

22 Total area of the two schemes presumed to be 6,500 or 9,600 ha. References to the combined area of the two schemes vary between 4,500 and 10,115 ha (respectively Technical Report 14, Table 3.3, p.23, and ibid Table 2.1, p.12) with 8 different values inbetween.

The project proposes a dike along the Batanghari, and Dendang Rivers and parts of the navigation canal (40.3 km new dike). No new primary canals are proposed[23]. An unspecified number of unspecified[24] secondary canals would be connected to each other (total 2 km of new secondary canal). The project further proposes 38.6 km rechannelization of primary canals (location not specified) and 153,7 km of secondary canals (location not specified). Impoundments and work on (new) canals involves 1,609,000 m^3 of earthwork. A large number of water control works, mostly stop-logs, supports the proposed design.

The schemes have 1,434 ha (22%) of very deep peat soil, all located in Dendang I. The two schemes share 3,562 ha (55%) of *Terric tropofibrists* and *Terric troposaprists* with moderate acid sulphate risk (upper 120 cm) and shallow peats. The two soil sub-groups contain on average 3-3.4% pyrite in the top 120 cm, but occasionally up to 3.7% It is unavoidable that pyrite will be exposed during excavation work, as earthwork will go (much) deeper than 120 cm.

Potential Impacts

- o increased flooding of the not or little disturbed primary peatswamp forest on the left bank of the Dendang River.
- o exposure of pyrite to oxidation and subsequent release of toxic exudates and acidification of soil.

Mitigation or alternatives

- o A hydraulic simulation model should investigate water displacement effects due to the dike on the right bank of the Dendang River. The dike should be located as far inland as feasible, to reduce discharge displacement, particularly in the wet season.
- o excavation work (dikes, (re)channelization) should start just after the beginning of the rain season and be completed before the last rains, to slow oxidation and release of toxic exudates and wash exudates from the land.

9.11 DENDANG III (JAMBI)

Annual floods cover 2,046 hectares or 71% (up to 105% depending on the total surface that ranges from 1,940 to 2,900 ha). Maximum floods affect 2,513 ha 87%(-130%). The project proposes a new perimeter dike of 19.7 kilometre and to rechannel 7.8 km of primary and 38.05 km of secondary canals. New dikes and rechannelization involves

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[23] Technical Report 6 Volume 1 *Review of Existing Detailed Design* Appendix 1.3 p.8 explicitly mentions that no primary canals are proposed. Yet Technical Report 14 *Studi Analisis Dampak Lingkungan* Table 2.2 mentions 11.7 km of new excavation on primary canals.

[24] Technical Report 6 Volume I, Appendix 1.3 does not specify number, total length or location (in Figure 1-3-6 of the report) of any earthwork on primary or secondary canals (new or rechannelization). Lengths and volumes have been be calculated from the Cost Estimate tables in TR 6 Volume II.

346,700 m^3 of earthwork, all from local origin or to be disposed off locally. The proposed water management improvements will be complemented by three sluice/flap gates.

Like Dendang I and II, Dendang III is completely isolated from the road network of the province. Contrary to Dendang I and II, Dendang III lacks within scheme tarmac roads. The project proposes to construct/upgrade 6 km of road with tarmac cover[25].

The scheme is plagued by a score of obstacles to a decent living and development, though floods rank as the single most disastrous of the problems.

The original scheme included two more primary canals (M and Q), which were abandoned before settlement of transmigrants because of predominantly (very) deep peats. Of the remaining three primary canals (from north to south: N, O, and P), only some 40% around the first three to five secondary canals (of in total twelve) are marginally useful for agriculture because of (very) deep peats. The last three to five secondary canals of the primaries are in fact located in the peat swamp forest and have never been cleared or settled.

The scheme is located on the fringe of the same large peat dome as Dendang I and II. The un-used canals drain the peat dome and peats seem to dry. In 1991, a large and long-lasting sub-soil fire destructed much of the tree crops (rice and palawija are hardly grown) west of the first two secondaries.

Since 1988, not a single rice harvest and very little palawija could be grown largely because of inundations. Yet, floods seem not to have been a problem before, according to local farmers. Several noted the coincidence of the start of the floods with the construction of a perimeter dike along the right bank of the Batanghari around the Simpang Puding scheme, and some explicitly blamed that dike for their problems. This seems not completely impossible.

Pigs, rats and Purple Swamphen (*Porphyrio porphyrio*) can be a problem, when there is a harvest on the land. Most of the original transmigrants have left, leaving less than one-third of the families. Farmers explained that they could easily handle pigs, rats and Swamphens "*if I have neighbours to work together with*" and no assistance was requested.

Potential Impacts

- the northern and western parts of the perimeter dike will go through (very) deep peat. Dike material will be predominantly peat, and the dike therefore permeable because of the large *horizontal* permeability of peat, contrasted to its low *vertical* permeability.

[25] Note that if all water management improvements are cancelled, the construction/upgrading of roads in this scheme makes little sense, as they will be flooded yearly.

- the sections of the perimeter dike along the left bank of the Batanghari River may contribute of an important bottleneck between the Dendang III and Simpang Pandan dikes (and the dike of Rantau Rasau), which may divert river water (and floods) to the land between Dendang I and III and to the Kandis village on the right bank of the Batanghari, and possibly even the pumped irrigation pilot project in Pamusiran.

Mitigation and Alternatives

The only feasible alternative seems to abandon the scheme as a resettlement target, and persuade most of the remaining farmers to resettle to other schemes under the resettlement component of the project (see also under Simpang Pandan, Block A). Contrary to Block A of Simpang Pandan, this scheme seems not suitable to be restored to a more or less natural condition. In contrast some form of land use more compatible with the peat soils seems more feasible, *e.g.*, pineapple, or jelutung latex.

When it is decided not to invest in improved water management, the roads would become less viable without protection from recurrent floods.

9.12 MUARA SABAK (JAMBI)

The project has not proposed any water management infrastructural measures in Muara Sabak. The only planned activities, 30 kilometre of pig fence and increased use of agro-chemicals, are discussed there.

9.13 LAMBUR (JAMBI)

In Lambur, the first of the five 'deltaic island' schemes to be discussed, floods inundate 2,852 hectares yearly (44%) but maximum floods can inundate up to 96% of the scheme. Floods are particularly rampant during the rain season in Block E in the north-east of the scheme, but absent or insignificant in Blocks A and B (southern third of the scheme). Floods in Block E would be caused by the backwater effect of the Batanghari River in the central navigation canal during floods in the river.

It should be noted that the central navigation canal was originally dead-ended, and open to the Batanghari only. At some time, local people have connected the dead-end of the canal, with the head waters of a small, black water river that had its source just north of the canal: the Simbur Naik River. The AWB team could not find out the motivation (presumably drainage and/or navigation). It is this part of the waterway that poses problems: it is narrow, shallow and virtually clogged with water weeds (Water Hyacinth and an unidentified floating grass species), while the upper part of the navigation canal is shallow.

Nypah vegetation along the Simbur Naik River reaches the narrow, shallow, and clogged stretch that connects to the navigation canal. Therefore, salt water from the sea reaches

this part, despite the distance to the shore (*c.* ten kilometres). Yet salt intrusion is not (yet) reported from the scheme.

Most of the scheme consists of *Terric troposaprist* (4,470 hectares or 69%) and *Typic sulfaquent* soils, containing up to 5.1% pyrite in the upper 120 cm, rendering excavation moderately risky.

The project proposes to rechannel (mainly dredge) a part of the navigation canal and the adjacent clogged reach of the Simbur Naik 'river' (5 kilometres) to improve drainage. A flap/sluice gate[26] is planned across the Simbur Naik River to prevent inflow from the sea during floods, yet allow regular one-way flushing of the deadlock to avoid sedimentation.

According to a simulation run of a hydraulic model, the proposed design would reduce flood level by 35 centimetres, improve water circulation in the scheme, and increase daily discharge through the Simbur Naik River *twenty-fold*, from the current 10,000 m^3/day to 200,000 m^3/day

In addition, two (or eight[27]) kilometres of new secondary canals and ten kilometres[28] of new tertiary canals are proposed, presumably in Blocks A and F. Finally, thirteen other water control works would complete the proposed improvement. Total earthwork involved would be 90,000 m^3, all local material.

Potential Impacts

- o The sluice/flap gate across the Simbur Naik River will prevent navigation between the scheme and the coast, which would have to be diverted via the Batanghari, or the proposed new primary canal in Pamusiran (the navigation canal in Rantau Rasau has recently been closed with a sluice gate), either way a considerable detour.
- o Salt water from the sea may reach the scheme, if:
  - the sluice/flap gate is not operated properly or when force-opened for flushing to prevent sedimentation;
  - there is insufficient water pressure/discharge from the Batanghari River through the navigation canal. The latter largely depends on an intricate interplay of the delay of tides.

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26 The accompanying map shows a singular water control work, *viz.* a *sluice* gate.

27 TR 14, Tab.2.2, p.16, mentions eight kilometres of new secondary canals but secondary canals are not mentioned in TR 6 Vol I, App. 1.2 (p.5), though unspecified lengths (*c.* 14 km when measured from the map) are shown in the accompanying Fig 1.2.2 However, most of the secondary canals shown in that figure are located in Block A for which it is proposed to leave the canals unchanged (p.5).
In contrast, TR 6 Vol II, App. 7, mentions two kilometres of 8 m^2 (= 16,000 m^3 of earthwork) in the cost estimate tables.

28 Tertiary canals are not shown on map of TR6 Vol I, Append. 1.2, Fig 1.2.2, and not (explicitly) mentioned in text on p.5. TR 14, Tab. 2.2, p.16 and TR 6 Vol II, App. 7, mention ten kilometres of 2.4 m^2 (= 24,000 m^3 earthwork).

- o If daily discharge through the Simbur Naik River would indeed increase twenty-fold, it seems that river banks, the vegetation thereon, (marginal) subsistence fishery in and along the river and the small village Simbur near the coast may need extra protection.
- o Excavation of secondary, and possibly tertiary canals will probably expose pyrite to oxidation.

Mitigation and Alternatives

- o The sluice/flap gate probably will be necessary to prevent salt intrusion after the navigation canal and the upper reaches of the Simbur Naik River have been rechanneled. There seems no mitigation possible or alternative feasible, unless at very high investments (a ship lock).
- o Extra care must be taken constructing and operating this sluice. The construction site must be careful selected to prevent seepage, *etc.* The floor and sides/wings must be long enough. The operator should be well-trained and motivated.
- o It seems advisable to re-run the hydraulic simulation model, and check carefully whether the increased discharge can be handled by the lower reaches of the Simbur Naik River.
- o All excavation should be done in the beginning and during the rain season to prevent excessive accumulation of toxic exudates from exposed pyrite soils.

9.14 PAMUSIRAN (JAMBI)

No significant flooding problem or salt intrusion have been reported in this scheme to either BCEOM or AWB teams. Tidal irrigation seems acceptable: 15% of the land is irrigated in the dry season (second to no other scheme in Jambi) and 61% in the wet season (second only to Simpang Puding). Only 29% of the land has shallow peats (no deeper peats) and the AWB team has not found signs of a PASS problem.

The project proposes a pumped irrigation pilot project in the southern half of Block A, closest to the Batanghari River. The irrigated area is not specified but the AWB team estimates the surface to be no more than 650 hectares. This pilot project requires a large, 15.8 kilometres long new canal in the former Green Belt (long since cleared) between the Lambur and Pamusiran schemes. The new canal is necessary to supply sufficient water to the primary canals to pump into the new secondary canals. Part of the pilot project are 8.8 km of new secondary[29] supply canals and three kilometres of new tertiary[30] canals. In

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[29] This length is quoted from TR 14, Tab. 2.2, p.16, but is not mentioned when the proposal is discussed in TR6 Vol. I, App. 1.1, though unspecified lengths show up in the accompanying Figures 1-1-4 and 1-1-5 (c. 9.5 km when measured form the map). TR6 Vol. II, App. 7, mentions a total of 8,800 m³ earthwork, but does not specify cross section and length. The quoted volume of earthwork seems a little low, considering that 3 km of tertiary canal would produce 42,000 m³ earthwork.

[30] The Consultant's proposal in TR6 Vol. I, App. 1.1 does not mention tertiary canals, nor do they show on accompanying maps (Figures 1-1-4 and 1-1-5). Only TR 6 Vol II, App. 7, mentions three kilometres.

addition the pilot schemes requires eleven pumps and forty-four off-take structures for gravitational distribution of irrigation water on a rotation base at the tertiary level, and twenty-six other water control works. The new canals will produce a total of 500,800 m^3 of earthwork, all to be disposed of locally.

Feasibility of the pilot project depends on soil permeability and peaty soils should be avoided. The new large canal requires further soil studies before a detailed design can be attempted.

The new large canal would increase the daily discharge through the Pamusiran River downstream from the canal *eleven-fold*, from the current 50,000 m^3/day to 550,000 m^3/day, according to a simulation run with a hydraulic model.

Potential Impacts

- The new large canal would create a navigable connection to replace the connection through Lambur and the Simbur Naik River that will be blocked for navigation by a sluice/flap gate.
- If daily discharge through the Pamusiran River downstream of the canal would indeed increase eleven-fold, it seems that river banks, the vegetation thereon, (marginal) subsistence fishery in and along the river and the small village Pamusiran near the coast may need extra protection.
- Oil and kerosine from the pumps may leak into irrigation water and affect crops.

Mitigation and Alternatives

- It seems advisable to re-run the hydraulic simulation model, and check carefully whether the increased discharge can be handled by the lower reaches of the Pamusiran River. The effects of the proposed dikes along the Batanghari River (Dendang III, Simpang Puding, Rantau Rasau) that may create extra water flow after the bottleneck there should be incorporated into the model.
- Soil studies should be detailed enough to spot small 'peat leaks', since success is dependent on soil permeability.
- Pump operators should be carefully trained and motivated.

9.15 RANTAU RASAU (JAMBI)

In this scheme, by far the largest and seemingly the most 'prosperous' in the Jambi project area, flooding is localized to an area close to the Batanghari River. Maximum flooding in the last ten years has been insignificant, and annual flooding affects only 399 hectares (4%), while 36% is tidally irrigated in the wet season (1% in the dry season). The project proposes 14.6 kilometres of new dike along the Batanghari, and along the boundary canal between Rantau Rasau and Simpang Puding. The dike is the only form of earthwork in this scheme, requiring 171,800 m^3 of material, all of local origin. In

addition fifty-three water control works are proposed to retain sufficient water circulation, yet improve flood protection and water retention in the dry season.

There are significant areas with shallow to deep peat, or with moderate pyrite risk, but not where the dike is planned.

Potential Impacts

There are no significant potential impacts anticipated in this scheme, but see also under Dendang III and Simpang Puding.

9.16 SIMPANG PUDING (JAMBI)

Situated between the Batanghari and Berbak Rivers, flooding is an important problem in Simpang Puding, where yearly 2,300 hectares (83-100%[31]) is affected. The project proposes a perimeter dike of 22.6 kilometres. Canals have been recently improved, so no improvements of canals are proposed. Total earthwork required in this scheme is 191,700 m^3, all of local origin. In addition, forty-two water control works are proposed to regulate the direction of the water flow in the scheme.

Simpang Puding has a large area of *active* acid sulphate soils (no data but roughly estimated at 30-40%), and shallow peats over about half the area. In fact, due to recent work on the canals in this scheme, oxidation of exposed PASS could be observed 'in action' on a large scale.

The situation is complicated, because most of *a* perimeter dike had been constructed prior to the AWB team's field visit. The dike largely follows the proposed location for the 'ISDP dike', but deviates in the south-east along the Berbak River. There, the secondary canal SK12 is impounded, contrary to the proposal. Construction of the section along the small rivers Teluk Sopan and Kemawa in the east has not started. The (collector?) drain inside the dike between the small Kuala Pelita (north) and the Teluk Sopan (east) Rivers still connects to secondary canal SK1, where a large gap remains in the new dike. It could not be established whether the dike was build according to specifications proposed under the ISDP project.

With the new dike, large, sluice/flap gates had been build across the primary canals, possibly of the design that was considered "*not realistic in a swamp scheme such as Simpang Puding with very soft soils*".

Potential Impacts

Since 90% of the proposed perimeter dike exists, no further impacts are anticipated.

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[31] Total surface varies between 2,300 and 5,555 hectares, but here the most often quoted area, 2,760 ha and the total area in the inundation table (TR1, Tab.6.2, p.91) are used as a base.

It should be noted that farmers at the Dendang III scheme across the Batanghari River explicitly blamed the new dike for their flooding problems. Several farmers stated that floods only became a problem, *after* the dike around Simpang Puding had been constructed.

The AWB has not directly spoken with 'non-ISDP farmers' living outside the proposed impoundments along the Batanghari and Berbak. It seems that those farmers requested the new dike to be constructed directly along the rivers (rather than on the scheme boundaries) such that their land would be protected too, but renegated when told that they would not be compensated for land lost to the dike.

It should further be noted that the constellation of proposed dikes along the Batanghari at Dendang III, Simpang Puding and Rantau Rasau creates a bottleneck just after the Berbak splits from the Batanghari. The proposed configuration seems to reduce the overflow area and storage capacity during floods, in fact essentially attempts to do so. As a result of the dikes, river water normally inundating most of Dendang III and Simpang Puding and parts of Rantau Rasau, somehow needs to find a way through, particularly in the wet season.

A simulation run of a hydraulic model has looked into this problem, to assess the water level upstream of Dendang III and Simpang Puding, and the flow distribution between the Berbak and Batanghari (and Pamusiran) Rivers. It was concluded that impoundment of Dendang III and Simpang Puding will "*have little impact on the flood behaviour*" and only "*results in an increase of the maximum water level of 10 cm at Puding, 6 cm at the Berbak confluence, and 4 cm at the BAT-4 gauging station*" (BAT-4 station is located near Rantau Panjang, some twenty kilometres upstream of Puding).

The "*figures need to be handled with caution: they result from a rough modelling of the system with little accurate* [reliable topographical] *data* [on river bank levels]."

Mitigation and alternatives

- the hydraulic model simulation needs to be re-run with more accurate and reliable topographic data. This will probably require a separate study.

9.17 KAPUAS II & III (W KALIMANTAN - WESTERN SUB-PROJECT)

The project proposes the increase of the crest height of the perimeter dike with an average of 1.4 m, to protect this tidal scheme from inundation from the sea. This work will stretch over a total length of 13,050 m and 16,500 m for Kapuas III and II respectively.

Potential Impacts

Although none of the 20 Technical Reports give details about the exact locations of the upgrading of the perimeter dike on Kapuas III (total length about 30 km), all potential

sections cover PASS soils with low levels of pyrite (composite of all soil horizons up to 1.2 m depth). However, pyrite concentrations higher than 2.4% are to be expected if materials are taken from soil depths deeper than ½ m.
Kapuas II has more PASS soils with higher pyrite levels; but composite levels are still well below 2.4%. Locally, in particular along the Sungai Berembang (primary Jeruju Besar), Sungai Kakap/Sungai Jawi and Sungai Jeruju sub-soil layers have composite pyrite concentrations of over 3.3%, which after oxidation will release toxic levels of effluent.

However, negative impacts from the release of high amounts of acid and toxic minerals like iron and aluminum are not expected to further degrade the aquatic environment or terrestrial vegetation. Most fish species recorded during the field visit of the team are those adapted to a wide range of habitats; and no natural vegetation or wildlife will likely be affected by temporarily changes in the water quality. Experiences in other PASS soil development areas learn that if any fish kill occur, the effects on fisheries are only temporary due to quick influx of new fish from adjoining waters. Also, due to proximity to the sea, effluent released will be buffered by brackish water if sufficient flushing will be guaranteed.

The proposed improvements in the water control structures is expected to have a positive impact on the agricultural lands which now show high levels of salt in the soil matrix. A decrease in the salinity levels of the canals on the schemes might change the aquatic habitat, rich in brackish water fish and prawn. As several families make a modest living from captive fisheries in the canals, mainly catching Freshwater Prawn.

Major project impact anticipated is of a socio-economic nature. The 29 km of earthwork will cut through residential and agricultural land. People interviewed supported the idea of hydrological improvements but had not yet been fully consulted about the actual earthworks on their land. This could lead to resentments considering the project.

Safeguard and Mitigation

All earthworks should be preceded by consultation with the inhabitants of the scheme about the impacts to their agricultural land or settlements. Compensation costs should only be made in case of disproportional destruction of their crops.
During and at least three months after major earthwork have been done, all adjoining canals should be regularly flushed to avoid a build-up of effluent from the exposed PASS soil materials. The best season for this would be the rainy season when sufficient quantities of surface water are available. More details are discussed in section 7.2.1.

The perimeter dikes along the Kapuas river and sea are separated from these waters by a zone of swampy land, broad about 100-200 meters. This area has a very degraded mangrove vegetation, with human occupation spread along it length. For several reasons this land should be left and managed as a greenbelt. Protection of the dike against coastal erosion should be guaranteed by removal of all settlements and agricultural activity at the seaward side. People could be provided compensation for losses of agricultural land elsewhere at the schemes.

9.18 JAWI AND KALIMAS (W KALIMANTAN - WESTERN SUB-PROJECT)

A total of about 23,350 m of perimeter dike for flood protection will be raised in crest height, in Jawi I, II and III, and Kalimas block P, B, C and DE. This work will involve digging of about 105,670 m^3 of earth.
Existing dikes along the coast and the Punggur Kecil are bordered on the seaward side by degraded Nipah riparian vegetation backed by mangroves. Most other sections of the perimeter dikes run through agricultural land, with a collector drain on the inland side of the dike.
Of particular interest is the location of the coastal dikes in Jawi I and II were degradation of mangroves has led to erosion and finally breaking of the perimeter dike at Jawi III.

Potential Impact

The main environmental issue to deal with is the occurrence of PASS soils along the route of the perimeter dikes.
Soil analysis show that 'Typic Sulfaquents' soils with pyrite concentrations up to 3.2% (composite of first 120 cm) occur in Jawi and Kalimas. About 20% of the earthworks on the perimeter dikes cover this type of soil. See for exact locations the appended Environmental Issues map (Map 4C). This calls for special attention during and after the rehabilitation of the dikes. To make things worse: this type of soil is composed of soil horizons (25-50 cm) with pyrite concentrations up to 7.5%, able to release excessive amounts of acid and toxic metals like iron and aluminum after oxidation. Earthworks will also include soils of the 'Haplic Sulfaquents' type with pyrite up to 4.3% at 25-50 cm depth.

Similar to the other coastal sites discussed above no serious negative impact is anticipated to fish and wildlife. Acidity and other effluent, however, will reach toxic levels locally during and after the earthworks take place.
A clear example of the effect of PASS soils is found in Kalimas Block P, were dikes were rehabilitated in 1990 because of subsidence due to peaty underground. Today these dike are still devoid of any vegetation regrowth. But, water quality in most collector drains and canals did not show high acid levels (pH 5-6) as expressed in a varied aquatic plant and fish life. Presumably this is because the buffering effect of tidal brackish water from the Punggur Kecil river flushing these canals daily.

Safeguards and Mitigation

Negative impacts to water quality locally caused by PASS soils can be strongly reduced by regular flushing of the collector drains and canals during and after (up to three months) the earth works take place. The best water to use for this is the tidal brackish inflow which should be drained on the other side of the schemes. It is up to a hydrologist to design a system for effective flushing.
The ongoing degradation of the coastal mangroves of Jawi I and III, and of the riparian vegetation along the waterways on the schemes, like the Punggur Kecil river gives doubt about the sustainability of the proposed dike improvements. Increased consultation with

the local population about function and maintenance of dikes, including protective greenbelts has to improve the awareness and social control regarding infringements. Proper mapping and delineation of greenbelt boundaries should also assist in this.
Public Works as the main beneficiary should take more responsibility in managing these greenbelts, which means more manpower and capital investments.

9.19 BETUTU (W KALIMANTAN - WESTERN SUB-PROJECT)

Also for the Betutu scheme it is proposed to increase the crest height of the perimeter dikes of both blocks (north and south). The work will be done over the total length of the 12,000 m long dikes, with a volume of about 58,800 m^3 soil to be worked.
Wildlife habitat is restricted to the riparian vegetation along the main water courses and supports smaller mammals like Small-clawed Otter, squirrels and birds. Former existing populations of Proboscis Monkey have already disappeared. In particular this was said to be related to the recent clearing of forest at the scheme Selat Kering (non-ISDP), south of Betutu.

Potential Impacts

About 80% of the route of the dikes in the northern and southern blocks have soils with a composite pyrite content (up to 120 cm depth) of 2.9 - 3.4%, which classifies these soils a moderate PASS soils. Earthworks at this scheme will probably lead to lower concentrations of effluent release (per volume) than at Kalimas and Jawi, but the significantly larger extent of PASS soils will result in much larger total volumes of acid and toxic metals released to the surface waters.
The less developed drainage system at the scheme might hamper sufficient water flow to flush the canals during and after the earthwork takes place. Especially the collector drains along the dikes will build up unacceptable levels of effluent if not regularly flushed, which will make this water unsuitable for agricultural and household use. The already low production levels of rice paddy will be further decreased if effluent enter these lands via surface water. Much less problems with water quality are anticipated in the larger rivers along the perimeter of the scheme, like Punggur Kecil, Sungai Nyirih, and the Selat Kering river.

Safeguards and Mitigation

No possibilities exist at Betutu to use nearby soils with a lower pyrite content as alternative dike material. Also flushing possibilities of the collector drains are restricted. It is therefore advised that in addition to the regular flushing of surface waters at the scheme during and after (up to at least three months) the rehabilitation of dikes, work will be done during the rainy season, when sufficient amounts of freshwater are available to avoid intrusion inland.

The same applies for the riparian forests as explained in the section on Jawi and Kalimas, in order to improve the protection and management of the greenbelts.

9.20 RASAU JAYA I, II & III (W KALIMANTAN - EASTERN SUB-PROJECT)

Proposed project activities at these schemes will be restricted to the upgrading of water control structures, potable water supply and the upgrading of the road system. No new road routes will be developed, but existing earth-roads will be paved or otherwise improved. On the Environmental Issues map (Map 4C) can be seen that road development will not cross any PASS soils of importance to an environmental evaluation. Technical problems will occur at some stretches with peat soils.

Potential Impacts

Of more importance is the present degradation of the peat swamp forests east and north of Rasau Jaya I. Years of extraction of logs by transmigrants have degraded these forests to such extent that present tree crown coverage is less than 30%. Plans for extra transmigration settlements in these forests have been cancelled because of too deep peat layers (up to 3 m). However, recent initiatives of local people has led to the demarcation and opening up of extra land for agriculture in these forests.
Forests along the Punggur Besar river towards the next scheme Sei Bulan, including the above mentioned lands, are classified as Production Forest (see appended Land Use/Forest Status map, Map 4B). RePPProT (1987) proposed to extend this status to include all forest land between the Kapuas and Punggur rivers, in order to conserve forest resources and to avoid negative impacts from development of deep peat areas.

Present developments have (and still are) led to the total destruction of the peat swamp forests. Deep peat soils in the Rasau Jaya schemes has forced transmigrants to search for off-farm income due to failing agriculture (interviews with inhabitants of R.J.I). Formerly agriculture on Rasau Jaya was more successful than at Rasau Jaya II, but this has radically changed today now peaty-clay top soils are disappearing and much less fertile silicate sands and PASS soils come to the surface. This process will be repeated by the farmers who open-up the forests off-site of Rasau Jaya I and eventually will force them to leave the area.

Safeguards and Mitigation

No direct mitigation is required related to impacts of proposed project activities. However, off-side forest resources should be better managed. All schemes in West Kalimantan will get problems with the supply of firewood and construction wood in the near future. Rasau Jaya is no exception to this, in particular in relation to the high population density of these schemes.
The ISDP project could look into possibilities to establish multipurpose tree plantations around the margins of the schemes. Trees are best suited as a crop to the extremes conditions of peat land. The design of these plantings and the proposed establishment of a perimeter pig fence should be integrated in such way that they maximize the effect of pest management. More details about mitigation of the pig problem are given in section 7.4.1.

9.21 SEI RADAK (W KALIMANTAN - EASTERN SUB-PROJECT)

Main problems hampering agricultural development at this site are the deep yearly floods, insufficient water circulation in the primary canal and deep peat and PASS soils. The project proposes to build a total of 16,150 m flood protection dikes, rechannelizing 9,800 m of tertiary canals, and the installation of 104 water control structures in tertiary canals. The total earth work will have an estimated volume of 296,700 m^3 soil. Exact details about project components and locations of potential impacts are given on the Project Activities map (Map 4A and Map 4C respectively).

This scheme is one of the least successful schemes, with only 40% of the available land under cultivation. Annual change in population amounts up to -7%/year since the first settlements were started in 1984. Sei Radak Unit II, situated east of the primary canal was settled in 1986. Serious soil problems have kept the transmigrants from opening any LU2 land. This area is now completely overgrown with shrubs, like *Macaranga* and the fern *Steanochlea palustris*. Because of the large areas of overgrown unproductive land wild pig are a serious pest problem.

The scheme is at close proximity to forest land, with a very large area of logged-over peat swamp forest at the east, and with the margins of tidal swamp forests along the Sei Radak to the south. It was reported however, that at least 50% of the available work force at the site is being employed working for sawmill and logging operations.
The forests directly bordering the scheme are officially classified as Unclassified Land. The Regional Physical Planning Programma for Transmigration (RePPProT, 1987) however strongly recommended to include these valuable forest resources under Production Forest and Protection Forest Status (tidal swamp land along the S. Radak). In particular this latter habitat with a transition between freshwater and brackish water swamps is expected to harbour precious populations of the Storm's Stork (*Ciconia stormi*) which is endangered worldwide.

Potential Impacts

No negative environmental effects are predicted related to PASS soils with critical concentrations of pyrite.
A bigger problem is the large amount of uncleared land at both units which at Sei Radak Unit II has led to serious pig problems. About 85% of these lands have peat with depths up to 2.5 m, which is keeping the farmers from clearing (a second time) these lands for agriculture. Clearly the project should pay attention to pest management to assist the farmers. However, even with a successful programma the farmers are left with less optimal soil conditions and lack of manpower and capital for technical investments to make agriculture successful.

Also swamp forest adjoining the scheme on the south and east are negatively impacted by inhabitants of the scheme, who collect logs and other forest products at unsustainable levels. Though large forest reserves remain the fauna is surprisingly poor in species, with most abundant Bearded Pig, Wild Pig and Sambar Deer. Hunting and habitat degradation is accounted for this.

Safeguard and Mitigation

The management of the forest adjoining the scheme should be improved to the benefit of the population and the forestry objectives set by the Ministry of Forestry. Firstly, forest land status indicated as 'Unclassified' would have to be changed into Production Forest status to allow for more sustainable types of forest management. The inhabitants at the scheme need more alternatives for off-farm income, in particular now forest resources (logs) are running out of stock. Sei Radak is nearly devoid of any larger tree vegetation around the agricultural and settlement areas (LU1), giving serious doubts about the future wood supply. Wetland forests along the upper watershed of the Sei Radak river need to be protected as proposed by the Regional Physical Planning Programma for Transmigration (RePPProT, 1987).
A possible option to stabilize land-use around the scheme, to raise income for the inhabitants and to improve the forestry sector including conservation is the development of community forestry activities on-site on the deep peat lands and to establish tree plantations as a buffer-zone along the scheme. Design and location of the proposed pig fence could be adapted to these forestry activities.

9.22 SEI NIPAH (W KALIMANTAN, EASTERN SUB-PROJECT)

Sei Nipah is a scheme with serious flooding problems throughout the year. To upgrade this site a total of 74,550 m of dikes and 15,400 m collector drains will be build. The project will also rechannel 33,000 m of existing canals. Total earthworks will move an estimated 592,950 m^3 soil, which ranks this site as number one for West Kalimantan.
The natural peat swamp forests south-east of the scheme have been logged twice in the past and only wild pig, Sambar Deer, Long-tailed Macaque and Silvery Leaf-monkey do still occur here in low numbers. The area was reported to be rich in Small-clawed Otter which often in large groups visit the blocks along the Punggur Besar river. Pigs were not identified as a pest problem by the farmers.

Potential Impacts

Clearly local soil conditions have to be evaluated for potential environmental problems during the project. However, no chemical analysis have been made of the PASS soils occurring on the scheme to assess the amount of pyrite (TR 4, vol. II). Instead soil data have been used from feasibility studies done in 1975 (UGM). This report indicates the following types of PASS soil as extremely acid: Typic Sulfihemist and Typic Sulfihemist. These soils cover about 1000 ha (40% of the scheme). Most problems due to the exposure of pyrite are anticipated for the earthwork along the primary canal in the northern block (along the Punggur Besar) and along the dike planned along the same main river (northern block).
The area has a brackish water environment which to a certain level will buffer any toxic levels of the effluent released by the PASS soils. However, study of the drainage system show that not much possibilities exist (by tide) to flush the scheme because only one connection exists with the tidal Punggur Besar river.

The physical impact of earthworks to the vegetation is low as most of the scheme is devoid of any natural vegetation. Only some coconut and banana groves will be effected by the proposed work. The value of the greenbelt along the Punggur Besar river will not be impacted as the perimeter dike will is planned to be located at least 200 m inland from the river.

Safeguard and Mitigation

To avoid the build-up of toxic levels of effluent in the collector drains sufficient flushing should be guaranteed. With the present design of drainage this can only be achieved by opening the (new) ferrocement flap gates along the secondary canals during low tide in the rainy season, when sufficient precipitation is available. Machinery can easily be brought in during the rainy season on pontoons via the canals.

9.23 ARUS DERAS (W KALIMANTAN, EASTERN SUB-PROJECT)

Project activities in this scheme will be restricted to raising the crest height of the existing dike along the primary canal, provision of drinking water via a pressed water pipeline from the Ambawang Mountains and building of flap gates in all secondary canals. This scheme will be discussed also in relation to the forest resources south of the site and the water catchment area in the Ambawang Mountains.

The area has been unsuccessful with a low annual production of rice due to floods and possibly due to the effects of exposed PASS soils (50% of the area). Pigs originating from the surrounding degraded swamp lands and adjoining forests constitute a serious pest for crops like maize, young coconut, tuber-crops, peanuts, etc. As a result more than 14% of the families have left the scheme yearly, since the first establishment in 1983. Many of the male population has found off-farm income in logging. In addition large areas of swamp forests have been cleared for agriculture in the area south of the scheme along the Arus Deras river (Sei Kiri and Sei Kanan). The cleared area stretches until the foothills of the Ambawang Mountains where farmers from former unsuccessful transmigrant projects (1950's) south of Pontianak have successfully started a new village with rice paddy cultivation.

Potential Impacts

Although soil maps indicate large areas of PASS, no negative impacts are anticipated related to earthworks due to the restricted scale of this and the general low concentrations of pyrite.
Of more importance are the developments off-site were large areas of new agricultural land are being developed and remaining peat swamp forests are stripped of any marketable logs. These forest are rich in fauna like Proboscis Monkey (protected by law), Pig-tailed Macaque, Sambar Deer, Kantjil, Bearded Pig and Wild Pig. Clearing of this forest has advanced up to the first hills of the Ambawang Mountains, which is the only location in the ISDP project area with potable white water resources. Ironically all these

lowland and hill-forests of the Arus Deras catchment area are classified as Conversion Forest and Unclassified Land.

The original Detailed Design of this project plans to build two pressed-water pipeline systems from the source of the Arus Deras and Air Putih rivers to the schemes Sei Nipah, Arus Deras, Pinang Luar, Pinang Dalam and Air Putih. Additional road are planned from the schemes along these two rivers up to the first hills.
Records were made during fieldwork about the extraction of large trees from the hill forests of these mountains. These steep faced mountains consist of intrusive granitic rock on which shallow soils have developed. It is anticipated that any further degradation of these water catchment forests will inevitable lead to drying up of the two rivers planned to be exploited for potable water.

The project also proposes the support to the additional settlement of 125 households at the scheme. Present developments on and around the scheme however indicate that this very likely would add to the negative impacts transmigrants have on the remaining forest resources. It should first be proven that the scheme with its present population will improve in its success of agriculture and that further clearing of forests and extraction of logs will stop.

Safeguard and Mitigation

Uncontrolled clearing of land and logging off-ste of the scheme should be stopped immediately, in particular around the catchment area of the Arus Deras and Air Putih rivers in the Ambawang Mountains. Developments induced by the construction of the road along the Arus Deras river towards source of the Arus Deras river in the mountains should be strictly monitored.
In addition to the proposed flood protection measures possibilities could be evaluated to stabilize land-use by officially allocating 'new land' to those farmers of the scheme who still remain with unproductive land after project implementation. Ideally this 'new land' should be located on already cleared sites close to the scheme (outside the flooding zone).

For the moment, no extra settlements should be allowed at the Arus Deras scheme.

A clear zoning of land-use has to be developed, detailing areas to be strictly protected, including all forests of the Ambawang Mountains, areas for rice paddy, and areas for sustainable types of forest exploitation. A project like ISDP should much more than present assist the farmers in non-agricultural types of income, like community forestry and the establishment of tree crop plantations. The proposed options for stabilizing land-use and to stop further misuse of the forests have to be preceded by including the Ambawang Mountains under Protection Forest status by the Department of Forestry.

9.24 AIR PUTIH (W KALIMANTAN, EASTERN SUB-PROJECT)

Not much project activities are proposed for the Air Putih scheme. Of environmental significance is the development of a pressed-water pipeline system, with potable water to

be extracted at the source of the Air Putih river in the Ambawang Mountains. Also here a road is planned to be built along this pipeline up to the mountains. Potable water will be collected in a concrete tank in the mountains at 40 m altitude. The Department of Public Works is also repairing a weir at the same location, which is planned to divert water for irrigation of rice paddy east of the scheme. The debit of the spring to be tapped for drinking water has been estimated to vary between 2 and 25 l/s. No mentioning is made to what extent the extraction of irrigation water (planned weir) and potable water (ISDP) do influence each other in water discharge.

All original forests bordering the Ambawang Mountains on the south have been cleared for agriculture by the local people (Dayak, Chinese and Malayu). However, these communities have much more problems with floods and pigs than the neighboring the ISDP scheme, resulting in large areas of unproductive 'wasteland'. Local people reported the steep decline in wildlife numbers after the establishment of the transmigration scheme. During fieldwork records were made of logging of the forests on the Ambawang Mountains. This operation (at least the one we found) is organized by locals living in the village at the foot of the mountains (outside the scheme).

Potential Impacts

No direct environmental impacts are anticipated related to project activities. However, road development and present off-scheme exploitation of the surrounding forests, could lead to the degradation of the catchment of the Arus Deras river.

Safeguard and Mitigation

Developments induced by the construction of the road from the scheme to the mountains should be monitored. In particular water supply for consumption and irrigation should be guaranteed by strict protection of the catchment of the Air Putih and Arus Deras rivers. Upgrading of the hill forests of the Ambawang mountains to Protection Forest should be discussed by the project with the Ministry of Forestry.
The existing pest problems with pigs will be dealt with as discussed in section 7.4.1.

9.25 PINANG LUAR (W KALIMANTAN, EASTERN SUB-PROJECT)

Part of the existing detailed design has already been implemented. The present project proposes further improvements to the water protection system, including the impoundment of the southern secondary canal. Also a new collector drain will be made along the perimeter dike along the Punggur Besar River. Total earthworks will move about 126,000 m^3 soil.

The area consists of Block A (western) and block B (eastern). Block A falls short in agricultural success compared to Block B because of deep peat occurring. Large areas of unproductive degraded peat land occur on the margin of Block B. The scheme is bordered on the south by a large area of degraded logged-over peat swamp forest. Pigs are a pest problem to the farmers operating south of the primary canal. A large area planted with

hybrid coconut palms was destroyed by wild pigs, even with the wooden fence built around the site. Some people hunt pigs regularly and sell these on Pontianak markets.

Due to constant crop failure the original transmigrants of Block A left their land and have been replaced later by local (spontaneous) settlers. It was reported that large numbers of young people did work outside the scheme in jobs such as on sawmills, logging and even find did so in Malaysia.
Extra settlements (150 households) are planned to be supported by this project.

Potential Impacts

No direct negative impacts will develop from the proposed project activities. PASS soils do only occur at a restricted scale, and pyrite concentrations are low. The pig problem is serious and should be tackled immediately. The proposed design of this component is further discussed under section 7.4.1.
Off-site impacts related to remaining forest resources are similar to those discussed for the other sites.
The extra settlements are planned for Block A, lands which are now only marginally suitable for permanent cultivation, like treecrops. With the present environmental situation it seems wise to wait with these settlement until it has been fully proven that available lands are suitable for rice cultivation, and moreover that land is still available for this.

Safeguards and Mitigation

Forest resources south of the scheme are classified as Conversion Forest (close to Ambawang Mountain) and as Unclassified. This however does not mean that these resources would be allowed to be misused for any purpose. In particular Conversion Forests, if converted to other types of land-use, should remain productive in the sense of economies. It is generally known that the most optimal type of land-use on peat lands is to keep a forest vegetation. This could be natural types of forest or plantations of treecrops. Marginal suitable land with moderate to deep peat are found at the margin of this scheme, which could be developed into more productive types of land-use. Also inhabitants need to diversify crop production to sustain their income in times of excessive drought, floods, plant diseases or other natural impacts. The present conditions prove this point. This is why possibilities should be evaluated by the local government, supported by the ISDP project to develop forestry activities on and along this scheme.

9.26 PINANG DALAM (W KALIMANTAN, EASTERN SUB-PROJECT)

This scheme has some flood problems in Block A and B for which the project proposes to build a total of 3700 m impoundments along the primary and secondary canals (for exact position see Map 4A, Project Activities). This includes the upgrading of the canal system up to a total of 48,740 m^3 earthworks.

Only about 42 % of the scheme is presently under cultivation with large areas under unproductive fern or shrub peat land. See Map 4B (Land Use/Forest Status) for more

details. In particular Block A and the abandoned land north of this block are 100% covered with this type of vegetation. Main reasons for this are the deep peats, yearly bush fires and the pig pest problems. As a result a population decline at an average of 8% a year has occurred since the establishment of the first transmigration settlements. Very progressed plans exist (which will continue independent of the ISDP project) to settle 120 extra households on these problem lands. Ironically the design places settlements at the alluvial soils closes to the river and allocates agriculture for the deep peat lands along the primary canal.

Potential Impacts

Earthwork will hit PASS soils of the Sulfic Fluvaquents type, which widely occurs along the riverside of Block B. Although composite levels (first 120 cm soil profile) give only 2.2% pyrite, concentrations are found up to 7% for soil horizons deeper than 50 cm. Given the restricted scale of operations no impact of significance is expected.
Vegetation along the Kubu river is well developed and relatively less disturbed then elsewhere with some populations of Proboscis Monkey (protected) and Silvered Leaf-monkey, using this vegetation as feeding and resting habitat. Building of the dike along the river and the extra planned settlements might lead to a further decrease in suitable habitat for these monkey populations. Considering the overall degradation of riparian forest along the major rivers at the ISDP project area, every additional impact by the project should be avoided to support wildlife and to protect against erosion.
Problems observed with the management of the remaining forest resources west of the scheme are similar to those discussed for Pinang Luar, Air Putih, Sei Nipah and Arus Deras.

Safeguard and Mitigation

The planned flood protection dike along the Kubu river should be located at least 100 m inland from the river. This is in accordance with the Presidential Degree No. 32/1990, Article 16, concerning the establishment of a protective greenbelt along all rivers in Indonesia.
The existing pig problem and proposed establishment of a fence will is discussed in section 7.4.1.
Inhabitants of this scheme have and certainly still do benefitted from the extraction of forest products off-site. However, times have come that these are running short because of serious misuse of the forests. The issue raised related to the management of the forest resources off-site should be handled similar to the above discussed schemes situated along the Ambawang Mountains.

9.27 JANGKANG I (W KALIMANTAN, EASTERN SUB-PROJECT)

Planned earthworks in this scheme are restricted to the recanalization of 4650 m of primary and tertiary canals to improve the water circulation. The scheme is only for 51% cultivated, has more than 700 ha of deep peat and 668 ha of PASS soils. The large extent

of shrub peat land and the adjoining peat swamp forests (degraded) to the east of the site support a large population of pigs who regularly raid the farmland for food.
This year (1992) 100 and 200 new transmigrant families have been settled in Jangkang III and Jangkang II respectively. Which is considerably more than the planned 50 families under ISDP.

Potential Impact

Earthworks at the canals will hardly have any environmental impacts other than the physical destruction of border vegetation. This however is acceptable in this disturbed agricultural environment.
Of more concern are the extra settlements which will add to the pressure on the remaining forest resources. Reports were received from the scheme that people extract logs from these forests, which are classified as Unclassified Land. However, nothing can be said about the scale of these exploitations.

Safeguards and Mitigation

No particular safeguards are needed for project implementation. The forestry sector however should be studied to identify present and future needs for construction and firewood on the scheme. Given the increase in peat depth going east of the scheme, best land-use options for the near future are those with a permanent tree cover. The ISDP project should discuss this matter with the local authorities for follow-up.
The activities related to the pig problem are detailed in section 7.4.1.

9.28 OLAK-OLAK KUBU (W KALIMANTAN, EASTERN SUB-PROJECT)

Main environmental aspects to consider for this scheme is the construction of 6950 m of flood protection dikes and 3500 m recanalization of tertiary canals to improve the draining of these lands. This involves a total of 147,300 m^3 soil work.
Although contradictionary to the information extracted from the Technical Reports the scheme appeared to be quite successful in agriculture. But pig and rats were reported to impact crop production. Today more than 75% of the area is under cultivation, even with the identified 764 ha of pyritic soils and deep peat in the north-east of this scheme.

Forest resources north of the scheme are restricted to a small degraded zone directly bordered to the north by the Jangkang II and III schemes.
A bridge and a connecting road have been built by the Ministry of Transmigration at the eastern border, connecting this scheme with the Terentang II and III schemes (non-ISDP, east of the scheme). It was reported that additional settlements (250 households) would be located along this new road. Study of the soil map as well as field visits reveal the occurrence of peat soils up to 1.50 m depth at these same lands.

Potential Impacts

Although the soil studies of the Technical reports do not provide analytical data on pyrite content of the PASS soils occurring, several sections of the earthworks are planned in PASS soils identified as extremely acid. These include Typic Sulfihemist soils. As a result toxic effluent will be released during and after the building of dikes in the eastern section of the scheme. However, aquatic environments like the Terentang River (Arowana fish !) are not expected to be impacted by these earthworks because of the existing rate of disturbance and small scale of earthworks planned.

Safeguards and Mitigation

No mitigation is needed.

9.29 DESA KUBU (W KALIMANTAN, EASTERN SUB-PROJECT)

Main problem of this scheme is the salt water intrusion in the northern section (with a perimeter dike) because of repeated dike breach at three locations.
The project proposes to repair this dike and to rechannel 2500 m of existing tertiary canals and to make a collector drain along the eastern perimeter dike. This will involve a total of 185,100 m^3 earthworks. The project also proposes to support the extra settlement of 75 families.
After the establishment of the original drainage system by Public Works (before 1983) it appeared that at least 1/3 of the area drained could not be successfully reclaimed from the mangroves, which today have been regenerating to a healthy forest, intersected by the former canals.

The existing perimeter dike off the three locations of dike breach is located on swampy land in the middle of mangrove vegetation. This area is daily inundated by the tidal movement of the nearby sea, which apparently is of sufficient force to repeatedly destroy the dike. It was also found that the planned perimeter collector drain has already been implemented and appeared to be a broad and deep canal closely located to the dike. This design might also add to undermining the structure of the flood protection dike.

Of particular interest in this scheme are the mangroves which border the site on the south and the remaining peat swamp forests (logged-over) north-east of the settlements. The scheme itself was measured to be cultivated for a maximum of 50%, with agriculture hampered by saline intrusion and the occurrence of PASS soils south of the Sungai Terus river.

The mangrove and Nipah swamps along the Sei Radak Runtung river are part of the largest remaining tidal swamp forest of West Kalimantan. These forests large 108,000 ha (Selat Pandang Tikar) are of high importance to typical wildlife of Kalimantan swamps like Proboscis Monkey and Storm's Stork (both protected by law), and as nursery and breeding side for fish and prawn species, including many of commercial value. These forest have been proposed to be included under Protection Forest status by the Regional Physical Planning Programma for Transmigration (RePPProT), 1989). For more details see the appended Land Use/Forest Status map (Map 4B) and section 5.2.1.

Potential Impacts

No high pyritic PASS soils will be crossed during earthworks. However, serious doubt is expressed concerning the sustainability of dike repairs. The location of some parts of the dike and the tidal action have proven in the past to repeatedly undermine the dike due to abrasion. Also part of the scheme within the perimeter dike has a healthy mangrove vegetation which better would be protected to support local fisheries. Further technical studies should determine if the dike could be relocated more inland on less swampy land.

Many local settlements are found along the Kubu and Terentang rivers and including the swamp development settlements appear to be rapidly expanding in area (see the appended Land Use/Forest Status map, Map 4B). Nearly all greenbelts along these rivers are degraded, including those in the estuary of the Kubu river. Mangrove forest in the estuarine swamps of Selat Padang Tikar were found to have been logged at large scale, even with large parts already included under Protection Forest status. Given the high importance of these swamps for captive fisheries steps should be taken by the local government to protect these forests from further spontaneous developments.

Safeguard and Mitigation

To avoid continued breach of the perimeter dike, resulting in serious saline intrusion of agricultural land, possibilities should be studied to relocate the southern section of the dike more inland.
Responsibility should be taken by the ISDP project in developing management of the forest resources off-site, as a large area of mangroves is located in or close to the scheme. A project aimed at poverty alleviation of swamp development sites should look into the benefits and possibilities for protection or sustainable exploitation of natural swamp lands like mangroves.

9.30 SEI BULAN (W KALIMANTAN - EASTERN SUB-PROJECT)

The development of this area is seriously hampered by the seasonal flooding from the Punggur Besar river and the Sei Bulan river and its upstream catchment area. Water also enters the fields along the primary canals in Block A and B. In addition wild pig raids along the forested boundaries are a big problem. About half of Blocks A and B, and the whole of Block C have not been cleared from the peat swamp forest, and vegetation is contiguous with the forests extending north up to the Kapuas river (± 15 km away). Very deep peat (up to 7 m) is found at Block C and the uncleared part of Block B.
The scheme is characterized by the high number of people which are forced to find a living in off-farm work, in particular logging.

The project proposes to build 20.2 km of dike along the primary canals and as perimeter dike starting in Block C, along the Punggur Besar, along the Sei Bulan river and up to the end of the eastern canal no 12 in Block A. Estimated volumes of earthwork give a total of 155,400 m3. It is not clear from the Technical Reports if the tertiaries no 11 (west)

and no 12 (east) will be rehabilitated to function as collector drain along the perimeter dike.

Most larger logs have been extracted from the forests north of the scheme and new agricultural land is being opened along the Sei Bulan river north of Block A. Forest degradation in the catchment of the Sei Bulan river has decreased the buffer function of these peat swamps, resulting in higher peak flows and flooding downstream.
Though degraded, these forest are still worth to be protected from further exploitation, also in relation to the wildlife occurring. Four species of monkey live here, including Prohoscis Monkey (protected by Indonesian law), Long-tailed Macaque, Pig-tailed Macaque and Silvered Leaf-monkey.

Potential Impacts

All earthwork will take place on the scheme itself without touching any peat swamp forests. Composite pyrite levels classify the soils as low risk PASS soils. However, locally along the planned dikes, Typic Sulfohemist PASS soils occur with 5.3% pyrite at the top soil layer. In particular the impounding of the primary canal and along the Punggur Besar river, both in Block B will expose these PASS soils to oxidation. The overall environmental impact to agriculture and the water quality of the canals is estimated to be low.

Of higher importance is the negative impact of logging on the surrounding forest reserves. With present rates of degradation no productive forest will remain as required by its official status (Production Forest).
Agricultural land development along the Sei Bulan river degrades the existing green belt along its borders, which will increase the danger that the planned dike will be eroded away in the near future.

If floods can be contained after the proposed hydrological improvements, agriculture will be more succesfull, which on its turn might attract more people from abroad or the return of former transmigrants. Extra settlement if ever planned should however never be situated on the uncleared parts of the scheme because of the very deep peat layers, which will lead to crop failure after a few years.

Safeguards and Mitigation

The only safeguards deemed necessary are to avoid build-up of toxic levels of acid and other effluent from the exposed PASS soils, in the tertiary canals. This can be best guaranteed during the rainy season when flushing is aided by excessive amounts of precipitation.
At a more regional level are the need to protect the existing green belts along the Punggur Besar and Sei Bulan rivers. Presently no programs exist for the sound management of forest resources, to safeguard future needs for forest products and environmental stability. Possibilities should be evaluated by the project to stimulate the development of forestry

activities by the inhabitants of the schemes on the uncleared lands on block A, B and C. This will generate alternative types of income and stabilize land-use around the scheme.

10.0 IMPACT ASSESSMENT SUMMARY TABLE

This section presents a summary table of the overall impacts of the project on various aspects of the environment. Each major element of the environment is treated seperately, with the positive and negative aspects of the project components summarised, along with management and monitoring options, and the likely overall effects after implementation.

In this manner, the relative importance of the project components on the environmental components can be identified. Further information on the management and monitoring options proposed is contained in the Management and Monitoring report.

The following table is divided into two sections; summarising impacts on the socio-economic environment, and on the natural environment.

Environmental Component Affected.	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
On-scheme agricultural production	New and upgraded dikes, canals and water control structures	Reduced wet season flooding of fields Improved dry season irrigation Improved water circulation reduces acidity problems Improved control of salt intrusion	Exposure of PASS soils creates risk of acid sulphate contamination of fields Substantial earthworks on agricultural lands required Local disturbance during construction Loss of land	Identify areas of significant PASS soils in relation to construction Woven bamboo fences laid on dikes to contain pyritic soils Liming of affected dikes. Ensure free movement of water via collector drains.	Monitoring of soil acidity Monitor flood levels and hydrological change Proper maintenance of dikes & canals Compensation to adversely affected farmers	Reduced flooding of fields improves chances of successful wet season cropping Improved dry season irrigation enables additional cropping Better control of salt intrusion and water circulation Acidity problems reduced over time.
	New or upgraded transport and navigation components	Improved transport within schemes Improved transport between schemes and markets Possibility of attracting new settlers	Easier access for unwanted or unauthorised visitors Loss of some agricultural lands Risk of PASS soil exposure Local disturbances and disruptions during construction	Identify areas of significant PASS soils in relation to construction Compensation for land disruptions	Regular maintenance of transport systems	Improved capability to market agricultural products
	Strengthening of agricultural support services including: Agricultural extension; Improved water use management; Tertiary Demonstration Units; Land development; training & workshops; research and extension.	Improved education, organisation, technology and support for agriculture production.	None	None required	Ensure project components meet the farmer's requirements	Increase in production through improved education and technology

Environmental Component Affected.	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
On-scheme agricultural production, continued	Strengthening of agricultural support: Perimeter pig fence	Reduction of pig problem on schemes Clear delineation of scheme boundaries	Difficulty of maintenance Likelihood of theft or damage		Maintenance of fence	Reduction in pig numbers on schemes increases cropping success
	Strengthening of agricultural support: Rat control	Reduction of rat pest problem on schemes	Potential deaths of farm animals through ingestion of poison	Ensure correct dosages of poisons administered Regulation of supply of poisons on schemes Education program	Monitoring of pesticide use Monitoring of success of program	Improved crop production
	Strengthening of agricultural support: Improved seed production	Increased crop yields	None			
	Estate crop development	Better utilisation of currently unused lands Diversification of agriculture	Difficulties in adjusting to new methods and technologies	Identification of land suitability Ensure appropropriate estate crops are planted		
On-scheme public health	Installation of individual cisterns for drinking water supply	Improved quality and availability of drinking water	None	Ensure effective installation and maintenance of systems	Monitoring of public health	Improved health in community
On-scheme social setting	Support for agro-industries, pilot credit scheme and social development components	Improved opportunities for financing of projects Improved education and development of women's role.	None			Improved social setting

Environmental Component Affected.	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
	New and upgraded dikes and canals	Reduction of flooding in some areas	Increased flooding of neighbouring fields in some areas Risk of crop damage in adjacent fileds through construction activities, especially exposure of PASS soils Reduced water avialable for dry season irrigation Perception of transmigrants receiving preferential treatment	Identification of PASS soils locations Identification of local flooding/irrigation problems Compensation of affected communities	Regular assessment of impacts on neighbouring land users	Retention of social harmony
	Clearing of peripheral blocks	None	Conflicts with logging concessions over ownership of valuable timbers	Identification of land status	Co-ordinated management of neighbouring lands	Retention of social harmony
	Perimeter pig fence	Clear delineation of scheme boundaries	Movement of pigs onto adjacent properties	None	None	
	New or upgraded transport and navigation components	Improved regional transport systems	None	Maintenance of transport systems	None	Better integration of schemes in wider community

Environmental Component	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
Terrestrial Fauna	Wildlife exploitation	Reduced opportunity for exploitation through more efficient pest (pig) control Increased farm productivity reduces incentives for exploitation of wildlife	Success of schemes may lead to increased population and possible greater likelihood of exploitation	Active promotion of safer pest control alternatives. Environmental education program.	Regular fauna surveys. Monitoring transmigrant wildlife collecting activities.	Improved baseline data on local fauna provides better capability to monitor problems.
	Accidental death of rare species	Reduced incidence of captures through more efficient pest control	Unlikely to completely solve problem.	Active promotion of safer pest control alternatives. Environmental education program.	Monitoring of capture of rare species.	Reduced capture of rare species. Greater awareness through education.
	Removal of on-scheme wildlife habitats due to land clearing	None	Animals killed during clearing of land Reduction in available habitat Reduction in biodiversity on schemes	Care taken during land clearing operations. Proper management of adjacent forest. Retention of "green belts". Retention of larger trees for bird habitat.	Monitoring of adjacent lands. Co-operation with neighbouring landholders.	Wildlife retreats to adjacent forest. Wildlife remains secure in adjacent forests.
	Perimeter pig fence	Reduced opportunity for other wildlife to enter schemes	Fragmentation of wildlife habitats. Wildlife trapped within schemes.	Use of pig fence only on small schemes Siting of fence around cropped areas rather than around uncleared land	None required.	Wildlife less likely to visit schemes Some species trapped within schemes unlikely to survive
	Perimeter dikes and canals	None	Fragmentation of wildlife habitats Access routes to off-site forests Drainage of swamps reduces habitat quality	Siting of new dikes and canals around cropped areas rather than uncleared forest		Wildlife retreats to less disturbed adjacent forest.
	Construction of dikes and canals within schemes.	Nohe	Reduction, fragmentation and degradation of habitats.	Minimal disturbance to natural vegetation during construction phase.	None required.	Reduced wildlife populations within schemes.
	Use of pesticides	None	Poisoning of non target species through direct ingestion, or through feeding on poisoned animals	Selection and use of appropriate pesticides Education in use of pesticides		

Environmental Component	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
Adjacent forests	Off-site timber harvesting	Improved agricultural success may reduce need for forest products.	Unlikely to completely stop harvesting of timber products off site. Success of schemes may open area for more exploitation.	Identification of timber needs within schemes. Possible setting up of woodlots on abondoned or disused lands to meet needs on-site.	Regular checks on wood usage in community. Monitoring of productivity of woodlots or on scheme forest plots.	Reduction in utilisation of off-site forests. Improved supply of timber if management of woodlots, etc. successful.
	Perimeter dikes and canals	None	Exposure of PASS soils may cause vegetation death. Loss of vegetation during construction. Opening of forest to weeds Draining of forest creates water stress for plants.	Siting of new dikes and canals around cropped areas rather than uncleared forest.		Forest remains, but in a more degraded condition.
On-site forests and fallow land.	Removal of on-scheme habitats due to clearing for agriculture.	Removal of weed species.	Removal of natural vegetation. Unless land is cropped, weed species will invade.	Supervision during clearing.	Ensure cleared land is cropped. Regular maintenence of uncropped land.	On site forests removed.
	Construction of dikes and canals within schemes.	None	Reduction or degradation of on-site vegetation. Draining of swamps causes vegetation stress. Exposure of PASS soils leads to vegetation death.	Minimal disturbance to natural vegetation during construction phase. PASS soil areas well drained.	Regular maintenance of canals.	Reduced on-scheme forests.

Environmental Component	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
On-scheme aquatic environment	Use of herbicides and pesticides.	Clearance of weeds from canals.	Pollution of waters.	Strict regulation of use of chemicals. Education in use of chemicals. Use of mechanical means of aquatic weed removal. Improved pest control means lower usage of poisons.	Water quality monitoring program.	Maintenance of good water quality through reduction in ues of poisons and through regular monitoring.
	Construction of new or upgraded dikes and canals within schemes.	Improved water circulation. Additional aquatic habitats available.	Destruction of existing aquatic habitats in some areas. High acidity in canals if PASS soil exposed. Turbidity increase. Aquatic fauna accidentally killed during excavations.	Identify areas where PASS soil may be a problem. Construction of collector drains in PASS soil areas. Ensure free movement of water in PASS areas.	Water quality monitoring program.	Acidity problems likely to be short term. Colonisation of new canals by aquatic plants and animals.
	Construction and operation of water gates.	None.	Restriction of water movement creates stagnant conditions. Restricted movements of aquatic animals. Possible build up of acidity. Ideal conditions for weed growth.	Closure of gates regulated to ensure good water flow.	Regular monitoring of water quality, weed growth and aquatic fauna diversity in canals.	Establishment of balanced aquatic ecology in canals.
	Rechannelisation of on-scheme rivers and removal of deadlocks.	Improved stream flow.	Temporary destruction or change to habitats. Increased turbidity and possible erosion. Aquatic fauna accidentally killed during excavations.	Supervision during rechannelisation projects to ensure safety of large aquatic animals (eg Crocodiles, turtles). Netting of areas known to contain large aquatic fauna before excavation works proceed.	Regular monitoring of water quality, weed growth and aquatic fauna diversity in canals.	Recolonisation of aquatic environments.

Environmental Component	Source of Impact	Positive Impacts of Project on Environmental Component	Negative Impacts of Project on Environmental Component	Management Options	Monitoring Options	Likely Effects after Implementation
Off-site and peripheral stream aquatic environments	Construction of dikes adjacent to river banks.	None	Removal of bankside vegetation. Increased siltation of rivers. Possible increase in acidity due to exposure of PASS. Disturbance to stream bed. Changes in riverine habitat.	Identification of areas of PASS. Disturbance to river banks kept to minimum. Erosion control where necessary. Revegetation of banks.	Monitor erosion problems and success of revegetation.	Temporary disturbances to aquatic environment.
	Rechannelisation of rivers.	None.	Disturbance to stream beds. Disturbance to bankside environment. Change in river flow.	Disturbances kept to minimum.	None	Temporary changes to aquatic habitats.
	Use of herbicides and pesticides.	None	Pollution of local river systems.	Strict regulation of use of chemicals. Education in use of chemicals. Use of mechanical means of aquatic weed removal. Improved pest control means lower usage of poisons.	Monitoring of water quality.	Pollution levels in rivers not expected to increase.

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APPENDICES

Appendix 1: Basic Information Jambi Schemes		SCHEMES										
		Simpang Pandan	Lagan Hulu	Muara Sabak	Lambur	Pamusiran	Rantau Rasau	Simpang Pudong	Dendang I	Dendang II	Dendang III	ISDP-JAMBI
DESCRIPTION												
Surface (in ha),	total	6,500	4,030	1,950	6,440	4,140	9,110	2,760	4,500	2,000	1,940	43,370
Rice land (monoculture)	(ha)	1,275	1,300	0	2,950		4,145		620		?	10,290
Rice + 12.5 % Coconut	(ha)	1,435	495	1,030	2,750		2,345		1,796		?	9,851
Rice + 40% Coconut	(ha)	0	90	450	2,065		3,523		877		?	7,005
Total mixed Rice + 12.5-40% Coconut (ha)		1,435	585	1,480	4,815		5,868		2,673		?	16,856
Coconut (+ Fruit)	(ha)	0	0	0	400		0		0		?	400
	Total cropped land (ha)	2,710	1,885	1,480	8,165		10,013		3,293		?	27,546
	Total cropped land (%)	42%	47%	76%	77%		84%		51%		?	64%
Farm households	(households)	1,270	927	750	3,483		5,217		1,930		?	13,577
Mean area cropped	(ha/hh)	2.13	2.03	1.97	2.34		2.01		1.71		?	2.1
Rice intensity	(Rice + <12.5% coconut on suitbale soils)	65%	91%	54%	55%		73%		59%		?	?
Cropping intensity	(%)	73%	33%	74%	95%		90%		69%		?	?
Less developed land	(ha)	806	1,000	175	250		0		1,100		?	3,331
Cropped+Less developed (ha)		3,516	2,885	1,655	8,415		10,013		4,393		?	30,877
Cropped+Less developed (%)		54%	72%	85%	80%		84%		68%		?	71%
Fish ponds, existing	total area per scheme (ha)	0.10	0.10	1.65	0.25	3.59	1.50	2.00	3.10	1.88	0.20	14.37
Fish farmers (main & side)	(households)	10	30	5	10	70	100	125	250	50	15	665
Fish ponds/household (ha/hh)		0.01	0.00	0.33	0.03	0.05	0.02	0.02	0.01	0.04	0.01	0.02

Appendix 1: Basic Information Jambi Schemes		SCHEMES										ISDP-JAMBI
		Simpang Pandan	Lagan Hulu	Muara Sabak	Lambur	Pemusiran	Rantau Rasau	Simpang Puding	Dendang I	Dendang II	Dendang III	
CONSTRAINTS/PROBLEMS												
Inundation (in ha)	maximum (last 10 years)	5,372	2,912	?	6,204	Not significant	Not significant	2,300	7,380		2,513	26,681
Inundation (in ha)	annually	3,887	1,180	?	2,852	Not significant	399	2,300	6,140		2,046	18,804
Inundation (in ha)	wet season (spring tide)	0	0	?	1,176	2,543	3,270	2,066	2,612		244	11,911
Inundation (in ha)	dry season (spring tide)	0	0	?	51	614	125	125	230		0	1,145
Inundation (in % of total)	maximum (last 10 years)	83%	72%	?	96%	?	?	83%	114%		130%	62%
Inundation (in % of total)	annually	60%	29%	?	44%	?	4%	83%	94%		?	43%
Inundation (in % of total)	wet season (spring tide)	0%	0%	?	18%	61%	36%	75%	40%		13%	27%
Inundation (in % of total)	dry season (spring tide)	0%	0%	?	1%	15%	1%	5%	4%		0%	3%
Soils, mineral (in ha)	pyrite soils/PASS	88	75	87	176	210	0	0	100	0	1,940	2,676
Soils, mineral + shallow peat	(suitable for rice + <12.5% coconut)	4,167	1,963	1,907	10,316		8,934		4,122		?	31,409
Soils, peats (in ha)	shallow (<100cm)	2,436	0	1,336	4,858	1,192	7,088	1,050	2,084	1,446	865	22,355
Soils, peats (in ha)	medium (100-200cm)		1,525	0	0	0	737	0			400	2,662
Soils, peats (in ha)	deep (>200cm)	1,620	145	0	28	0	0	0	1,434	0	675	3,902
Soils, all peats	total	4,056	1,670	1,336	4,886	1,192	7,825	1,050	3,518	1,446	1,940	28,919
Aqua-culture potential,	tidal ponds (ha)	0	0	15	0	20	35	10	22	0	8	110
Aqua-culture potential,	non-tidal ponds (ha)	25	20	0	15	0	0	0	0	0	10	70
Aqua-culture potential,	rice-field demo plots (ha)	0	0	20	0	100	160	50	60	0	5	395
Aqua-culture potential,	canals/ditches (ha)	0	0	0	2.5	2.5	2.5	2.5	0	0	0	10
Aqua-culture potential,	cages (ha)	0	0	0	2	2	2	2	0	0	0	8
Pigs		major	major		not		not		main		major	-
Rats												-
Other pests					weeds		birds			otters		-
Disease(s)		None specifically mentioned, or solutions planned										-
Forest nearby/adjacent		Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	-

Appendix 1: Basic Information Jambi Schemes		SCHEMES										
		Simpang Pandan	Lagan Hulu	Muara Sabak	Lambur	Pamusiran	Rantau Rasau	Simpang Puding	Dendang I	Dendang II	Dendang III	ISDP-JAMBI
PROJECT ACTIVITIES/ASPECTS												
Dikes (in km),	new	5.8	0	?	0	0	14.6	22.6	40.3		19.7	103.0
Dikes (in km),	rehabilitation	6	0	?	0	0	0	0	0	0	0	6.0
New canal(s) (in km),	navigation	0	0	?	0	15.8	0	0	0	0	0	15.8
New canal(s) (in km),	primary	0	0	?	0	0	0	0	11.7		0	11.7
New canal(s) (in km),	secondary	0	0	?	8	8.8	0	0	2		0	18.8
New canal(s) (in km),	tertiary	0	0	?	10	3	0	0	0	0	0	13.0
Rechannelization (in km),	river(s)	2	8	?	0	0	0	0	0	0	0	10.0
Rechannelization (in km),	navigation canals	6	3.5	?	5	0	0	0	0	0	0	14.5
Rechannelization (in km),	primary canals	5.8	0	?	0	0	0	0	38.6		7.8	52.2
Rechannelization (in km),	secondary canals	10	0	?	0	0	0	0	151.7		38.05	199.8
Rechannelization (in km),	tertiary canals	0	0	?	0	0	0	0	0	0	0	0.0
Earth work (new & rehab),	dikes (1,000 m3)	32.2	0.0	?	0.0	0.0	171.8	191.7	260.5		168.4	824.5
Earth work (new & rehab),	river (1,000 m3)	40.0	586.5	?	50.0	0.0	0.0	0.0	0.0		0.0	676.5
Earth work (new & rehab),	primary canal (1,000 m3)	125.0	0.0	?	0.0	450.0	0.0	0.0	752.1		121.2	1,448.3
Earth work (new & rehab),	secondary canal (1,000 m3)	162.0	0.0	?	16.0	8.8	0.0	0.0	596.5		57.1	840.3
Earth work (new & rehab),	tertiary canal (1,000 m3)	0.0	0.0	0.0	24.0	42.0	0.0	0.0	0.0		0.0	66.0
Total earth work (new & rehab; 1,000 m3)		359.2	586.5	0.0	90.0	500.8	171.8	191.7	1609.1		34	3,855.7
Water control works,	stop-log	127	0	?	118	4	26	10	161		0	446
Water control works,	sluice gate	0	0	?	1	9	17	26	0	0	0	53
Water control works,	flap gate	1	0	?	9	10	3	0	4	2	0	29
Water control works,	sluice/flap gate	3	0	?	0	0	4	5	3	4	3	22
Water control works,	permanent earth closures	0	0	?	4	3	3	1	0	0	0	11
Water control works,	pumps	0	0	?	0	11	0	0	0	0	0	11
Water control works,	off-take structures	0	0	0	0	44	0	0	0	0	0	44
Roads	new/upgrading (to tarmac)	"0"	"0"	0	0	0	0	0	15.1		6	21.1

Appendix 1: Basic Information Jambi Schemes		SCHEMES										
		Simpang Pandan	Lagan Hulu	Muara Sabak	Lambur	Pamusiran	Rantau Rasau	Simpang Puding	Dendang I	Dendang II	Dendang III	ISDP-JAMBI
Bridges		0	0	0	0	0	0	0	0	0	0	0
Jetties	new/reconstruct/repair	1	0	0	0	0	0	1	1	0	0	3
Pig fence	(km)	41	48	30	28	22	25	17	35		0	246
Pig fence	(m/ha)	6.3	11.9	15.4	4.3	5.3	2.7	6.2	7.8	0.0	0.0	60
Drinking water,	cistern units	1,270	927	?	1,125	611	4,470	747	1,942		267	11,359
Agro-chemicals,	urea, HYV's only (kg/ha)	40 increasing to 100										
Agro-chemicals,	TSP, HYV's only (kg/ha)	20										
Agro-chemicals,	KCL											
Agro-chemicals,	insecticide (l/ha)	0.8 increasing to 2.0										
Agro-chemicals,	rodenticide (kg/ha)	0 increasing to 2.5 and down to 0.5										
Agro-chemicals,	herbicide (kg/ha)	0 increasing to 2.5										
Aqua-culture,	hatchery centre	0	0	0	0	0	1	0	0	0	0	1
Aqua-culture, demonstr.	tidal ponds	?	?	?	?	?	?	?	?	?	?	7
Aqua-culture, demonstr.	non-tidal ponds	?	?	?	?	?	?	?	?	?	?	3
Aqua-culture, demonstr.	rice-field culture	?	?	?	?	?	?	?	?	?	?	2
Aqua-culture, demonstr.	ditch culture	?	?	?	?	?	?	?	?	?	?	4
Aqua-culture, demonstr.	cage culture	?	?	?	?	?	?	?	?	?	?	4
Socio-economic	Multi-Purpose Center	?	?	?	?	?	?	?	?	?	?	3
Socio-economic				+								
Research,	field stations	?	?	?	?	?	?	?	?	?	?	?
Research,	Technical Demonstration Units (TDUs)	?	?	?	?	?	?	?	?	?	?	9

APPENDIX 2:

DATABASE ISDP SITES WEST KALIMANTAN

	Kapuas II	Kapuas III	Jawi/Kalimas	Betutu	Punggur Kecil	S. Nipah	Rasau Jaya	Arus Deras	Pinang Luar	Pinang Dalam	S. Bulan	Jangkang I	Air Putih	Olak² Kubu	Desa Kubu	S. Radak	TOTAL
Total Area (ha)	3430	3259	2000	1300	9000	2600	7520	635	2100	1900	1390	1960	2420	2350	1750	2500	46114
Cultivated (ha)	3500	1350	1380	950	6750	2225	4975	550	1875	800	250	1000	2000	1775	875	1000	31255
Ratio Cultivated/Total area	100%	41%	69%	73%	75%	86%	66%	87%	89%	42%	18%	51%	83%	75%	50%	40%	68%
Peat >150cm(ha)					775	9	1950	59	551	383	peat	700	19	187		peat	4633
Pyrite within 100cm	2467	3259	1881	1208	1475	1634	468	295	48	145	371	668		764	651	608	15942
Flooded, max. (ha)	x	x	x	x		2380	350	250	x	x	760	x		x		700	4440
Salt Intrusion	x	x	x			x									x		
Households (Hh.), 1990	?	?	?	?	1646	926	2726	143	454	183	311	246	391	645	259	746	
Anual Change in Hh.(%)	?	?	?	?	?	?	6.29	-13.72	-4.32	-8.22	-5.57	0	-0.88	-9.02	6.55	-7.18	
Income on-farm x1.000 Rp			824	824	783	603	620	941	594	618	234	1008	463	348	502	1214	684
Income off-farm x1.000 Rp			406	464	207	334	315	177	403	435	142	397	96	245	551	255	316
Rice production, ton/ha	1.1	0.8		0.8		0.8	1.2	0.83		1.1	0.83	1.1	1.1	1.1		1.01	
Extra Settlements ISDP							175 Hh	125 Hh	150Hh	120Hh		50Hh	175Hh		75Hh		
Wild Pig Pest							R.J. I	yes	yes	yes	yes	yes	yes	yes	?	yes	
Rat Problems	x	x	x			x	x		x			x	x	x		x	
Remaining Sec. Forest on Scheme (ha)	60		130		585	305	335		185	10		135	215	75	490		2525
Logging Nearby Forest			mangrove				logs & agricul.	logs & agricul.	logs	yes	logs	logs	logs	yes	mangrove	logs	
Detailed Design																	
Hydrological Infra.	yes	yes	yes	yes	no	no	?	no	yes	yes	no	no	no	no	no	no	
Hydrological System	Semi-Open Tidal	Semi-Open Tidal	Polder	Polder	Parits												
Lack Potable Water	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

FAUNA ON OR NEAR ISDP SITES, AUG-SEP 1992

OBSERVATIONS
O = Observed by AWB teams Aug-Sep 1992
C = Identification by call, AWB teams
R = Reliably reported to AWB teams Aug-Sep 1992
? = Uncertain identification
* = Occurs in cultivated areas/canals
I = Introduced

STATUS
P = Protected in Indonesia
AppI = Appendix I CITES
AppII = Appendix II CITES
E = Endangered (RDB)
V = Vulnerable (RDB)
R = Rare (RDB)
I = Indeterminate (RDB)
K = Unknown (RDB)

UTILISATION
F = Used for food by humans
S = Sold for skin
A = Agricultural (labour, traction, meat, etc)
K = Kept/sold as a pet
P = Pest species

Group / Family / English Name	Local Name	Scientific Name	Sites						Status	Utilisation
						Jabiru	Kakadu	Ranger/Nourlangie		
CRUSTACEANS										
Family Thalassinidae										
Mudlobster	Udang Getah	*Thalassina anomala*					O	O		
Family Palaemonidae										
Freshwater Prawn	Udang Galah	*Macrobrachium spp.*	O	O			O	O		F
Family Portunidae										
Mangrove or Swamp Crab		*Scylla serrata*						O		
FISHES		Total fish species/significant fish species:	32/2		14/1		31/2			
Family Dasyatidae (Rays)										
Sting Ray	Pari	?		R						
Sting Ray	Pari	*Himantura signifer*					O			F
Family Carcharinidae (Sharks)										
Shark	Hiu	Carcharinidae		R						
Family Pristidae (Sawfishes)										
Wide Swordfish	Ikan Gergaji	*Pristis pristis*			O			P		F
Family Osteoglossidae (Bonytongues)										
Asian Bonytongue	Arwana/Kayangan/Kelesa	*Scleropages formosus*	R	R			R	R	K;AppI;P	S,F
Family Notopteridae (Featherbacks)										
Featherback	Belida	*Notopterus chitala*	R	R					P	F
Featherback	Belida	*Notopterus borneensis*					R	O		F
Family Cyprinidae (Carp-like Fishes)										
Rasbora	Pantau/Seluang	*Rasbora vaillanti*	O,R	R	O					
Rasbora	Seluang	*Rasbora argyrotaenia*					O	O		F,S
Carp	Ikan putih	*Osteochilus schlegeli*		O	O					F
Carp	Kelemak/Melem	*Osteochilus hasselti*			O					F
Carp		*Dangila sp.*		O						F
Carp	Seluang	*Oxygaster anomalura*						O		
Barb	Seluang	*Puntius fasciatus*		O						F
Family Bagridae (Catfishes)										
Bagrid Catfish	Lundu	*Mystus planiceps*			O					F
Freshwater Catfish	Baung/Ikan duri	*Mystus nemurus*	O,R	O,R						F

English Name	Local Name	Scientific Name						Status	Utilisation
Bagrid Catfish	Baung	*Mystus wolffi*				O			F
Family Clariidae (Walking Catfishes)									
Common Walking Catfish	Limbat/Lele/Keli	*Clarias batrachus*	O,R	R		R	R		F
Family Pangasiidae (Giant Catfishes)									
Pangasius	Patin	*Pangasius polyuranodon*	R	O,R		R	R		F
Family Siluridae (Eel-tailed Catfishes)									
Eel-tailed Catfish	Lais/Selais/ Serendang	*Kryptopterus sp.*	O,R	R					F
Giant Catfish	Tapah	*Wallago sp.*	R			R	R		F
	Lais/Tabirin	*Belodontichthys dinema*		O					F
		Kryptopterus bicirrhis			O				F
Family Hemiramphidae (Halfbeaks)									
Halfbeak	Puput, Julung-julung	*Hemirhamphodon sp.*	R			O	O		
Halfbeak	Julung-julung	*Hemirhamphodon cf. phaiosoma*			O				
Family Syngnathidae (Pipefishes)									
Pipefish	Kutu buaya	*Doryichthys deokhatoides*					O		
Family Datnioididae (Triple-tails)									
Four-banded Tigerfish		*Datnioides quadrifasciatus*		O					F
Family Chandidae (Glass Perches)									
Glass Perch	Serinding	*Parambassis wolfi*	O			O	O		F
Glass Perchlet	Serinding	*Parambassis macrolepis*				O	O		
Family Sciaenidae (Drums, Croakers)									
Jewfish	Kuraw, Gulamah	*Johnius cf dussumieri*		O					F
Family Eleotridae (Gudgeons)									
Marbled Goby	Belutuk	*Oxyeleotris marmoratus*	O,R	O		O	O		F
Family Gobiidae (Gobies)									
Mudskipper	Glodok	*Periopthalmus spp.*	O	O		O	O		
Mudskipper	Glodok	*Periopthalmus minutus*			O				
Gobies	Gelang gendis	*Brachygobius doriae*				O	O		
Mudskipper	Selontok	*?*			O				
Family Tetraodontide (Puffers)									
Pufferfish	Ikan Buntel	*Tetraodon nigroviridis*				O	O		
Family Cynoglosside (Tonguefish)									
Tonguesole	Ikan Sebelah	*Cynoglossus waandersi*				O			F
Family Channidae (Snakeheads)									
Forest Snakehead	Gabus	*Channa pleurophthalmus*	O,R	R					F
Giant Snakehead	Toman	*Channa micropeltes*	O,R	R			R		F
Common Snakehead	Gabus/Lompong/ Selendang	*Channa striata*	O,R	O,R		O	O		F
Forest Snakehead	Gabus/Runtuk	*Channa lucius*			O				

Order/ Family/ English Name	Local Name	Scientific Name						Status	Utilization
Family Anabantidae (Climbing Perches)									
Climbing Perch	Betok/Batik/Cacong	*Anabas testudineus*	O,R	O,R	O,R	O	O		F
Family Belontidae (Gouramies)									
Snake-skin Gouramy	Sepat Siam	*Trichogaster pectoralis*		R,I		O	O		F
Two-Spot Gouramy	Tabakan/Sepat	*Trichogaster trichopterus*	O,R	O,R	O	O	O		F
	Sepat	*Trichogaster leeri*			O				
Fighting Fish	Tempela	*Betta sp.*					O		
Family Osphronemidae (Giant Gouramies)									
Giant Gouramy	Gourami	*Osphronemus gouramy*		R,I		R	R		F
Family Synbranchidae (One-gilled Eels)									
Swamp Eel	Belut	*Monopterus albus*	O,R	O,R		R	R		F
Family Mastacembelidae (Spiny Eels)									
Spiny Eel	Tilan	*Mastacembelus erythrotaenia*		O					F
Family Cichlidae (Cichlids)									
Common Tilapia	Mujair	*Oreochromis mossambica*		R,I		R	R		F
Nile Tilapia	Nila	*Oreochromis nilotica*		R,I		O	R		F
Family Pristolepidae (Mud Perches)									
Mud Perch	Beterung/Biawan	*Pristolepis grooti*			O				F
AMPHIBIANS		Total amphibian species/significant amphibian species:	5/0		1/0	2/0			
Family Bufonidae (True Toads)									
Common Toad	Kodok	*Bufo melanostictus*	O	O	O				
Family Ranidae (Bullfrogs)									
Ground Frog	Katak hijau	*Rana limnocharis*	O	O		O	R		F
Ground Frog	Katak	*Rana erythaea*	O	O		R	R		
Ground Frog		*Rana cancrivora*	O	O					
Family Rhacophoridae (Tree Frogs)									
Tree Frog		*Rhacophorus sp.*		C					
REPTILES		Total reptile species/significant reptile species:	31/6		6/2	10/4			
Family Crocodylidae (Crocodiles)									
False Gavial	Buaya sungai	*Tomistoma schlegeli*	O,R	R		R?	R?	E;AppI	S
Estuarine Crocodile	Buaya katak	*Crocodylus porosus*	R	R		R?	R?	E;AppII	S
Family Testudinidae (Freshwater Turtles)									
Freshwater Turtle	Kura-kura	*Bellia crassicollis*	O?	O					S
Malasian Giant Turtle	Kura-kura	*Orlitia borneensis*	O,R	R					
Family Trionychidae (Soft-shelled Turtles)									
Soft-shelled Turtle	Labi-Labi	*Trionyx cartilagineus*	R?	R?		R	O		S
Family Geckonidae (Gecko Lizards)									
Common House Gecko	Cicak	*Hemidactylus frenatus*	O	O	O	O	O		
Flat-tailed House Gecko		*Cosymbotus platurus*		O	O				
Mutilate Gecko		*Gehyra mutilata*		O					
Tokay Gecko	Toke	*Gekko gecko*	O	C	C				
Family Agamidae (Dragon Lizards)									

English Name	Local Name	Scientific Name							
Common Flying Dragon		*Draco volans*	O	O					
Common Green Dragon		*Calotes cristatellus*		O					
Family Varanidae (Monitor Lizards)									
Forest Monitor		*Varanus dumerili*		O		O?	R?	Appll	S
Asian Water Monitor	Biawak	*Varanus salvator*	O,R	O,R	O,R	R	R	Appll	S
Family Lacertidae (Lacertid Lizards)									
Six-lined Lacertid		*Tachydromus sexlineatus*		O					
Family Scincidae (Skink Lizards)									
Skink		*Lygosoma sp.*		O					
Sun Skink	Kadal	*Mabuia multifasciata*	O	O		O	O		
Family Typhlopidae (Blind Snakes)									
Blind Snake		*Ramphotyphlops sp.*		R					
Family Boidae (Pythons and Boas)									
Short Python		*Python curtis*	R?	R				Appll	
Reticulated Python	Ular sawah	*Python reticulatus*	R	O,R	R		R	Appll	S,K
Family Aniliidae (Pipe Snakes)									
Two-headed Snake	Ular Kepala Dua	*Cylindrophis rufus*		O					
Family Acrochordidae (Water Snakes)									
Javan File Snake		*Acrochordus javanicus*	R	R					S
Family Colubridae (Non-venomous and Rear-fanged Colubrine Snakes)									
Racer		*Elaphe melanura*		O					
Painted Bronzeback		*Dendrelaphis pictus*		O					
Dwarf Reed Snake		*Pseudorhabdion longiceps*		O?					
Dog-faced Water Snake		*Cerberus rhynchops*		O					
Mangrove Snake		*Boiga dendrophila*	R	R			R		
Family Elapidae (Front-fanged Venomous Snakes)									
Banded Krait		*Bungarus fasciatus*	R	R					
Black Spitting Cobra	Ular sendok	*Naja naja*	R	R	R				
King Cobra	Upar/manew	*Ophiophagus hannah*	R	R					
Family Viperidae (Vipers)									
Sumatran Pit Viper		*Trimeresurus sumatranus*	R	R					
Wagler's Pit Viper		*Trimeresurus wageri*		R			O		
		Total bird species/significant bird species:		99/28		109/26		32/10	
Family Phalacrocoracidae (Cormorants and Darters)									
Oriental Darter	Pecuk ular	*Anhinga melanogaster*			O		O	P	
Family Ardeidae (Herons, Egrets, Night-herons, Bitterns)									
Grey Heron	Cangak abu	*Ardea cinerea*			O				
Purple Heron	Cangak merah	*Ardea purpurea*			O	O	O		
Intermediate Egret	Kuntul perak	*Egretta intermedia*					O	P	
Javan Pond-heron	Blekok	*Ardeola speciosa*	R						F,S
Striated Heron	Kokokan laut	*Butorides striatus*			O	O			
Cinnamon Bittern	Kokokan	*Ixobrychus cinnamomeus*	O	O	O				
Family Ciconiidae (Storks)									
Grey Stork	Bluwok	*Mycteria cinerea*	O		O			V,P	K

Group / Family / English Name	Local Name	Scientific Name	SUL	SUL	SUL	SUL	SUL	Status	Utilisation
Lesser Adjutant	Bangau tontong	*Leptoptilos javanicus*	O	R	O	O	O	V,P	S
Family Threskiornithidae (Ibises, Spoonbills)									
Black-headed Ibis	Ibis kepala hitam	*Threskiornis melanocephalus*			O			P	
Family Accipitridae (Buzzards, Kites, Eagles, Harriers, Hawks)									
Black-winged Kite	Elang tikus	*Elanus caeruleus*	O	O	O			AppII,P	
Brahminy Kite	Elang bondol	*Haliastur indus*	O	O	O	O	O	AppII,P	
White-Bellied Sea-eagle	Elang laut perut putih	*Haliaeetus leucogaster*			O	O		AppII,P	
Grey-headed Fish-eagle	Elang ikan kepala kelabu	*Ichtyophaga ichtyaetus*	O	O	O		O	AppII,P	
Crested Serpent Eagle	Elang ular	*Spilornis cheela*	O	O	O			AppII,P	P
Crested Goshawk		*Accipiter trivirgatus*	O					AppII,P	P
Black Eagle	Elang hitam	*Ictinaetus malayensis*		O	O			AppII,P	P
Rufous-bellied Eagle	Elang perut karat	*Hieraaetus kienerii*	O?	O				AppII,P	
Cangeable Hawk-eagle	Elang brontok	*Spizaetus cirrhatus*	O					AppII,P	
Family Falconidae (Falcons, Kestrels, Hobbies)									
Black-thighed Falconet	Alap-alap capung	*Microhierax fringillarius*			O			AppII,P	
Family Anatidae (Swans, Geese, Ducks)									
Wandering Whistling-duck	Belibis kembang	*Dendrocygna arcuata*				O			
Lesser Whistling-duck	Belibis	*Dendrocygna javanica*	R,O						
White-winged Duck	Serati	*Cairina scutulata*		R				V,AppI,P	P
Pacific Black Duck	Itik gunung	*Anas superciliosa*	O?						
Family Phasianidae (Quails, Partridges, Junglefowls, Pheasants, Peafowl)									
Blue-breasted Quail	Puyuh pepekoh	*Coturnix chinensis*	O						F,S,K
Family Turnicidae (Button-quails)									
Barred Button-quail	Puyuh tegalan loreng	*Turnix suscicator*	O	O	O				F,S,K
Family Rallidae (Rails, Crakes, Moorhens, Coots)									
Slaty-breasted Crake	Mandar padi	*Gallirallus striatus*			O				
Ruddy-breasted Crake	Mata merah	*Porzana fusca*			O				
White-breasted Waterhen	Kareo	*Amaurornis phoenicurus*	O		O		O		F,S
Watercock	Ayam-ayaman	*Gallicrex cinerea*	R						F,S
Common Moorhen	Mandar batu	*Gallinula chloropus*	R						F,S
Purple Swamphen	Mandar/Cengger/ Kerdut/Senter-api	*Porphyrio porphyrio*			O				
Family Charadriidae (Lapwings, Plovers, Dotterels)									
Pacific Golden Plover	Trulek lid-it	*Pluvialis fulva*			O				
Lesser Sand-plover	Cerek	*Charadrius mongolus*			O				
Family Scolopacidae (Curlews, Godwits, Snipes, Woodcocks, Sandpipers)									
Whimbrel	Gajahan	*Numenius phaeopus*			O			P	
Black-tailed Godwit	Biru laut ekor hitam	*Limosa limosa*			O				
Marsh Sandpiper	Trinil rawa	*Tringa stagnatilis*			O				
Common Greenshank	Trinil betis hijau	*Tringa nebularia*			O				
Terek Sandpiper	Trinil terik	*Xenus cinereus*			O				
Common Sandpiper	Trinil pantai	*Actitis hypoleucos*	O	O	O	O	O		
Ruddy Turnstone	Pembalik batu	*Arenaria interpres*			O				
Asian Dowitcher	Blekek Asia	*Limnodromus semipalmatus*			O			R,P	
Pintail Snipe	Senip ekor lidi	*Gallinago stenura*	R						F,S
Rufous-necked Stint	Kedidi	*Calidris ruficollis*			O				
Family Glareolidae (Pratincoles)									
Oriental Pratincole	Terik	*Glareola maldivarum*	R						F,S

Family Columbidae (Green Pigeons, Fruit-doves, Imperial Pigeons, Doves)											
Thick-billed Green Pigeon	Punai paruh tebal	*Treron curvirostra*				O					
Little Green Pigeon	Punai kecil	*Treron olax*	O			O					
Pink-necked Green Pigeon	Punai leher merah	*Treron vernans*	O	O		O					F,S,K
Green Imperial Pigeon	Pergam hijau	*Ducula aenea*	O			O		O			
Mountain Imperial Pigeon	Pergam gunung	*Ducula badia*				O					
Spotted Dove	Tekukur	*Streptopelia chinensis*	O	O		O		O			K
Zebra Dove	Perkutut	*Geopelia striata*	O	O		O					K
Emerald Dove	Delimukan	*Chalcophaps indica*	O								K
Family Psittacidae (Lories, Lorikeets, Parrots, Cockatoos, Hanging-parrots)											
Long-tailed Parakeet	Betet ekor panjang	*Psittacula longicauda*	O	O		O				AppII	K,P
Blue-crowned Hanging Parrot	Serindit	*Loriculus galgulus*	O	O		O				AppII	K
Family Cuculidae (Hawk-cuckoos, Cuckoos, Koels, Malkohas, Coucals)											
Indian Cuckoo	Belanda mabok	*Cuculus micropterus*	O	O							
Banded Bay Cuckoo	Wiwik lurih	*Cacomantis sonneratii*	O								
Plaintive Cuckoo	Wiwik kelabu	*Cacomantis merulinus*	O	O		O					
Chestnut-bellied Malkoha		526 *Rhopodytes sumatranus*				O					
Raffles's Malkoha		523 *Rhinortha chlorophaea*				O					
Chestnut-breasted Malkoha	Kadalan	*Rhamphococcyx curvirostris*				O					
Lesser Coucal	Bubut alang-alang	*Centropus bengalensis*	O	O		O		O			
Family Tytonidae (Owls, Grass-owls)											
Barn Owl	Sirak	*Tyto alba*	O,R			O				AppII	A
Family Strigidae (Scopsowls, Owlets, Owls, Boobooks, Wood-owls)											
Collared Scopsowl	Celepuk	*Otus lempiji (=O.bakamoena)*	O	O						AppII	
Barred Eagle-owl	Hingkik	*Bubo sumatranus*	O							AppII	
Buffy Fish-owl	Bloketupu	*Ketupa ketupu*	R							AppII	
Family Caprimulgidae (Nightjars)											
Malaysian Eared Nightjar		602 *Eurostopodus temminckii*	O	O							
Large-tailed Nightjar	Cabak maling	*Caprimulgus macrurus*	O	O							
Savanna Nightjar	Cabak maling kota	*Caprimulgus affinis*	O	O		O					
Family Apodidae (Swifts, Swiftlets, Needletails, Palm-swifts)											
Glossy Swiftlet	Walet sapi	*Collocalia esculenta*	O	O							
Silver-rumped Swift	Kepinis pantat perak	*Rhaphidura leucopygialis*				O					
Little Swift	Kepinis rumah	*Apus affinis*	O	O		O					
Asian Palm-swift	Burung kendali	*Cypsiurus balasiensis*				O		O			
Family Hemiprocnidae (Tree-swifts)											
Grey-rumped Tree-swift	Kepinis pohon	*Hemiprocne longipennis*	O	O							
Whiskered Tree-swift		633 *Hemiprocne comata*				O					
Family Alcedinidae (Kingfishers, Kookaburras)											
Common Kingfisher	Burung udang	*Alcedo atthis*				O				P	
Blue-eared Kingfisher	Meninlin	*Alcedo meninting*	O	O		O		O		P	
Oriental Dwarf Kingfisher	Burung udang merah	*Ceyx erithacus*	O	O						P	
Stork-billed Kingfisher	Raja udang paruh bangau	*Pelargopsis capensis*	O	O		O		O		P	
White-throated Kingfisher	Cekakak dada putih	*Halcyon smyrnensis*	O	O		O				P	
Black-capped Kingfisher	Cekakak cina	*Halcyon pileata*				O				P	
Collared Kingfisher	Cekakak	*Halcyon chloris*				O				P	
Family Meropidae (Bee-eaters)											
Blue-tailed Bee-eater	Kirik-kirik	*Merops philippinus*				O					

group / family / English Name	Local Name		Scientific Name							Status	Utilisation
Family Coraciidae (Rollers, Dollarbirds)											
Common Dollarbird	Tiong lampu.		*Eurystomus orientalis*	O	O	O					
Family Bucerotidae (Hornbills)											
White-crowned Hornbill	Keke		*Berenicornis comatus*						O	P	
Bushy-crested Hornbill		697	*Annorhinus galeritus*	O		O				P	
Wrinkled Hornbill		699	*Rhyticeros corrugatus*	O						R,P	S
Wreathed Hornbill	Julang		*Rhyticeros undulatus*	O	O					I,P	
Asian Pied Hornbill		706	*Anthracoceros albirostris*		O	O				Appl,P	
Rhinoceros Hornbill	Rangkong		*Buceros rhinoceros*		O	O				AppII,P	
Great Hornbill		708	*Buceros bicornis*	O	O					AppII,P	S
Family Capitonidae (Barbets)											
Red-crowned Barbet		714	*Megalaima rafflesii*	O	O						
Yellow-crowned Barbet		719	*Megalaima henrici*	O	O	O					
Blue-eared Barbet	Tengeret		*Megalaima australis*		O	O					
Brown Barbet		724	*Calorhamphus fuliginosus*	O							
Barbet			*Megalaima sp.*		O						
Family Picidae (Piculets, Woodpeckers)											
Rufous Woodpecker	Pelatuk loreng		*Celeus brachyurus*			O					
Checker-throated Yellownape	Pelatuk gunung kumis abu		*Picus mentalis*		O						
Crimson-winged Yellownape	Pelatuk gunung kumis merah		*Picus puniceus*		O	O					
Common Goldenback	Pelatuk besi jari tiga		*Dinopium javanense*	O							
White-bellied Woodpecker	Pelatuk besar hitam		*Dryocopus javensis*			O					
Fulvous-breasted Woodpecker	Pelatuk ulam		*Dendrocopos macei*	O	O	O					
Brown-capped Woodpecker		745	*Dendrocopos moluccensis*						O		
PASSERIFORMES (Songbirds)											
Family Hirundinidae (Martins, Swallows)											
Barn Swallow	Layang-layang Asia		*Hirundo rustica*	O	O	O			O		
Pacific Swallow	Layang-layang biasa		*Hirundo tahitica*	O	O				O		
Family Motacillidae (Wagtails, Pipits)											
Grey Wagtail	Entod keuncang		*Motacilla cinerea*	O							
Richard's Pipit	Apung		*Anthus cf. novaeseelandiae*	O		O					
Family Campephagidae (Cuckoo-shrikes, Cicadabirds, Trillers, Minivets)											
Pied Triller	Kapasan		*Lalage nigra*		O	O					
Minivet	Sepah hutan		*Pericrocotus sp.*			O					
Family Pycnonotidae (Bulbuls)											
Sooty-headed Bulbul	Kutilang		*Pycnonotus aurigaster*		O	O				Feral	
Yellow-vented Bulbul	Cerukcuk		*Pycnonotus goiavier*	O	O	O			O		
Family Irenidae (Ioras, Leafbirds, Fairy Bluebirds)											
Common Iora	Cipoh		*Aegithina tiphia*	O	O	O					
Green Iora	Cipoh hijau		*Aegithina viridissima*			O					
Blue-winged Leafbird	Burung daun sayap biru		*Chloropsis cochinchinensis*	O	O	O					
Golden-fronted Leafbird		870	*Chloropsis aurifrons*			O					
Family Laniidae (Shrikes)											
Long-tailed Shrike	Bentet		*Lanius schach*			O					
Family Turdidae (Shortwings, Forktails, Cochoas, Geomalia, Thrushes)											

Oriental Magpie-robin	Kucica		*Copsychus saularis*	O	O	O		O				
Family Timaliidae (Babblers, Wren-babblers, Laughing-thrushes, Fulvettas)												
(Horsfield's) Babbler	Kancilan Sunda		*Trichastoma cf. sepiarium*			O		O				
Striped Tit-babbler	Ciong		*Macronous gularis*			O		O				
Family Sylviidae (Tesias, Stubtails, Warblers, Cisticolas, Prinias, Tailorbirds)												
Reed-warbler	Kerak basi		*Acrocephalus sp.*			O						
Zitting Cisticola	Cici padi		*Cisticola juncidis*	O	O	O						
Golden-headed Cisticola	Cici merah		*Cisticola exilis*	O								
Bar-winged Prinia	Prinjak sayap garis		*Prinia familiaris*	O	O	O						
Yellow-bellied Prinia	Prinjak perut kuning		*Prinia flaviventris*	O	O	O		O				
Dark-necked Tailorbird		1014	*Orthotomus atrogularis*			O						
Ashy Tailorbird		1016	*Orthotomus ruficeps*	O	O	O						
Family Acanthizidae (Mouse-warblers, Scrub-wrens, Thornbills, Gerygones)												
Flyeater	Burung remeluk		*Gerygone sulphurea*			O						
Family Monarchidae (Flycatchers, Monarchs, Boatbills, Fantails)												
Pied Fantail	Kipasan		*Rhipidura javanica*		O	O		O	P			
Family Pachycephalidae (Ploughbills, Whistlers, Shrike-thrushes, Pitohuis)												
Mangrove Whistler		1188	*Pachycephala grisola*	O								
Family Sittidae (Nuthatches, Sittellas)												
Velvet-fronted Nuthatch	Gelatik munguk		*Sitta frontalis*					O				
Family Dicaeidae (Berrypeckers, Flowerpeckers)												
Flowerpecker	Burung cabe		*Prionochilus sp.*			O						
Scarlet-backed Flowerpecker		1249	*Dicaeum cruentatum*	O								
Flowerpecker	Burung cabe		*Dicaeum sp.*			O						
Family Nectariniidae (Sunbirds, Spiderhunters)												
Brown-throated Sunbird	Burung madu kelapa		*Anthreptes malacensis*			O						
Olive-backed Sunbird	Burung madu kuning		*Nectarinia jugularis*		O	O		O				
Family Zosteropidae (White-eyes, Blackeyes)												
Oriental White-eye	Burung kacamata biasa		*Zosterops palpebrosus*			O						
Family Estrildidae (Firetails, Parrotfinches, Munias, Sparrows)												
White-rumped Munia		1393	*Lonchura striata*			O						
Javan Munia	Emprit		*Lonchura leucogastroides*			O						
Dusky Munia		1395	*Lonchura fuscans*					O				
Scaly-breasted Munia	Peking		*Lonchura punctulata*	O	O	O	O	O				P
White-bellied Munia	Bondol perut putih		*Lonchura leucogastra*	O	O	O						P
Chestnut Munia	Bondol hitam		*Lonchura malacca*	O	O	O						P
White-headed Munia	Bondol haji		*Lonchura maja*	O	O	O						P
Family Ploceidae (Sparrows, Weavers)												
Tree Sparrow	Burung gereja		*Passer montanus*	O	O	O						
Baya Weaver	Manyar Pilipina		*Ploceus philippinus*	O	O	O						P
Family Sturnidae (Starlings, Mynas)												
Common Myna		1432	*Acridotheres tristis*	O	O							S,K
White-vented Myna	Jalak ungu		*Acridotheres javanicus*	O						Feral		K
Hill Myna	Beo		*Gracula religiosa*	O	O	O				Feral		S,K

English Name	Local Name	Scientific Name						Status or Utilization	
Family Oriolidae (Orioles, Figbirds)									
Black-naped Oriole	Kepodang	*Oriolus chinensis*		O	O				K
Family Dicruridae (Drongos)									
Ashy Drongo		1460 *Dicrurus leucophaeus*	O						
Lesser Raquet-tailed Drongo	Saeran bendera pasir	*Dicrurus remifer*			O				
Greater Raquet-tailed Drongo	Saeran bendera batu	*Dicrurus paradiseus*	O	O					
Family Artamidae (Wood-swallows)									
White-breasted Wood-swallow	Burung buah	*Artamus leucorynchus*	O	O	O		O		
Family Corvidae (Jays, Magpies, Treepies, Crows)									
Slender-billed Crow	Gagak	*Corvus cf enca*		O					
Large-billed Crow	Gaok	*Corvus macrorhynchos*	O		O				
MAMMALS		Total mammal species/significant species:	35/15		17/10		28/10		
Family Erinaceidae (Gymnures)									
Moonrat	Tikus Bulan	*Echinosorex gymnurus*		R					
Family Soricidae (Shrews)									
House Shrew		*Suncus murinus*	R?						
	Cerurut	*??*				R	R		
Family Tupaiidae									
Lesser Treeshrew	Tupai	*Tupaia minor*					O		
Family Cynocephalidae (Flying Lemurs)									
Flying Lemur	Tando	*Cynocephalus variegatus*		R			R		
Family Pteropodidae (Fruit Bats)									
Large Flying Fox	Kalong	*Pteropus vampyrus*	R		O				F
Family Emballonuridae (Sheathtail-bats)									
Lesser Sheathtail-bat		*Emballonura monticola*		O					
Family Lorisidae (Loris)									
Slow Loris	Kukang	*Nycticeus coucang*						Appll;P	
Family Cercopithecidae (Monkeys)									
Silvered Leaf Monkey	Lutung	*Trachypithecus cristata*	O	O	O,R	R	O	Appll	
Long-tailed Macaque	Kera-kera	*Macaca fascicularis*	O,R	O,R	O,R	R	O	Appll	K,P
Pig-tailed Macaque	Beru	*Macaca nemestrina*	O,R	O,R	O,R		R	Appll	K,P,A
Proboscis Monkey	Bekanten	*Nasalis larvatus*					O	V;Appl;P	(K)
Red or Banded Leaf-Monkey		*Presbytis sp.*					R		
Family Hylobatidae (Gibbons)									
Agile Gibbon	Nyamang	*Hylobates agilis*	R,C	R,C				Appl;P	
Siamang		*Symphalangus syndactylus*			C				
Family Canidae (Dogs)									
Domestic Dog	Anging	*Canis familiaris*	O	O		O	O		
Family Ursidae (Bears)									
Malayan Sunbear	Beruang	*Helarctos malayanus*	R	R	R			Appl;P	P,S
Family Mustelidae (Otters and Weasels)									
Common Otter	Berang-berang	*Lutra lutra*	R	O				Appl	P

Small-clawed Otter	Berang-berang	*Aonyx cinerea*			R	R	R	K			
Family Viverridae (Civets)											
Common Palm Civet	Musang	*Paradoxurus hermaphroditus*	R?	R	R						
Family Felidae (Cats)											
Sumatran Tiger	Harimau	*Panthera tigris*	R	O	O,R			E;AppI;P	S		
Clouded Leopard	Macan	*Neofelis nebulosa*	R	R				V;AppI;P	P		
Leopard Cat	Macan Akar	*Felis bengalensis*		O	R	R	R	AppII;P			
Domestic Cat	Kucing	*Felis cattus*	O	O	O	O	O				
Family Delphinidae (Dolphins)											
Dolphin		Delphinidae		R		R					
Family Suidae (Pigs)											
Western Bearded Pig	Babi Hutan	*Sus barbatus*	R	R	R		R	V	P		
Wild Pig	Babi	*Sus scrofa*	O,R	O,R	O,R		R		P,K		
Family Tragulidae (Mouse-deer)											
Greater Mousedeer	Napu	*Tragulus napu*	R					P			
Lesser Mousedeer	Kancil	*Tragulus javanicus*	R	R				P	F,S		
Family Cervidae (Deer)											
Sambar Deer	Rusa	*Cervus unicolor*	R	R			R	P			
Sumean Yellow Muntjac	Kijang Mas	*Muntiacus atherodes*					R				
Family Bovidae (Cattle and Goats)											
Domestic Banteng Cattle		*Bos javanicus*	O	O					A		
Domestic Water Buffalo		*Bubalis bubalus*	O	O		O	O		A		
Domestic Goat		*Capra hircus*	O	O		O	O		A		
Family Manidae (Anteaters)											
Pangolin	Trenggiling	*Manis javanica*	R	R	R	R	R	AppII;P			
Family Sciuridae (Squirrels)											
Plantain Squirrel	Tupai	*Callosciurus notatus*		O		R					
Prevost's Squirrel		*Callosciurus prevostii*		O		O	R				
Three-striped Ground Squirrel	Bajing	*Lariscus insignis*					R				
Low's Squirrel	Tupai	*Sundasciurus lowi*	O								
Red Giant Flying Squirrel	Tupai terbang	*Petaurista petaurista*		O			R				
Spiked Ground Squirrel		*Rhelthrosciurus macrotis*					R				
Family Muridae (Rats and Mice)											
Brookfield Rat	Tikus sawah	*Rattus argentiventor*	R	O	R?				P		
Polynesian Rat		*Rattus exulans*	R?	R		R?	R?		P		
Black Rat	Tikus rumah	*Rattus rattus*	R?	R	R				P		
Malaysian Wood Rat	Tikus Belukar	*Rattus tiomanicus*				R?	R?		P		
Family Hystricidae (Porcupines)											
Common Porcupine	Landak	*Hystrix brachyura*	R	R			R	P			

APPENDIX 4

POPULATION STATISTICS FOR THE ISDP SCHEMES AND KABUPATEN, WEST KALIMANTAN

Kecamatan/Desa	Area (km2)	TOTAL POPULATION Sensus 1990	ISDP POPULATION (AMDAL-BPS 1990)	AVAILABLE LAND PER PERSON (HA) (Tot. Population)
TELUK PAKEDAI				
Sei Nibung	31	1,241		2.5
Seruat I	8	521		1.4
Kuala kerung	8	2,727		0.3
Tanjung Bunga	31	2,009		1.5
Teluk Gelam	4	723		0.6
Selat Remis	47	4,721		1
Teluk Pakedai Hulu	49	3,469		1.4
Teluk Pakedai II	7	1,839	771	0.4
Teluk Pakedai I	35	2,192		1.6
Pasir Putih	14	1,302	1,145	1.1
Madura	4	815	795	0.5
Sei Deres	47	1,827	1,788	2.6
Rasau Jaya V	10	1,095	711	0.9
Total	294	24,317	5,220	1.2
TERENTANG				
Tanjung Duku	20	303		6.6
Teluk Empening	25	563		4.4
Teluk Bayur	45	1,087		4.1
Permata I	40	250		16
Permata II	39	1,355		2.9
Terentang Hilir	35	1,075		3.3
Terentang Tengah	36	2,091		1.7
Terentang Hulu I	41	923		4.4
Terentang Hulu II	37	904		4.1
Batuah	100	252		39.7
Mertalaya	33	244		13.5
UPT Sei Redak			3,388	
Total	451	9,029	3,388	5
KUBU				
Kubu	235	4,636		5.1
Otak2 Kubu	174	3,852		4.5
Dabong	241	1,177		20.5
Seruat II	110	2,849		3.9
Seruat III	50	1,453		3.4
Sei Selamat	10	695		1.4
Sepakat Baru	15	393		3.8
Bemban	160	2,834		5.6
Ambawang	55	1,781		3.1
Kampung Baru	38	1,491		2.5
Pinang Luar	22	2,284	815	1
Air Putih	24	2,018	1,864	1.2
DSP T.Nangka	23	2,971	2,913	0.8
DSP Sei Terus	18	1,183	1,083	1.5
DSP P. Dalam	18	844	815	1.9
DSP Jangkang	20	1,211	1,194	1.7
Teluk Nangka		5		
Total	1,213	30,271	8,884	4
SUNGAI KAKAP				
Sungai Kakap	28	8,214	6,666	0.3
Sungai Itik	25	3,380	2,931	0.7
Jeruju Besar	21	4,455	4,005	0.5
Sungai Kupah	24	2,052	1,780	1.2
Sungai Rengas	42	5,155	5,701	0.8
Pal IX	47	8,061	6,898	0.6
Sungai Belidah	18	2,120	1,813	0.9
Kalimas	46	7,124	5,004	0.8
Punggur Kecil	46	9,123	8,476	0.5
Punggur Besar	60	9,408	7,517	0.8
Tanjung Saleh	48	5,158		0.9
Sepuk Laut	49	2,367		2.1
Rasau Jaya Umum	26	3,409	1,088	0.8
Rasau Jaya I	14	4,695	4,157	0.3
Rasau Jaya II	15	3,278	3,258	0.5
Rasau Jaya III	21	3,102	2,948	0.7
Bintang Mas	34	1,245	1,235	2.7
Total	564	82,344	63,457	0.7

APPENDIX 4

Kecamatan/Desa	Area (km2)	TOTAL POPULATION Sensus 1990	ISDP POPULATION (AMDAL-BPS 1990)	AVAILABLE LAND PER PERSON (HA) (Tot. Population)
Sei Raya				
Sei Raya (Total)	929	??		
Sei Bulan I + II			1,479	
Sei Bulan III				
Total	929		1,479	
TOTAL	2,522	145,961	82,206	1.7

TOTAL POPULATION (October 1990): 145,961 (excluding Sei Raya District)

ISDP SCHEMES POPULATION (OCTOBER 1990): 82,206

Source: Population census October 1990, BPS TKI I, West Kalimantan

APPENDIX 5

~~Table~~ : PASS Soils and Its Risks Related to Earthworks

PASS SOIL RISK CLASSES WITH POTENTIAL ENVIRONMENTAL IMPACT

ISDP Location	Soil Sub-group	Average % Pyrite, 0-120 cm	Highest Pyrite Content and Soil Depth	'Risk' Class
<u>West Kalimantan</u>				
Jawi/Kalimas	*Typic Sulfaquents*	2.7-3.2	7.5%; 25-50 cm	moderate
Sei Betutu	*Terric Sulfihemists*	2.9	4.8%; 25-50 cm	moderate
	Typic Sulfohemists	3.4	4.7%; 25-50 cm	moderate
Pinang Dalam	*Typic Sulfohemists*	3.4	7.4%; 0-25 cm	moderate
<u>Jambi</u>				
Pamusiran	*Sulfic Fluvaquenets*	2.9	5.3%; 25-50 cm	moderate
Lambur	*Terric Troposaprists*	3.1	5.1%; 0-25 cm	moderate
	Typic Sulfaquents	3.2	4.9%; 25-50 cm	moderate
Dendang I	*Terric Tropofibrists*	3	3.4%; 50-75 cm	moderate
Dendang II	*Terric Troposaprist*	3.4	2.7-3.7%; 75-100 cm	moderate
Smp Pandan	*Hemic Troposaprists*	0.2-3.1	3.9%; 0-25 cm	low -moderate
	Sapric Tropofibrists	6.1	5.7%; 25-50 cm	high
	Terric Troposaprists	3.0-5.9	12.5%; 75-100 cm	moderate-high
<u>Riau</u>				
Delta Reteh	*Terric Sulfihemists*	1.4-2.5	3.8%; 100-200 cm	moderate
	Haplic Sulfaquents	2.7	3.8%; 25-50 cm	moderate
	Typic Sulfihemists	1.5-1.7	3.8%; 100-200 cm	low #1
Tempuling	*Sulfic Fluvaquents*	2.8	3.9%; 25-50 cm	moderate
	Typic Troposaprists	0.6-0.7	2.5%; 140-200 cm	low #1
	Hemic Terric Troposaprists	0.6	2.7%; 170-200 cm	low #1

'Risk' Classes Determined on Average Pyrite Content of 0-120 cm Soil:

- **Pyrite < 2.4% : Low**
- **Pyrite 2.4-4.5% : Moderate**
- **Pyrite > 4.5% : High**

#1: included because relative high pyrite content below peat cover

Soil data extracted fromTR 4, Vol II; 'Risk' classes derived from Pons, 1975

Appendix 6: Pesticides

#	TYPE	AGENT	TRADE NAME	ACTIVE SUBSTANCE	JAMBI	RIAU	KALBAR	PERMITTED USES
1	?	?	Physan	?	N	N	Y	?
2	A	PT ICI Pestisida	Omite 570 ec	Propargite 570 g/l	Y	N	Y	Chili pepper, Tea, Apple
3	A	Mobay Chemical, USA	Alsystin 25 wp	Triflumoron 25%	N	N	Y	Onions, Chili pepper, Snake beans, Soybean, Oilpalm
4	A/F	PT Bayer	Morestan 25wp	Oxythioquinox 25%	N	N	Y	Apple, Tea
5	A/I	PT Petrokimia Kayaku	Mitac 200 ec	Amitraz 200 g/l	N	N	Y	Chili pepper, Soybean, Tea
6	A/I	?	Rogor L40	Dimethyl-S-(N-Methyl-carbamate)	N	N	Y	*None (not permitted)*
7	B	PT Pfizer	Agrimycin 15/1.5wp	Streptomycin sulfate 15% Oxytetracyclin 1.5%	N	N	Y	Potato, Tomato
8	B	CV Jasa Agro Mandiri	Agrept 25 wp	Streptomycin sulfate 25%	N	N	Y	Tomato
9	F	PT Bumi Delta Kimiatama	Benlate T	Benomil 20%, Tiram 20%	N	N	Y	Peanut, Soybean, Rice, Beans
10	F	PT Bumi Delta Kimiatama	Benlate	Benomil 50%	N	N	Y	Apple, Clove, Orange, Beans, Peanut, Rubber, Coffee, Potato, Pepper, Rice, Tomato, Sugarcane
11	F	Rhone-Poulenc Agrocarb	Zincofol 68 wp	Captafol 50%, Copper 12%, Zinc 6%	N	N	Y	Onion, Potato, Tomato
12	F	PT Indagro	Orthocide 50wp	Captan 50%	Y	N	N	Soybean, Tea, Tobacco, Onion, Chili pepper
13	F	PT Bumi Delta Kimiatama	Delsene MX-200	Carbendazim 6.2% Mancozeb 73.8%	N	N	Y	Chili pepper, Clove, Peanut, Rubber, Potato, Rice, Tobacco, Tomato
14	F	PT Sarana Agropratama	Derosal 60 wp	Carbendazim 60%	N	N	Y	Apple, Rubber, Sugarcane
15	F	PT Exindo Raharja Pratama	Dacohil 75 wp	Chlorothalonil	N	N	Y	Onion, Peanut, Coconut, Potato, Tea, Tomato
16	F	PT Krikras	Cobox	Copper oxychloride 50%	N	N	Y	Clove, Cocoa, Orange, Vanilla, Tea, Tobacco
17	F	PT Sarana Agropratama	Viligran blue	Copper oxychloride 60%	Y	N	N	Cocoa, Coffee, Tea
18	F	Rhone-Poulenc Agrocarb	Aliette	Fosetyl aluminum	N	N	Y	Coconut, Pepper
19	F	PT Indagro	Fujiwan 400ec	Isoprotiolan 400 g/l	N	Y	N	Rice
20	F	PT Indagro	Kasumin 20 AS	Kasugamycin 20 g/l	N	N	Y	Rice, Chili pepper
21	F	PT Kumia Dian Permai	Dithane M-45	Mancozeb 80%	N	N	Y	Onion, Clove, Cocoa, Peanut, Coconut, Potato, Coffee, Cinchona, Vanilla, Tea, Tobacco, Tomato, Pelsal, Rosella
22	F	PT Bumi Delta Kimiatama	Manzate	Mancozeb 83%	N	N	Y	Rubber, Potato, Tobacco, Tomato
23	F	PT Harina Chemicals	Velimek 80 wp	Maneb 72%, Zineb 8%	Y	N	N	Chili pepper, Clove, Potato, Tomato
24	F	PT Citraguna Saranatama	Ridomil 35 sd	Metalaxyl 35%	Y	N	N	Corn
25	F	PT Indagro	Ingropasta	PCNB, Quintozene 20%	N	N	Y	Rubber
26	F	PT ICI Pestisida	Fomac 2	PCNP, Quintozene 20%	N	N	Y	Rubber

Appendix 6: Pesticides

#	TYPE	AGENT	TRADE NAME	ACTIVE SUBSTANCE	JAMBI	RIAU	KALBAR	PERMITTED USES
27	F	PT Bayer	Antracol 70 wp	Propineb 70%	Y	N	Y	Onion, Chili pepper, Clove, Orange, Peanut, Potato. Cinchona, Pepper, Tea, Tobacco, Tomato
28	F	PT Bayer	Bayleton 250 ec	Triadimefon 250 g/l	N	N	Y	Rubber, Soybean, Coffee, Tea, Tobacco
29	F	PT Krikras	Calixin	Tridemorph	N	N	Y	Rubber, Tea
30	F	PT ICI Pestisida	PP Zineb 80wp	Zineb 80%	N	N	Y	Potato
31	F	CV Standard	Tiezene 80 wp	Zineb 80%	N	N	Y	Tobacco
32	H	PT Citraguna Saranatama	Rilof H	2,4-D , Piperophos	N	N	Y	Rice
33	H	Pacific Chemicals Indonesia	DMA-6	2,4-D 720 g/l	Y	Y	N	Rubber, Rice, Sugarcane, Tea
34	H	PT Indagro	Indamin 720 hc	2,4-D 720 g/l	Y	N	N	Rubber, Rice, Sugarcane, Tea
35	H	PT Monagro Kimia	Lasso	Alachlor 480 g/l	N	N	Y	Soybean, Peanut, Rubber
36	H	PT ICI Pestisida	Diran 950	Diuron 80%	Y	N	N	?
37	H	Hoechst, Germany	Diran 950	Diuron 82.45%	J	N	N	*None (no longer permitted)*
38	H	PT Sarana Agropratama	Basta	Glufosinate 200g/l	Y	N	Y	Cocoa, Rubber, Oilpalm, Coffee, Tea, Clove, Sugarcane
39	H	PT Sriwijaya Pakuan Sejati	Scout	Glyphosate 180 g/l Picloram 22 g/l	N	N	Y	Rubber
40	H	PT Mitra Kreasidharma	Spark 160 AS	Glyphosate, isopropylamine 160.4 g/l	N	N	Y	Rubber, Oilpalm
41	H	PT Sriwijaya Pakuan Sejati	Eagle IPA	Glyphosate, isopropylamine 480 g/l	N	N	Y	Rubber, Oilpalm, Tea, Fallow land
42	H	Rhone-Poulenc Agrocarb	Roundup	Glyphosate, isopropylamine 480 g/l	Y	Y	Y	Clove, Cocoa, Rubber, Coconut, Oilpalm, Coffee, Tea, Acacia
43	H	PT Citragung Saranatama	Dual 500ec	Metolachlor 500 g/l	N	N	Y	Onion, Chili pepper, Corn, Rubber, Soybean, Cabbage, Cassava
44	H	Rhone-Poulenc Agrocarb	Ronstard D83/83ec	Oxadiazon 83 g/l, 2,4-D 83 g/l	N	Y	N	Rice
45	H	PT ICI Pestisida	Para-Col	Paraquat 200 g/l, Diuron 200 g/l	Y	N	N	Clove, Cocoa, Cotton, Rubber, Coconut, Sugarcane, Oilpalm, Coffee, Pepper, Rice, Tea, Cassava
46	H	PT ICI Pestisida	Agroxone 4	Potassium MCPA 400 g/l	Y	N	Y	Rice, Corn, Rubber, Tea
47	I	PT Indagro	Orthene 75 sp	Acephate 75%	Y	N	N	Clove, Orange, Cocoa, Cotton, Soybean, Coconut, Oilpalm, Potato, Cabbage, Coffee, Pepper, Sugarcane, Tobacco, Tomato
48	I	PT Kapo Trading	Dipel	Bacillus thuringiensis 16,000 IU/mg	N	N	Y	Cabbage, Tomato
49	I	PT Bayer	Buldok	Beta cyfluthrin 25 g/l	N	N	Y	Onion, Chili pepper, Cocoa, Cotton, Tea, Soybean, Oilpalm, Cabbage, Pepper, Tobacco, Tomato, Potato

Appendix 6: Pesticides

#	TYPE	AGENT	TRADE NAME	ACTIVE SUBSTANCE	JAMBI	RIAU	KALBAR	PERMITTED USES
50	I	PT Bayer	Baycarb	BPMC	Y	N	Y	Rice, Cocoa
51	I	PT Sarana Agropratama	Hopcin 50 ec	BPMC 460 g/l	N	Y	Y	Cocoa, Soybean, Rice
52	I	Rhone-Poulenc Agrocarb	Kiltop	BPMC 460 g/l, Fenobucarb	N	Y	Y	Cocoa, Soybean, Rice, Tea, Tobacco
53	I	PT Petrokimia Kayaku	Bassa 500 ec	BPMC 500 g/l	Y	N	Y	Cocoa, Soybean, Pepper, Rice, Coffee
54	I	PT Dharma Niaga	Dharmabas 500 ec	BPMC 500 g/l	Y	Y	Y	Onion, Chili pepper, Rice, Sugarcane
55	I	PT Gama Agung Abadi	Indobas 500 ec	BPMC 500 g/l	Y	N	Y	Cocoa, Rice
56	I	PT ICI Pestisida	Nimrod 250 ec	Bupirimate 250 g/l	N	N	Y	Apple
57	I	Rhone-Poulenc Agrocarb	Sevidol 4/4 G	Carbaryl 4%, Lindane 4%	N	N	Y	*None (no longer permitted)*
58	I	Rhone-Poulenc Agrocarb	Sevin 85s	Carbaryl 85%	Y	Y	N	Corn, Peanut, Cotton, Soybean, Coconut, Oilpalm, Coffee, Pepper, Sugarcane, Tea
59	I	PT Dharma Niaga	Dharmafur 3g	Carbofuran 3%	Y	N	Y	Onion, Chili pepper, Soybean, Rice
60	I	PT Parama Bina Tani	Furadan	Carbofuran 3%	N	N	Y	Clove, Orange, Cotton, Potato, Pepper, Rice, Sugarcane, Tea, Tobacco, Tomato
61	I	PT ICI Pestisida	Atabron 50 ec	Chlorfluazuron 50 g/l	N	N	Y	Onion, Chili pepper, Cocoa, Cotton, Soybean, Oilpalm, Cabbage, Tea, Tobacco, Tomato
62	I	PT Pacific Chemicals	Dursban* 20 ec	Chlorpyrifos 200 g/l	Y	N	Y	Onion, Chili pepper, Cocoa, Corn, Coconut, Soybean, Peanut, Oilpalm, Cabbage, Tomato, Carrot
63	I	PT Petrokimia Kayaku	Petroban 200 ec	Chlorpyrifos 200 g/l	N	N	Y	Onion, Chili pepper, Soybean, Cabbage
64	I	PT Karang Emas Mustika	Ripcord 5ec	Cypermethrin 50 g/l	Y	Y	N	Chili pepper, Cocoa, Soybean, Oilpalm, Cabbage, Tea, Tobacco
65	I	PT Sarana Agropratama	Decis 2.5 ec	Deltamethrin 25 g/l	Y	Y	Y	Chili pepper, Corn, Cocoa, Beans, Cotton, Soybean, Oilpalm, Cabbage, Pepper, Tea, Tobacco
66	I	PT Citraguna Saranatama	Basudin 60 ec	Diazinon 600 g/l	N	N	Y	Corn, Orange, Soybean, Coconut, Cabbage, Petsai
67	I	PT Petrokimia Kayaku	Diazinon 60 ec	Diazinon 600 g/l	Y	N	Y	Soybean, Coconut, Cabbage, Sawi
68	I	PT Citraguna Saranatama	Nogos	Dichlorvos 500 g/l	N	N	Y	Orchids, Corn, Coffee, Tea
69	I	PT Bayer	Dedevap	Dichlorvos 650 g/l	N	N	Y	Cinchona, Cabbage, Tobacco
70	I	PT Krikras	Perfekthion 400 ec	Dimethoate 400 g/l	N	N	Y	Orange, Sugarcane
71	I	PT Sarana Agropratama	Thiodan 35 ec	Endosulfan 350 g/l	Y	N	Y	Corn, Cocoa, Cotton, Soybean, Coconut, Chili pepper, Oilpalm, Cinchona, Coffee, Pepper, Sugarcane, Tea, Tobacco
72	I	PT ICI Pestisida	Agrothion	Fenitrothion	N	N	Y	Cotton, Soybean, Coconut, Oilpalm, Pepper, Tobacco

Appendix 6: Pesticides

#	TYPE	AGENT	TRADE NAME	ACTIVE SUBSTANCE	JAMBI	RIAU	KALBAR	PERMITTED USES
73	I	PT Indagro	Sumithion 50 ec	Fenitrothion 50 g/l	Y	N	Y	Onion, Cocoa, Beans, Soybean, Coconut, Pepper, Tobacco
74	I	PT Bayer	Lebacyd 550 ec	Fenthion 550 g/l	Y	N	Y	Orange, Beans, Peanut, Cocoa, Soybean, Cinchona, Pepper, Tea, Sugarcane, Tobacco
75	I	PT Mitra Kreasidharma	Fenval 200 ec	Fenvalerate 200 g/l	N	N	Y	Onion, Cocoa, Soybean
76	I	PT Kosmos Raya	Mavrik 50 ec	Fluvalimate 50 g/l	N	N	Y	Onion, Chili pepper, Soybean, Cabbage, Tomato
77	I	PT Dharma Niaga	Dharmacin 50 wp	Isoprocarb 50%	N	N	Y	Rice, Pepper
78	I	PT Petrokimia Kayaku	Mipcin 50 wp	Isoprocarb 50%	Y	N	Y	Cocoa, Soybean, Coffee, Pepper, Rice
79	I	Chemifin Jaya Utama	Harcros Malathion 50ec	Malathion 500 gr/l	N	N	Y	*None (no longer permitted)*
80	I	PT Bayer	Mesurol	Mercaptodimethur 50%	N	N	Y	Chili pepper, Potato
81	I	PT Indagro	Monitor	Methamidophos	N	N	Y	Onion, Cocoa, Cotton, Soybean, Oilpalm, Cabbage, Tea, Tobacco
82	I	PT Bayer	Tamaron 200 lc	Methamidophos 205 g/l	Y	N	Y	Onion, Chili pepper, Orange, Beans, Soybean, Coconut, Cabbage, Tobacco, Tea, Tomato
83	I	PT Citraguna Saranatama	Supracide 40 ec	Methidathion 420 g/l	Y	N	Y	Chili pepper, Orange, Peanut, Beans, Cocoa, Soybean, Oilpalm, Coffee, Cabbage, tea, Sugarcane, Tobacco, Tomato
84	I	Rhone-Poulenc Agrocarb	Methavin	Methomyl	N	N	Y	Onion, Cabbage, Tobacco
85	I	PT Karang Emas Mustika	Azodrin 15 wsc	Monocrotophos 150 g/l	Y	N	Y	Onion, Corn, Cotton, Beans, Soybean, Tobacco
86	I	PT Alfa Abadi Pestisida	Gusadrin	Monocrotophos 150 g/l	N	N	Y	Onion, Cocoa, Soybean, Oilpalm, Tea, Tobacco
87	I	PT ICI Pestisida	Ambush	Permethrin	N	N	Y	Cotton, Soybean, Oilpalm, Cabbage, Pepper, Tobacco
88	I	Rhone-Poulenc Agrocarb	Corsair 100 ec	Permethrin 100 g/l	Y	N	Y	Cocoa, Soybean, Oilpalm, Cabbage, Tea, Tobacco
89	I	PT Fadjarpumama Pratama Intl	Dessin 5ec	Permethrin 43 g/l	N	N	Y	Cabbage
90	I	PT Dharma Niaga	Dharmasan 600 ec	Phenthoate 600 g/l	Y	N	Y	Onion, Chili pepper, Cotton, Soybean, Pepper, Sugarcane, Tobacco
91	I	CV Jasa Agro Mandiri	Elsan 60ec	Phenthoate 650 g/l	N	N	Y	Soybean, Cabbage, Pepper
92	I	PT Citraguna Saranatama	Dimecron 50 scw	Phosphamidon 500 g/l	N	N	Y	Clove, Orange, Beans, Coconut, Oilpalm, Coffee, Tea
93	I	PT ICI Pestisida	Silosan	Pirimiphos-methyl	N	N	Y	Storage pests
94	I	PT Citraguna Saranatama	Curacron 500 ec	Profenpfos 500 g/l	Y	N	Y	Cotton, Onion, Chili pepper, Orange, Beans, Potato, Cabbage, Sugarcane, Tobacco, Tomato

Appendix 6: Pesticides

#	TYPE	AGENT	TRADE NAME	ACTIVE SUBSTANCE	JAMBI	RIAU	KALBAR	PERMITTED USES
95	I	PT Bayer	Tokuthion	Prothiofos 500 g/l	N	N	Y	Onion, Chili pepper, Cabbage, Tobacco, Potato, Tomato
96	I	PT Sarana Agropratama	Hostathion 40 ec	Triazophos 420 g/l	N	N	Y	Chili pepper, Corn, Orange, Cotton, Soybean, Oilpalm, Potato, Coffee, Cabbage, Pepper, Tomato
97	I/N	PT Agrocarb	Temik 10g	Aldicarb 10%	N	Y	Y	*None (no longer permitted)*
98	I/N	PT Bayer	Curaterr 3 g	Carbofuran 3%	Y	Y	Y	Cotton, Soybean, Coconut, Potato, Coffee, Rice, Sugarcane
99	N	PT Bumi Delta Kimiatama	Vydate 100 es	Oxamyl 100 g/l	N	N	Y	Potato, Tomato, Tobacco, Coffee
100	R	PT ICI Pestisida	Klerat	Brodifacoum 0.003%	N	Y	Y	
101	R	PT Petrokimia Kayaku	Petrocum RM B	Brodifacoum 0.005%	N	Y	Y	

TYPE
A = Acaricide
B = Bactericide
F = Fungicide
H = Herbicide
I = Insecticide
N = Nematocide
R = Rodenticide

Cumulative list of pesticides commercially available in ISDP schemes at:
Jambi: * Rantau Rasau pasar SK 17
* Nipah Panjang
* Muara Sabak harbour/village
* a number of small hamlets
Riau: * Rumbai Jaya, Reteh.
W Kalimantan: Pontianak.
Data from: "Pestisida untuk Pertanian dan Kehutanan", 1991