Appendix A Field Visit Program

Date	*Location*	*Purpose*	*Location/agency*	*Contact*	*Function*
Jul 1-02	Jakarta	Meeting	Commission of the European Communities, Jakarta	Ir. Willem van Diest	Program Officer Sustainable Development/Environment
Jul 2-02	Jakarta	Meeting	World Bank Indonesia Country Office, Jakarta	Ilham Abla	Operations Officer Rural Development Sector Unit
Jul 3-02	Jakarta	Meeting	Consultant, Sriwijaya University (UNSRI), Palembang	Dr. Ir. Robiyanto Hendro Susanto, M. Agr. Sc.	Research Center for Land and Water Management
Jul 4-02	Jakarta	Meeting	Consultant	Ir. Aart van Nes	TL Java Irrigation Improvement and Water Resources Management Project (JIWMP)
Jul 5-02	Jakarta	Meeting	Consultant	Ir. Aart van Nes	TL Java Irrigation Improvement and Water Resources Management Project (JIWMP)
Jul 12-02	Jakarta	Meeting	World Bank Indonesia Country Office, Jakarta	Ilham Abla	Operations Officer Rural Development Sector Unit
Jul 15-02	Jakarta	Meeting	Ministry of Settlement and Regional Infrastructure	Ir. Sukrasno Sastrohardjono, Dipl. HE	Chief Sub-Directorate Wilayah Barat III, DGWR, Directorate Water Resources, Western Region
Jul 15-02	Jakarta	Meeting	Ministry of Settlement and Regional Infrastructure	Ir. Irama Aboesoemono Dipl. HE	Chief Sub-Directorate Policy and Strategy, Preparation, DGWR, Directorate Technical Guidance
Jul 15-02	Jakarta	Meeting	Ministry of Settlement and Regional Infrastructure	Drs. Pakpahan	Loan Coordinator Integrated Swamp Development Project (ISDP)
Jul 16-02	Jakarta	Meeting	Royal Netherlands Embassy	Jaco Mebius	First Secretary Water Resources Management
Jul 17-02	Jakarta	Meeting	Ministry of Agriculture	Dr. Effendi Pasandaran	Sr. Researcher Agency for Agricultural Research and Development (AARD)
Jul 18-02	Jakarta	Meeting	World Bank Indonesia Country Office, Jakarta	Ilham Abla	Operations Officer Rural Development Sector Unit
Jul 19-02	Jakarta	Meeting	Commission of the European Communities	Ir. Willem van Diest	Program Officer Sustainable Development/Environment
Jul 20-02	Jakarta	Meeting	Consultant	R. Mahendrarajah, BSc. MICE MIE	Staff Java Irrigation Improvement and Water Resources Management Project (JIWMP)
Jul 20-02	Jakarta	Meeting	World Bank Indonesia Country Office, Jakarta	Guy Alaerts	Sr Water Resources Specialist Rural Development Sector Unit
Jul 21-02	Jakarta	Meeting	Consultant	Ir. Mestika Djoeachir Dipl. HE	Water Resources Development Expert
Aug 7-02	Semarang	Meeting	Dinas PSDA, Central Java	Irt. Nidhom Ashari, Dipl. HE	Chief of Provincial Water Resources Service, Central

Date	*Location*	*Purpose*	*Location/agency*	*Contact*	*Function*
					Java
				Ir. Dyah Supriyo	Provincial Design Unit
				Ir. Sarwoko ME	Chief of SubDinas Oandmillion
				Ir. M. Alif	Consultant Irrigation Development and Turn Over (IDTO)
Aug 16-02	Semarang	Meeting	Balai PSDA Jragung-Tuntang (Jratun), Central Java	Ir. Tri Widodo	Chief of Jratun River Basin Management Unit (Balai)
Aug 18-02		Travel	Departure Amsterdam, the Netherlands		
Aug 19-02		Travel	Arrival Jakarta, Indonesia		
Aug 20-02		Travel	Jakarta—Semarang, Central Java		
Aug 20-02	Semarang	Meeting	Dinas PSDA, Central Java	Irt. Nidhom Ashari, Dipl. HE	Chief of Provincial Water Resources Service, Central Java
				Ir. M. Ghozi, Dipl. HE	Chief of SubDinas Program
				Ir. Harsono	Chief of SubDinas Cooperation and Institutions
				Ir. Ketut A. Indrawatara	Staff of Section Inter Departmental Cooperation
Aug 20-02	Semarang	Meeting	Balai PSDA Jragung-Tuntang (Jratun), Central Java	Ir. Bambang Sutedjo cs	Staff of Jratun River Basin Management Unit (Balai)
Aug 20-02	Semarang	Meeting	Consultants BWRMP and IDTO, Central Java	Ir. Asep Teguh Sukmono	Basin Water Resources Management and Planning (BWRMP) Project
				Ir. M. Alif	Irrigation Development and Turn Over (IDTO) Project
Aug 21-02	Field	Meeting	Tegowanu District, Central Java	Pudji Hadiwiyono	District Head
				Setyo Budi	Tajemsari Village Head/Chairman of WUA
				Winarno	Tajemsari Village Secretary
				Sugianto	NGO IFC Grobongan Regency
				Supanto	Tajemsari Village WUA member
				Sugito	Tajemsari BPD
Aug 21-02	Kudus	Meeting	Balai PSDA Serang, Lusi, Juana (Seluna), Central Java	Zaenal Achmad cs	Staff of Seluna River Basin Management Unit (Balai)
Aug 21-02	Field	Meeting	Ranting Tenggeles Cendono		Head of Ranting
					Chairman WUA Tirta Jaya
					Chairman WUAF
Aug 22-02	Semarang	Meeting	Diponegoro University (UNDIP), Semarang, Central Java	DR. Ir. Robert J. Kodoatie, M.Eng	Lecturer Civil Engineering, Technical Faculty, Hydraulic Group

Date	*Location*	*Purpose*	*Location/agency*	*Contact*	*Function*
				Ir. Pranoto Dipl. HE	Lecturer Civil Engineering, Technical Faculty, Hydraulic Group
				Ir. Hargono	Lecturer Civil Engineering, Technical Faculty, Hydraulic Group
				Ir. Al Fallah	Lecturer Civil Engineering, Technical Faculty, Hydraulic Group
Aug 22-02	Semarang	Meeting	Consortium University-NGOs to assist PSDA Central Java	Ir. Imam Wahyudi	Chairman, Sultan Agung Islamic University, UNISSULA Semarang
			in empowerment of farmers and WUAs]	Ir. Fauzi Fachrudin	Sultan Agung Islamic University, UNISSULA Semarang
				Ir. Sugiharjo	Sebelas Maret University, Solo
				Krisdiono	NGO Bina Swadaya Boyolali
				Yuni Pristiwati	NGO Persepsi, Klaten
				Sri Wiji Astuti	NGO LSK Bina Bakat, Surakarta
Aug 22-02	Semarang	Meeting	Proyek Induk PPWS Jratunseluna	Ir. Djendam Gurusinga Dipl. HE	General Manager
				Ir. Bambang Subiandono Dipl. HE	Project Manager Flood Control
				Ir. Sri Ediningsih Dipl. HE	Chief of Staff Planning and Design
Aug 23-02		Travel	Semarang-Jogyakarta, Central Java		
Aug 23-02	Jogyakarta	Meeting	Gajah Mada University (UGM), Jogyakarta, Central Java	Ir. Darmanto Dipl. HE, M.Sc	Dean of Civil Engineering Faculty
				DR. Ir.Sigit Supadmo, M.Eng, Ph.D	Dean of Agricultural Engineering Faculty
				DR. Ir. Mochammad Maksum, M.Sc.	Director of Rural Study Center
Aug 23-02		Travel	Jogyakarta-Jakarta		
Aug 24-02	Jakarta				
Aug 25-02		Travel	Jakarta-Palembang, South Sumatra		
Aug 26-02	Palembang	Meeting	Bappeda Tk. I, South Sumatra	Ir. Yohannes Hasiholan Toruan, M.Sc.	Chief of Regional Planning
Aug 26-02	Palembang	Meeting	Dinas Pengairan, South Sumatra	Ir. H. Anwar Arifin	Chief of Water Resources Department PU
				Ir. H. Kusnadi Bachrudin Dipl. HE	Chief of Musi River Basin Management Unit (Balai)
				Ir. H. Wahab Umar Spl	Chief of Sugihan River Basin Management Unit (Balai)
Aug 26-02	Palembang	Meeting	P2DR	Ir. M. Sapri, Dipl. HE	Project Manager Swamp Development project
Aug 26-02	Palembang	Meeting	Consultant	Keiji Sasabe, P.E.Jp	TL Comprehensive Planning Musi River Basin Study, JICA

Date	Location	Purpose	Location/agency	Contact	Function
				Kenichiro Kondo, P.E.Jp	Staff Comprehensive Planning Musi River Basin Study, JICA
Aug 27-02	Field	Meeting	Terusan Tenggah Village, Kampung 2, Delta Telang	Jemir, Syamsuddin, Husin, Suai	Farmers traditional spontaneous settlement, tidal swamp
Aug 27-02	Field	Meeting	Sumber Mulya Village, P6, Delta Telang		Farmers government transmigrant settlement, tidal swamp
Aug 27-02	Field	Meeting	Sungai Pinang Village, Rambutan Sub-District		Farmers traditional spontaneous settlement, nontidal swamp (lebak)
Aug 28-02	Palembang	meeting	Badan Ketahanan Pangan, South Sumatra	Ir. H. Trisbani Arief	Chief of Badan Ketahanan Pangan
Aug 28-02	Palembang	meeting	Centre for Data and Information Lowland-Wetland		Staff
Aug 28-02		Travel	Palembang-Jakarta		
Aug 29-02	Jakarta				
Aug 30-02	Jakarta				
Aug 31-02	Jakarta	Meeting	World Bank Indonesia Country Office	Guy Alaerts	Sr Water Resources Specialist Rural Development Sector Unit
				Ilham Abla	Operations Officer Rural Development Sector Unit

Appendix B Lowland Development Techniques

Swampland reclamation in Indonesia has important long- and short-term advantages over the development of remaining uplands. Such upland soils are usually less fertile than land developed earlier, and they are located in critical watershed and catchment areas that are susceptible to environmental degradation that may affect the downstream hydrology. The lack of water and low fertility of the uplands will require heavy investment in infrastructure and inputs for their successful agricultural development.

Tidal swampland is considered more fertile than uplands, when given sufficient time to improve the soils through reclamation and ripening. Tidal fluctuations in rivers allow for gravity drainage during the daily low tide, using simple and cheap technology. The abundance of water in the swamp areas is another important factor for sustainable long-term development. Constraints to swamp development include initial physical characteristics and the time and repeated interventions required for reclamation.

Reclamation of tidal swampland for agriculture will have to create an environment suitable for agriculture and for settlement. In its natural state, swampland is not suitable for intensive agriculture and large-scale habitation, but it is not entirely uninhabited. Local settlers have used swamp resources for gathering forest produce and hunting, and often claim the land by customary law. For centuries, people have come to these areas and settled along the coasts and riverbanks, where they earned their livelihoods from trade, fisheries, and agriculture. Forests, coastal fisheries, and wildlife are precious resources, so any lowland development has to be balanced with sound conservation measures to protect national interests.

Swampland is usually subdivided into:

- *Tidal swampland* in the coastal area and lower reaches of rivers, where river levels are dominated by daily tidal fluctuations. These areas include a zone of mangrove followed by extensive freshwater swamps characterized by shallow inundations in the wet season caused by stagnant rain water. The daily low tide in the rivers offers good opportunities for drainage of excess water through simple and low-cost facilities.
- *Nontidal swampland* in the near-coastal zone, beyond the tidal swampland [*lebak*]. River water levels are dominated by seasonal fluctuations rather then daily tides, which causes deep inundation of the land in the wet season and makes drainage difficult and expensive in the absence of daily low river water levels.
- *Inland swampland,* separated from the other swampland by surrounding uplands. These swamps cover relatively small and isolated parts of noncoastal areas.

Most agricultural development has taken place in the tidal swampland due to its accessibility along the coast and major rivers and the relatively simple and low-cost drainage technologies involved. This is particularly true for many of the traditional and spontaneous settlements with small-scale and selective development and, to a lesser extent, for the large-scale and less selective government developments of the 1970s and 1980s

Tidal lands are formed by mineral sediments carried by river and sea. These sediments are deposited along the river and river mouth, and often contain clayey and acid sulphate soils. Once land levels are built up above average high tidal water levels, the marine influence diminishes, and freshwater (rainfall) conditions become prevalent. This may lead to the formation of peat soils overlaying the mineral deposits.

Deep peat layers may not sustain agricultural development in the long term due to low fertility or high subsidence upon drainage.

Typical of the tidal lands environment is the high diversity in physical characteristics. These will change even more as a result of and during reclamation. While the slope of the tidal lands shows a very small gradient and conditions are seemingly homogenous, micro-differences at field level of land elevation and soil and hydrological properties are all-important with respect to tidal irrigation potential (flooding during high tide), drainage, and other agronomic aspects.

Swampland most suitable for agricultural development has shallow peat layers and little acidity. It is especially important to consider future land levels in relation to drainage at low tide after reclamation and subsidence has taken place. Much swampland is not suitable because its future drainage potential is insufficient. Soils in the tidal lands show a wide range of suitability. Only well-selected areas will be suitable for sustainable development.

Large areas of acid sulphate soils are found in the coastal plains of Sumatra, Kalimantan, and Irian Jaya. Acid sulphate soils have a favorable topography for irrigated agriculture and are also often located near densely populated areas, with pressure on land resources. This would make acid sulphate soils the logical solution to the problem of land shortage. Nevertheless, these soils are problem soils. Upon exposure to the air, pyrite in the soil profile oxidizes to form sulphuric acid, which may render the soil unsuitable for agriculture. Still, large areas of acid sulphate soils have been successfully developed for agriculture in various countries in the region.

Acid sulphate soils are formed in marine or brackish sediments. During sedimentation, sulphate (SO_4^{2-}) from the seawater is reduced in the presence of organic matter to form pyrite (FeS_2). As long as the pyrite has not oxidized, these soils are waterlogged and unripe, resulting in low bearing capacity, poor accessibility, and poor construction properties.

To be developed for agriculture, these soils have to be drained to some extent. Care should be taken with the reclamation of acid sulphate soils to avoid excessive drainage of pyrite layers and the burning of peat layers and, hence, the exposure of underlying pyrite soil.

Upon drainage and subsequent exposure to air, pyrite oxidizes to sulphuric acid (H_2SO_4). Related to acidification are chemical, biological, and physical problems caused by aluminum, and ferric iron toxicity, nutrient deficiencies, arrested soil ripening, and corrosion of metal and concrete structures. If acid and toxic elements are released, they may adversely affect the quality of ground and surfacewater in and outside the reclamation area.

One of the government's main objectives for opening up new agricultural lands was to increase rice production. However, flooding acid soils for rice cultivation induces toxic levels of aluminum, ferrous iron, hydrogen sulphide, and carbon dioxide. The submergence of organic soils may also cause the formation of organic acids, which are harmful to plant life.

Initially, all swamps were considered suitable for wetland rice. As a result, infrastructure design and water management sought minimal drainage to maintain proper soil and water conditions for rice growing. It is now realized that these assumptions cannot be generalized.

The reclamation of tidal swampland involves the construction of drainage canals in the swamp interior, which connect to the tidal rivers. The land can then be drained through gravity flow during the daily low tide in the rivers and canals, as the land is located above or at average high-water levels. Following the construction of the canals, land is cleared, and basic infrastructure is built (e.g., housing, minor roads, and public facilities).

The objective of drainage here is first of all to reclaim and develop the land to avoid ponding and evacuate excess rainfall, to ripen the soils, and to evacuate acidic and toxic residues of soil processes. Not only is this necessary for (future) agriculture, but the land must also be consolidated to allow construction and settlement. Water management is needed to maintain appropriate water levels in the field for each crop. However, especially during reclamation, conflicting interests in drainage will occur especially in wetland rice areas. The drainage system in most cases also has an important function for navigation, since land transportation is not well developed in these coastal areas.

Some canal systems are gradually developed from the river into the interior, as is often the case in spontaneous settlements. The early settlers have the opportunity to select the best lands and hydrological conditions for their farming. Land near the river, with a strong tidal influence, can be drained freely and, during the same daily tidal cycle, flooded (irrigated) at high water. In the government schemes, which entail the conversion of large areas at one time, construction of the drainage system is often rigid and less adapted to the micro-diversity of the tidal lands. Only a small part of the swampland can be irrigated at high tide. The farther away from the river, the less pronounced is the tidal movement, and hence the more limited the drainage and irrigation potential. Tidal irrigation is an enormous advantage, because it contributes to the leaching and flushing of toxic elements and acidity, especially in the critical root zone of the topsoil. In other areas, the only choice is to practice controlled drainage so as to minimize acidification while maintaining lower groundwater levels to allow leaching of the topsoil through rainfall.

Water retention, and for that matter poorly maintained drainage systems, often leads to stagnant water conditions and accumulation of acidity and toxicities. Rice yields under these circumstances often range from 0.5 to 1.5 t/ha. In schemes with adequate drainage, rice yields often soar to levels comparable to irrigated areas, 3.0 to 6.0 t/ha.

There is now some consensus that (controlled) drainage is the key to the reclamation and management of (acid sulphate) tidal land soils. Excess drainage should be avoided, although this may prove difficult, or impossible, during extremely long dry seasons such as El Niño. It is thus essential that the drainage system be designed for the evacuation of acidity and toxicities.

Farmers, who often originate on Java and are unfamiliar with the specific reclamation type of water management needed, tend to grow rice and hence to maintain higher water levels in the field. Over the years, farmers have been moving toward crops, including tree crops, more suitable for local conditions. Crop diversity also offers better income security. In schemes where drainage has been improved, the impact has been considerable. One of the main issues is to reach the stage where soil ripening allows mechanized land preparation, often with hand tractors. From that moment on, agricultural development really takes off.

Initially the schemes were constructed without water control structures. The low bearing capacity of the soils would hamper construction as would the future subsidence of the highly organic soils. The water control structures later installed now function only partly. Structures should be built only after the soil is consolidated. Experience from the One Million Hectare project in Kalimantan and other projects shows that building structures on unconsolidated soils in the early stages of reclamation meets with severe difficulties.

It is nowadays also realized that dead-ended canal systems hamper water circulation and flushing of the canals. Modern design would require canals to be double-connected to rivers and main canals. The land must be developed gradually.

In developing tidal swampland for agriculture, the government has opted for an approach in stages to allow initial development of large areas at limited cost to satisfy resettlement targets, to allow time for the gradual development of drainage and soils, and to collect experience before designing later stages of development.

Swamp development in stages anticipates returning interventions to consolidate and increase the levels of agricultural production achieved under previous development stages. As time is essential for swamp projects to reach maturity, the government designed development in project cycles of up to several decades.

Crucial steps in swamp development include planning and selection. In the past many, mistakes were made due to the scale of development and under political pressure. The One Million Hectare project is the most recent example. Next it is important to maintain support to see swamp development through all its intended phases. An essential shortcoming in the swamp development program has been the lack of continuous involvement and support and the lack of monitoring and research for sufficiently long periods. Barely any data series are available, and none goes back all the way to the start of the swamp development program. Hence, although much know-how has been obtained, there is still much room for the discussion of major concepts in the absence of reliable data. In addition, the ongoing decentralization has added to the dispersion of the unique swamp development expertise.

A clear distinction must be made between the new development of tidal lands and the further development of existing settlements such as the spontaneous settlements and the large government settlements in Kalimantan and Sumatra. In the first instance, development would drastically change the landscape and environment and therefore requires sufficient deliberation and balancing of environmental and national concerns. The second case of development would be aimed at increased production and welfare to a large group of settlers with minimal disturbance and inputs.

Appendix C Environmental Impact of Lowland Development

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
Forest conversion and removal of vegetation	▪ Physical loss of vegetation cover ▪ Loss of floral biodiversity and vegetation type ▪ Loss of fauna biodiversity, habitat, and refuge sites ▪ Barrier to wildlife movement	▪ Displacement of fauna populations, overcrowding, habitat/survival, and protected area management implications ▪ Barrier to wildlife movement and protected area management implications ▪ Biodiversity and genetic impacts on adjacent ecosystems and protected areas (decreased genetic dispersal and exchange)	▪ Affects basin water flows (flooding, dry season flow) and riverine, estuarine, and marine water quality (erosion , silt, estuarine salinity) ▪ Affects water transport ▪ Affects drinking water supplies ▪ Increases flooding ▪ Biodiversity and genetic impacts on downstream freshwater ecosystems and protected areas (decreased genetic dispersal and exchange)	▪ Loss of terrestrial and freshwater biodiversity, habitats and ecosystems (peat swamp, fresh water swamp, and lowland rainforest) ▪ Loss of natural landscape ▪ Damage to catchment hydrological function ▪ Degradation of catchment water quality ▪ Damage or loss of estuarine and marine habitats, ecosystems, and biodiversity (mangroves, estuaries, seagrass beds, coral reefs, and near-shore ecosystems)	▪ Loss of natural timber and non timber resources; ▪ Loss of traditional freshwater fishery resources ▪ Degradation of near-shore and marine fisheries ▪ Loss of tourism and recreational resources ▪ Loss of genetic resources ▪ Displacement or loss of traditional communities, cultures, residence/resource use rights, and systems of resource management

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	***Broad environmental implications***	***Broad socioeconomic implications***
	▪ Degradation of peatlands (water table, hydrology, and water quality impact) ▪ Site (forest and peat) burning ▪ Destruction of natural ecosystem ▪ Destruction of natural landscape	▪ Degradation of adjacent peatlands, forests and protected areas (water table impacts) ▪ Degradation of all adjacent habitats (especially peat forest) and protected areas ▪ Destruction or disturbance of adjacent ecosystems and natural landscapes	▪ Affects basin water flows and riverine, estuarine, and marine water quality (erosion and silt) ▪ Affects water transport ▪ Affects drinking water supplies ▪ Destruction or disturbance of downstream freshwater, lacustrian, estuarine, coastal, and marine ecosystems	▪ Knock-on effects via food chain support to other more distant ecosystems ▪ Damage or loss of coastal protection functions of mangroves and seagrass beds ▪ Negative implications for global carbon balance, climate change, and biogeochemical cycling due to forest and peatland loss ▪ Loss of natural landscapes, genetic resource, conservation, heritage, and scientific values	▪ Destruction or disruption of previously existing local economies and livelihoods
Site drainage and use of problematic soils Peat soils and acid sulphate soils	*Peat soils* ▪ Rapid and irreversible physical changes in soil properties due		▪ Changed catchment flow regime due to loss of flood season water storage and flood buffering	▪ Damage to catchment hydrological function	▪ Loss of natural timber and non-

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
	to degradation, oxidation, subsidence, and compression of peat soil layers upon drainage ▪ Rapid lowering of natural (raised) groundwater tables with loss of peat layers (up to 50cm or more in first. year; several cm a year after that) ▪ Much increased risk of on-site fires caused by dying out of peat layers. ▪ Multiple impacts on soil water quality within on-site drainage lines due to peat layer degradation (nutrient export; toxic leachate release (e.g., Al, Fe); organic pollutant release; and eutrophication)	▪ Degradation or destruction of adjacent peatlands, forests, ecosystems, protected areas and natural landscapes due to changed water tables, hydrology changes, drying out of site, increased fire risk (particularly peat), and increased incidence of fires spreading from adjacent projects ▪ Loss of biodiversity in adjacent ecosystems and protected areas due to fire damage and hydrology change ▪ See *Land suitability impact*	capacity of peat layers; and consequent increase in downstream flooding and decrease in dry season flows ▪ Increased downstream flooding and loss of catchment flood buffering function leading to increased erosion, silt inputs, silt movement, and flood discharge rates, all with potentially serious negative impacts on estuarine (mangrove), near-shore (seagrass and coral) and marine ecosystems ▪ Decreased dry season flows and risk of estuarine and near-coastal ecosystem changes ▪ Changed and degraded freshwater (stream, river and lake) and possibly estuarine	▪ Degradation of catchment water quality Damage or loss of estuarine and marine habitats, ecosystems and biodiversity (mangroves, estuaries, seagrass beds, coral reefs, and nearshore ecosystems) ▪ Knock-on effects via food chain support to other more distant ecosystems ▪ Damage or loss of coastal protection functions of mangroves and seagrass beds ▪ Negative implications for global carbon balance, climate change, and biogeochemical cycling due to peatland loss and peatland and adjacent forest burning	timber resources and genetic resources within burnt area adjacent to peat reclamation schemes ▪ Loss of traditional freshwater fishery resources and degradation of near-shore and marine fisheries downstream of peatland areas ▪ Possible loss of coastal and marine tourism and recreational potential due to marine ecosystem and water quality changes induced by degraded catchment function and water quality ▪ Destruction or disruption of previously existing local economies and livelihoods caused by fire,

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
	▪ Physical difficulties of soil subsidence (e.g. damage to infrastructure; unstable soils for tree crops; peat domes "collapsing" to below water level) ▪ Agronomic problems of soils (excessive topsoil drainage; excessive lateral and impeded vertical drainage in subsoils following subsidence, extreme soil infertility and low pH—4.0 or less) *Acid sulphate soils* ▪ If exposed, major acidification impact on on-site groundwater (pH 2.0–2.5) and on run-off/drainage water (pH 2.5); also involving toxic leachate release (Al and Fe)	▪ See *Land suitability impact*	water quality and ecosystems due to peat degradation, nutrient and leachate inputs combined with water flow changes. Plus possible biodiversity loss, disruption of fish migration, eutrophication and water weed spread (causing further ecosystem degradation) ▪ Definite water quality degradation, plus biodiversity and ecosystem impacts, due to acid drainage water (rivers definitely; estuaries and marine probably)	▪ Loss of terrestrial and freshwater biodiversity, habitats, ecosystems, and natural landscapes (peat swamp, fresh water swamp and lowland rainforest) due to peatland drainage, loss, adjacent water table changes and induced forest and habitat destruction by fire	water quality, and catchment function–related impacts of peatland loss
Land suitability and	*Land suitability*	▪ Difficult	▪ Failed or failing	▪ Loss of terrestrial	

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
problematic site conditions Peat soils, acid sulphate soils, and saline water conditions	▪ Very questionable land suitability of problematic soils for most crops due to low land capability and poor crop tolerances ▪ Very questionable economic feasibility due to cost of site development, high cost of needed agricultural inputs (fertilizer, lime, micro-nutrients, other soil conditioners, transport costs) and generally very low crop yields per area developed ▪ Very questionable social feasibility of employing inexperienced, nonlocal, farmers (e.g., upland farmers off nontidal mineral soils), to farm very difficult and infertile soils under difficult water management conditions, in	conditions, inexperienced farmers, high incidence of crop failure, economic and social hardship, leading to poverty and full or partial scheme failure. Poor, displaced, or failed settlers, lacking knowledge and respect for local resource management systems, resource use rights, traditional laws and local customs supplementing income by "poaching" wildlife, timber, rattan, non timber forest products or fish from adjacent forests and protected areas. Possible "informal expansion" activities (e.g., slash and burn agriculture, brackish pond aquaculture, destructive fishery production, or gold	schemes; plus displaced and destructive new settlers; leading to increased vegetation loss and damage (fires, clearing, and illegal logging); and induced impacts on water quality (e.g. poison fishing, gold mining, mangrove clearing, prawn and fish pond operation) ▪ All leading to further degradation of catchment hydrologic function, change in natural water flows, water quality, and coastal protection (e.g., mangroves) ▪ Leading to negative impacts on freshwater, estuarine, and marine biodiversity, habitats, ecosystems, and natural landscapes downstream (or	and freshwater biodiversity, habitats, ecosystems, and natural landscapes (peat swamp, freshwater swamp and lowland rainforest) due to expansion of forest clearing, burning, and overharvesting or destructive harvesting activities of failed and displaced settlers ▪ Damage to catchment hydrological function and degradation of catchment water quality ▪ Damage or loss of coastal protection, due to mangrove clearing (timber and charcoal harvest and prawn and fish ponds) ▪ Damage to estuarine and marine habitats,	▪ Loss of timber resources caused by expansion of informal settlement and settler activities ▪ Increased competition for, and harvesting pressure upon, timber and non-timber resources; freshwater, near-shore marine fishery resource; and wildlife resources, by displaced settlers encroaching into local community harvesting areas ▪ Possible loss of coastal, marine, and forest area tourism and recreational potential due to damage caused by expansion of informal settlement and settler activities

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
	remote areas, with expensive and possibly infrequent supply of agricultural inputs and limited technical and social back-up	mining) beyond scheme boundaries ▪ Further degradation and destruction of adjacent peatlands, forests, biodiversity, habitats, ecosystems, protected areas and natural landscapes due to “informal” land clearing, burning, poaching, destructive short-term economic activities, and increased human impacts on already occupied lands	adjacent)	ecosystems and biodiversity (mangroves, estuaries, seagrass beds, coral reefs, and nearshore ecosystems) ▪ Further negative implications for global carbon balance, climate change, and biogeochemical cycling due to more peatland and adjacent forest burning by failed settlers	▪ Destruction or disruption of previously existing local economies, livelihoods, and cultures. Expansion of informal settlement and settler activities
New settlements and infrastructure development	▪ Increased settlements and human populations ▪ Increased roads and road access to, within, and around site. ▪ Development of dikes and causeways in previously inaccessible swamp and mangrove areas	▪ Dramatically increased human presence; resource use pressures, and increased site access to previously remote and inaccessible areas ▪ Leading to dramatic increases in degradation and destruction of adjacent peatlands,	▪ Dramatic increases in degradation of catchment function and water quality and all downstream freshwater, estuarine and near shore marine ecosystems; caused by catchment and coastal destruction from human presence and activities (previously noted)	▪ As above but much more extensive and serious damage caused both by “newcomers,” new corporate activity as well as failed settlers.	▪ As above but much more extensive and serious damage caused both by “newcomers,” new corporate activity, and failed settlers

Activity/issue	*On-site impact*	*Adjacency impact*	*Downstream impact*	*Broad environmental implications*	*Broad socioeconomic implications*
	▪ Clearing and drainage of previously inaccessible and impassable swampland	forests, habitats, biodiversity, ecosystems, protected areas, and natural landscapes due to increased environmental disturbances (fires, clearing, hunting, pet trade, poison use, mining, aquaculture, timber harvest, and human and boat traffic)	and improved catchment access		

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