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FOOD AND AGRICULTURE ORGANIZATION
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A SUGGESTED NATIONAL SOILS POLICY FOR INDONESIA

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1994

For bibliographic reference purposes this document must be referred to as: FAO/UNEP (1994) - Advisory Services to Indonesia and Jamaica on the Formulation of National Soils Policies.

Foreword

In Indonesia, an archipelagic state, land and water conservation issues including the protection of soil (including groundwater), water balance, the atmospheric ecosystem, and the sustainability of flora and fauna to fulfil human needs, have been given considerable attention by the Government. The endeavour to attain environmentally sound development will depend on the successful establishment of soil conservation policies. If environmental degradation due to inappropriate land use and soil conservation policies occurs, erosion, sedimentation, salinisation, land subsidence, and other natural disasters could follow. Some small islands in Indonesia might sink. This possibility might increase if the sea level rises as a result of climate change caused by global warming.

In order to prevent the possibility of environmental degradation and natural disasters due to the implementation of inappropriate land use and soil conservation policies, and to direct environmentally sound and sustainable development endeavours, accurate information about soil and water from every region is absolutely essential. This information is needed as a basis for the formulation of a national strategy on land and water conservation.

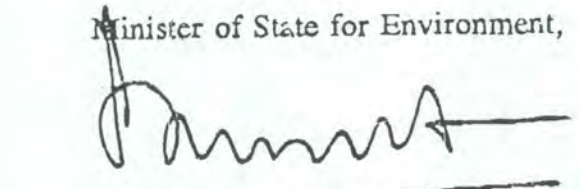
Based on the above premise, I appreciate the publication of this report entitled "A Suggested National Soils Policy for Indonesia" resulting from the FAO/UNEP project: "Advisory Services to Indonesia and Jamaica on the Formulation of National Soils Policies" undertaken in 1993. This report is a preliminary strategic effort in the development of soil information. The report will be used as a basis for the formulation of Indonesia's soil conservation policy.

Given that this project was designed as a preliminary activity only, I hope that the cooperation between UNEP, FAO and the Government of Indonesia will be continued, especially to establish soil conservation policies for each island in different regions of Indonesia, in order to fulfil the Second Twenty-five Year Long-term Development Plan.

It is expected that the result of this project will be used as a reference both in the area of international cooperation and at the national level. Naturally, I believe that the information contained in the report will be used and continuously developed to achieve a firm consensus in understanding and formulating a national policy concerning soil conservation.

On behalf of the Government of Indonesia, I thank FAO and UNEP for their assistance.

Minister of State for Environment,



Sarwono Kusumaatmadja.

Jakarta, February 1994

Foreword

There is a relatively strong awareness at the government level of the need for an ecologically sound and sustainable use of the soils in Indonesia. Soil erosion in the uplands consequently has adverse downstream effects; waterlogging and flooding, salinization and alkalinization, acid soils and nutrient depletion are the major soil problems in Indonesia.

Acknowledging that soil is one of the greatest assets possessed by Indonesia and that soil loss through degradation and other causes was taking place at an unprecedented rate, the Government of the Republic of Indonesia entered with UNEP and FAO into a technical cooperation project for the formulation and subsequent implementation of a National Soils Policy.

This proposed National Soils Policy for Indonesia was prepared under UNEP/FAO project FP/6101-91-02 by fielding a multidisciplinary team of two national consultants and two international experts. The team carried out its work in Indonesia during September and November 1992. The ready assistance given to the team by the national and international bodies concerned with land use in Indonesia is gratefully acknowledged.

The Soils Policy suggested in this document is meant to be illustrative rather than exhaustive in character, and by no means a substitute for local experience, foresight or prudence. If properly implemented, the suggested Soils Policy will have a variety of impacts. For instance, it will not only enhance the quality and productivity of soils, but it will also aid the entire development process, promoting the economic well-being of the people of the Republic of Indonesia. These benefits will be obtained through incorporating the policy in all development plans that touch on or involve soils as the basis of land resources.

I sincerely hope that the Suggested National Soils Policy will meet the practical needs of the Republic of Indonesia.

Reuben Olembo
Assistant Executive Director
Office of the Environment Programme
United Nations Environment Programme

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Arrangement of the Report

This document — A suggested National Soils Policy for Indonesia — consists of an Executive Summary and four main Chapters.

- Chapter One sets out the background to the formulation of a national soils policy, placing it in its international context, and highlighting the relevant concerns, objectives and benefits.

- Chapter Two is a descriptive account of the present situation in Indonesia, in particular with respect to overall geographical setting, the occurrence and properties of the soils and major geosystems, and the institutional and legal aspects germane to a national soils policy.

- Chapter Three is an analytical examination of problems and issues considered as being of direct relevance for the policy. It covers in particular the social, technical, institutional and legal aspects which are at the origin of the proposed policy.

- The final Chapter, Four, describes the present status of national soil policies in Indonesia and proposes a new approach, in line with the specific conditions of the country and with the Government's long-term objectives. It also includes a series of recommendations with respect to strategies and modalities for implementation, as well as for follow up activities.

Acronyms, abbreviations and glossary of local terms used

Adat	Custom, customary law
ADB	Asian Development Bank
AIDAB	Australian International Development Assistance Bureau
AMDAL	Environmental Impact Assessment *Analysis Mengenai Dampak Lingkungan*
Bakosurtanal	Coordinating Agency for National Surveys and Mapping *Badan Koordinasi Survei dan Pemetaan Nasional*
BAL	Basic Agrarian Law of 1960
Bapedal	Environmental Impact Management Agency *Badan Pengendalian Dampak Lingkungan*
Bappeda	Regional Development Planning Agency *Badan Perencanaan Pembangunan Daerah*
Bappenas	National Development Planning Agency *Badan Perencanaan Pembangunan Nasional*
BPN	National Land Agency *Badan Pertanahan Nasional*
Bupati	Head of Level-II Local Government (*Kabupaten* level)
Camat	Head of Sub-District (*Kecamatan* level)
CIDA	Canadian International Development Agency
Cipta Karya	Directorate General for Human Settlements, Ministry for Public Works
CSAR	Centre for Soils and Agroclimate Research *Pusat Penelitian Tanah dan Agroklimat* See also SRI
Daerah	District, but with no administrative connotation
Desa	Village (administrative unit)
DG	Directorate General
Dinas	Office of Regional (i.e., Provincial or District) Government
DPR	[National] House of Representatives *Dewan Perwakilan Rakyat*
DPRD	Regional (i.e., Provincial or District) House of Representatives
EIA	Environmental Impact Assessment — the local term *Amdal* is used in this report
EMDI	Environment Management Development in Indonesia project
FAO	Food and Agriculture Organization of the United Nations
IFAD	International Fund for Agricultural Development
Inpres	Presidential Decree *Instruksi Presiden*
IBRD	International Bank for Reconstruction and Development
IPB	Agricultural Faculty, Bogor *Institut Pertanian Bogor*
GBHN	State Policy Guidelines *Garis-garis Besar Haluan Negara*
GIS	Geographical information system
GTZ	German Agency for Technical Cooperation
HITI	The Indonesian Soil Science Society
Kabupaten	Chief administrative sub-unit within the province

Kanwil	*Kantor Wilayah* Representative Office of government departments at provincial level, acting as a coordinating body for official activities at provincial level
Kecamatan	Subdistrict, administrative subdivision of a *kabupaten* or *kotamadya*
Kepas	Research Group on Agro-ecosystems *Kelompak Penelitian Agro-Ekosistem*
KLH	Ministry of State for Population and Environment *Kependudukan dan Lingkungan Hidup*
Kotamadya	Municipality or Urban Area (administrative unit)
LECS	Land Evaluation Computer System
LH	Ministry of State for Environment *Lingkungan Hidup*
LREP	Land Resource Evaluation Planning project
MPR	People's Consultative Assembly *Majelis Permusyawaratan Rakyat*
NGO	Non-governmental organization
Palawija	Non-rice, annual food crop, especially maize, pulses, vegetables, cassava or sweet potato
Repelita	Five-Year Development Plan
RePPProt	Regional Physical Planning Programme for Transmigration
Sawah	Irrigated riceland
SRI	Soil Research Institute, now redesignated CSAR
SUFS	Sustainable Upland Farming Systems
UAC	Upland Agriculture and Conservation project
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WALHI	The Indonesian Environmental Forum

Executive summary

Soils are a basic natural and almost non-renewable resource, the use of which should be governed by two major principles:

- soil losses and degradation must be avoided, and
- soils must be used to their maximum potential for human benefits, but within the limits of environmental soundness and of sustainability (1.1[1]).

Therefore a national soils policy should constitute a set of guidelines that aim to ensure and promote maximum utilization of soils on a sustained basis, without lowering productivity or causing direct or indirect damage to the environment. A national soils policy has four basic aspects, addressing respectively technical, socio-economic, institutional and legal elements (1.2).

Indonesia covers almost 2 million km², with a wide range of soils, agroclimates and resultant land-use types. About 30% of the total land surface — 60 million ha — is considered suitable for agricultural production, and half of that is already under cultivation.

The 1990 census put the population at 179.2 million, with a striking range of population densities, from Java/Madura at 690/km², Maluku at 19/km², to Irian Jaya at <3 /km². Despite a successful family planning programme, population pressure remains the dominant factor in soil policy making and sustainability issues (2.1.4).

Land use is characterized by a number of features. Agriculture has always been of primary importance in Indonesia's national objectives, in view of the need to achieve food self-sufficiency. Two forms of cultivation dominate: a very intensive cropping system (based on wetland rice) in Java and Bali, and a more extensive or shifting cultivation type on the outer islands. Small-scale production dominates at almost all levels of agricultural activities, with some 70% of all farms having less than 1 ha (2.1.5).

At present, soil survey, soil conservation and land evaluation activities are carried out by a number of bodies, including government agencies and research institutes, university departments, commercial companies and donor-assisted projects (2.2.1-2.2.5).

Soils and soil potential in Indonesia are largely determined by the combination of the geological characteristics of the soil parent material, the climatic conditions and weathering intensities. Slightly weathered soils of riverine and estuarine plains are most productive, and are therefore frequently used for intensive rice production. The lower slopes of volcanoes are also often of high agronomic value, particularly in Java, but the higher slopes are very erosion-sensitive in some places. All the outer islands have soils which are often deficient in some way, either because of their intrinsic properties or because of a less favourable climate (2.2.6).

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1 Numbers refer to Sections in the Main Report.

Seven major geosystems occur in the country, each of them with a characteristic combination of soils, agroclimate and land-use types. As their soil potentials also differ, then they each require separate strategies for optimal use and conservation (2.3).

- Java and Bali have fertile lowland soils with good potential for multiple rice cropping, but upland areas are easily eroded and less suitable; competition for land is a major social problem.

- Sumatra has highly weathered soils and a climate which is generally suitable for estate cropping.

- Kalimantan includes large areas of tidal swamps, with moderately good production potentials for rice; manpower shortage is often a problem.

- Sulawesi has a very complex soil and climatic pattern, ranging from fertile to almost unproductive areas.

- Soil potential in Nusa Tenggara is largely determined by the (limited) length of the rainy season, and by the presence of shallow and calcareous soils.

- Maluku and Irian Jaya are still dominated by extensive forests; they have low population densities and the soils are highly weathered and nutrient-deficient.

There are at least 13 institutions and agencies dealing with soil and land use affairs, ranging from soil survey and data collection to land titling and policy making, each of them with a mandate which more or less touches soils. A large number of donor-assistance projects are active in the country. Most of them are administratively coordinated by Bappenas, but others have direct links with sectoral departments or provincial bodies (2.4.1).

There is a relatively strong awareness at the government level of the need for an ecologically sound and sustainable use of the soil, but awareness is much weaker at provincial and kabupaten levels. Poor upland farmers are more concerned about short-term subsistence conditions than about long-term speculations of sustainability (2.4.3).

In terms of legislation, laws made at the national — i.e., supreme — level are mainly confined to general policy statements. Most details concerning implementation are laid down either by Ministers at national level, or by Provincial or District bodies. Coordination mechanisms, in both vertical and horizontal senses, are essential within such a system in order to ensure orderly and effective decision-making (2.5).

Major social issues germane to a national soils policy are the continuing population pressure, the encroachment on cropland for non-agricultural uses, and the adverse effects of traditional farming systems in erosion-prone uplands or areas under shifting cultivation. The social dimension in Indonesia, in terms of demographic pressure, and the overall national objective of safeguarding food self-sufficiency, will continue to be a major influence overriding all other concerns for future soil policies and environmental impact assessment of sustainability (3.2).

Soil erosion in the uplands and consequent adverse downstream effects, such as siltation of dams and water reservoirs, are the main technical issues, especially in Java. Prevention of soil losses and introduction of soil conservation practices are major concerns of the various projects

implemented under the umbrella of, or associated with, the Inpres Regreening and Reforestation Programme. Preliminary conclusions from on-going work in pilot conservation projects indicate that purely technical or plant-based solutions have a poor success rate if not backed by associated socio-economic measures to improve farm incomes (3.3.1 and 3.3.2).

Technical problems such as waterlogging and flooding, salinization and alkalinization, and treatment of potential acid-sulphate soils, can be solved using techniques and expertise already available elsewhere. Similarly, nutrient depletion can be overcome by adequate, balanced fertilizer applications (3.3.4 to 3.3.7).

Soil pollution is a very complex problem. In the past decade Indonesia has received international recognition and acclaim for the way it has handled its pest control programme for rice cultivation. However, the intensive use of agrochemicals on Javanese soils, and the probable effect this can have on eutrophication processes in soils and waterways, has received little attention. The contribution to Global Warming resulting from methane production from paddy fields has not been considered in this report. The issue of industrial waste disposal and of various other forms of soil pollution should be handled in the new Amdal regulations, which are (1993) in the process of being defined (3.3.8).

A major institutional problem is the large number of agencies with soil-related mandates. All of these have their own, often sectoral, approach, special methods and terminology, and this has lead to confusion for the user-community, both regarding the proper agency to approach for soil information, and in interpreting and understanding the information once obtained. There is an urgent need for a standardization of procedures used by institutions involved in natural resource data collection and interpretation (3.4), and for the introduction of a single, nationally accepted soil classification.

The mandates and activities of a number of agencies need critical review. The relative vagueness of their mandates often leaves space for interpretations and extension of activities according to the circumstances and ambitions of such agencies (3.4.1).

Data reliability has to be improved, as it is clear that any policy or programme will be flawed if it is developed on the basis of incorrect base data (3.4.3).

Legislation has introduced mechanisms for planning, either by a central planning system or more recently by land-use planning, cross-sectoral, environmental laws, administered by LH and the Spatial Use Management Coordinating Board. There are, however, weaknesses in enforcement of planning decisions, and therefore a broad-based approach to improving land use management, with direct public participation at village level, will be essential (3.5).

Although there are no specific laws in Indonesia on soil conservation, all persons or bodies holding land rights are required by law to prevent land degradation. Under the Indonesian central planning system, the main decisions on major land use are made by the Government, and they are given their effect by grant of licences, permits, titles and other concessions by the different sectoral ministries. The new legislation in the last decade aims at installing environmental safeguards in all future land allocations, and major projects are now subject to environmental impact assessment (3.5).

Indonesia has a long-standing commitment to the basic principles and concepts of sound environmental management, and in the past the Government has shown its obvious concern by

taking action to stop soil erosion and to rehabilitate critical land, as well as to protect as much as possible of its forest reserves. However, existing land-use policies are mainly sectoral, and often result in competing and conflicting demands on land, which tend to be solved on an *ad hoc* basis (4.1).

The present sectorial and incidental approach cannot be maintained under persisting conditions of high demographic pressure and continuing land conversions. Hence, there is a need for an entirely new approach; one that includes in an integrated way all future land uses, as they are defined by the national long-term development objectives (4.1).

The long-term development objective of the Government of Indonesia is to raise standards of living and to improve the welfare of people through, among other things, increased agricultural production. This is not only needed to meet people's direct food demands, but also to provide raw material for an expanding agro-industry. In the past, targets of food self-sufficiency were mainly met through intensification of existing agriculture and by opening up new cropland at the expense of forest areas. This situation cannot last indefinitely. Future policies must take a new perspective — that of sustainability and preservation of the ecological balance.
Agricultural production increase in Indonesia is constrained by a number of factors:

- continuing encroachment on cropland for urban and industrial expansion;
- inherent natural or man-induced limitations of the soil itself; and
- the persistence of farming systems that are not properly adapted to the specific agro-ecological conditions of each area (4.2).

The national soil policy suggested for Indonesia aims at obtaining maximal sustainable agricultural production from the land, and preserving a fair balance between agricultural and non-agricultural uses. It has four major principles:

- land is to be used according to its inherent potential and carrying capacity;

- allocation of land to sustainable uses, either for forestry, agriculture, city expansion or other activities, should be regulated by an Integrated Land-use Plan, prepared on the basis of both natural soil potential and anticipated future development needs of the nation;

- implementation provisions regulating the land use planning process and the authority for planning decisions should be vested in the new Spatial Use Management Coordinating Board which will be able to override all eventual sectorial interests;

- soil conservation practices should be based on technical (i.e., mechanical and vegetative), economic, social and cultural means, as well as involving direct farmer participation (4.3).

This is in line with the new Nation State Policy which states, "There is a need to strengthen and refine efforts in the rehabilitation of forest and critical land, soil conservation, rehabilitation of rivers, swamps, mangrove areas, conservation of natural caves, coral reefs, endangered species of flora and fauna, and improvement of watershed management. Rehabilitation of critical land to preserve soil fertility, springs, and environmental carrying capacity has to be enhanced through soil conservation measures and regreening".

Successful implementation of such a policy is fully dependent on the development of strategies directly related to the principles on which the policy is based. Those refer in particular to:

- a correct knowledge of the soil potential, its sensitiveness to degradation, and the carrying capacity;
- the establishment of an Integrated Land-use Plan, independent of all sectoral interests, but based on the natural soil potential and on future anticipated land use needs;
- the need for an authoritative national planning body for establishing and monitoring the implementation of the Plan; and
- proper knowledge of conservation practices and adapted farming practices for sustainable maintenance of the ecological balance in erosion-prone areas.

Except for macro-planning at the national scale, basic information for accurate evaluation of inherent soil potentials is not yet available in the country. Modalities to overcome this deficit include the concentration into one single organization of the currently dispersed activities in data collection and retrieval. The single organization would be responsible for ensuring uniformity and standardization of soil and land-use data and terminology, and for the establishment of proper methodology for data generation and interpretation (4.4.1). A key step towards uniformity in the national system would be the introduction of standard computer programs for data entry and processing, coupled with comprehensive manuals providing the agreed methodologies for the various stages of survey and land evaluation.

Various methods for evaluation of the national soil potentials and carrying capacity of land have been applied in Indonesia. There is an obvious need for a single, nationally accepted land evaluation system to be used by all agencies dealing with resource mapping and evaluation. With the progress in information and computer technology an application of a user-friendly computerized land evaluation system such as an expert system should be promoted.

No Overall Land-use Plan exists in Indonesia. One should be drafted on the basis of recommendations made both by experts dealing with natural potential of the land and by decision makers concerned with the long-term development policy of the country (4.4.2).

A 'national authoritative body' was established under the Presidential Decree no. 75 of August 1993, whose major role is to decide upon the destination of land in the future and upon the enforcement of such decisions. The administrative and legal structures necessary are gradually being put in place through the adoption of the Spatial Use Management Law (4.4.3).

Soil conservation practices should not only deal with technical, i.e., mechanical and vegetative, means to abate soil erosion, but also should concentrate strongly on farmers' involvement and poverty alleviation, based on the experience that the improvement of living conditions of poor farmers is a major tool towards a more sustainable system of soil protection (4.4.4). The active and real involvement of farmers at all stages is needed, and should be reinforced through the introduction of adapted farming systems. The extension services will need strengthening so as to be able to provide competent assistance in areas outside of their traditional expertise.

The Government will need to undertake a number of activities to implement the National Soils Policy. These include:

- a rreview of the mandates of the many different institutions dealing with soils to avoid duplication of work and the setting of uniform standards (4.5.1);

- leading agencies introducing and documenting standardized methods and terms for soil data collection and interpretation and then enforcement of their application (4.5.2);

- further work in developing the national data bank located with Bakosurtanal and expanding the work to include the regular monitoring of changes in land use (4.5.3);

- introducing appropriate and effective land evaluation methods to provide the basis for the evaluation of the physical environment and the various land-use scenarios to be considered within the Overall Land-use Plan (4.5.4).

- finalizing and enacting the draft soil conservation act and developing technical solutions to soil erosion problems which will increase farm production as well as being conservation effective (4.5.5);

- introducing a public awareness campaign to stress the importance of good land use (4.5.6).

Chapter 1

Origin and objectives of a National Soils Policy

1.1 INTERNATIONAL CONTEXT AND CONCERNS

Worldwide, soils are being used with increasing intensity to meet the needs of continuously growing populations, and Indonesia is no exception. Such demands have to some extent been met through major progress in plant breeding, fertilization and soil management, or by opening up of new land for agriculture. Unfortunately, such solutions cannot continue indefinitely.

Besides the obvious population pressure, other factors affect world food demands, such as the gradual increase in material expectations of people, and the general trend to more evenly distributed wealth. The net result is that the demand for food, raw materials and energy is expected to increase faster than anticipated population growth.

Worldwide, agricultural records for the past few decades indicate that food production in many parts of the developing world is not keeping pace with population growth, and that the intrinsic production capacity of the land is rapidly decreasing. Reasons for this include inadequate land management practices; loss of land through erosion; physical or chemical degradation; pollution; and urban development.

The sound management of natural resources is a prerequisite for economic development. If growth is pursued without due regard for its immediate impact on the environment and the natural resource base, it can jeopardize longer-term development. The concept of sustainable development acknowledges the importance of economic growth, but it differs from previous concepts of development in its recognition that natural resources are finite and that the wasteful use of resources today will cause an unnecessary sacrifice of income and wealth in the future.

Realizing that broad-based sustainable development is not feasible, especially in the long term, without sound environmental assessment at the inception stage, and learning from adverse experiences, international organizations have increasingly expressed their growing concern over the alarming developments in food production. Hence the United Nations Environment Programme (UNEP), in collaboration with FAO and Unesco, has emphasized the importance of a coordinated *World Soils Policy*, and has urged the need for national policies aimed at conserving precious natural soil resources. In this context, the *World Soil Charter* (FAO, 1981) was drafted, and UNEP issued its *World Soils Policy* in 1982. The Agenda 21 resolutions, adopted at the UNCED Conference in Rio de Janeiro in June 1992, are fully in line with those earlier expressed concerns.

All these documents draw attention to the importance of soil as a basic natural and almost non-renewable resource for agriculture, forestry and other rural land uses. They stress two major principles: one, of avoiding soil loss and degradation; and, two, of utilizing soils to their maximum potential, but within the context of sustainability. The second principle thus promotes the best use of soils and other land resources to meet present needs, whilst at the same time conserving the basic soil resource for populations of the future.

Following a series of international meetings, UNEP issued *Environmental Guidelines for the Formulation of National Soils Policies* (1983), linked to the World Soil Conservation Strategy (1981). Those guidelines aim in particular to:

i. maintain essential ecological processes and life support systems;

ii. preserve genetic diversity; and

iii. ensure the sustainable utilization of species and ecosystems.

UNEP Governing Council Decision No. 12/12 II (Soil), endorsing the *Plan of Action for the Implementation of the World Soils Policy*, and the related UNEP GC Decision 13/27.1, urge Governments to accelerate the establishment of national soils policies. In 1989, UNEP invited the Government of Indonesia, through the Minister of External Affairs, to enter into a technical cooperation project for the formulation and implementation of a national soils policy. Following the expression of willingness on the part of Government of Indonesia to participate in such an arrangement, a round-table discussion was held in Rome in April 1992, attended by a Representative of the Ministry of State for Population and Environment of the Government of Indonesia, and the modalities for the fielding of a technical mission were discussed.

The UNEP/FAO Mission fielded under UNEP/FAO project FP/6101-91-02, 'Advisory services to Jamaica and Indonesia on the formulation of National Soils Policies', comprised two international and two national consultants. It held discussions with government agencies dealing with soil issues, and with a number of other agencies with an involvement in relevant aspects of the issue, and made visits to examine representative problem areas and successful achievements. A list of persons consulted during the mission is given in Appendix 1.

The Misson attempted to identify the main problems of soil conservation and land utilization in relation to their specific environmental and socio-economic conditions, and investigated the impact of various land uses on soil quality, soil conservation, and management. Special attention has been paid to the integration of the soils policy with other natural resource policies within the framework of a national development plan. The most important legal, scientific, technical and institutional elements of a national policy have been identified, with the aim of providing the Government of Indonesia with advice on:

- the strengthening of institutional structures for the implementation of a policy tailored to suit Indonesia's environmental conditions; and

- measures for combatting urgent, soil-related problems, including soil degradation due to landslides, soil toxicity, soil acidity, soil reclamation, mining, etc.

1.2 OBJECTIVES

A national soils policy is a set of guidelines, aiming at ensuring and stimulating maximal utilization of soils on a sustained basis without lowering productivity, and limiting direct or indirect damage to the environment. Emphasis is therefore placed upon knowledge of the varied nature and properties of soils, and, as a consequence thereof, the need for their appropriate management.

A policy, as defined above, has to take into consideration the nation's diversity and particular problems. It should therefore not only focus on soil conservation problems, but should also cover a variety of aspects dealing with development, conservation and use of cropland and pasture lands, as well as management of forest and mining areas. Ultimately, even land-use planning is touched upon, in view of its obvious role in mediating between land-use patterns and practices and the achievement of soil conservation goals and objectives.

A national soils policy has four basic aspects, addressing respectively technical, socio-economic, institutional and legal elements. In broad terms, national soils policies should aim to bring about activities which will:

- assess available land resources and improve soil productivity by applying better management techniques and developing and promoting more productive agricultural systems;
- enlarge cropping areas and improve the quality of available agricultural land wherever feasible;
- slow down losses of agricultural and forest land, monitor changes in soil quality and quantity, and evaluate the way land is used;
- bring to the attention of all concerned the dangers and adverse consequences of soil degradation and the need for conservation and appropriate legislation; and
- create or improve the capability national institutions to carry out these aims.

1.3 EXPECTED BENEFITS

Potential benefits arising out of a coherent national soils policy are:

- to obtain sustainable and optimal production from the land, according to its inherent properties and related to specific market demands and national objectives;
- to provide a policy framework within which programmes and projects can be integrated and their continuity in terms of objectives and methods can be achieved; and
- to strengthen national capabilities for conducting soil research, monitoring, conservation and extension, and to identify domains for upgrading education and training, enabling staff to keep abreast of advances in knowledge.

Chapter 2

Present situation

2.1 GEOGRAPHICAL SETTING

Indonesia consists of five major and more than 17 000 smaller islands, stretching from 6°08' north to 11°15' south latitude, and from 94°45'to 141°05' east longitude. Its total land area is 1.92 million km². The archipelago can be divided into three groups (Figure 1). Java, Sumatra and Kalimantan, with the many smaller islands between, lie on the Sunda Shelf; Irian Jaya in the east is on the partly submerged northern extension of the Australian Shelf. Between these are belts of deep-sea basins and island chains, including Sulawesi, Nusa Tenggara and the Maluku Islands.

2.1.1 Geology and physical geography

The Indonesian archipelago is one of the most active volcanic regions in the world and it shows in its overall relief. Tertiary and Quaternary, often still active, volcanoes form the central mountainous axis of Sumatra and Java, with peaks well above 2 500 m above sea level (masl). Tectonic activity and related uplifting of older sedimentary deposits in Kalimantan, Sulawesi, Sumatra and Irian Jaya produced the steep mountain ranges of those islands, with extensive recent alluvial deposits at lower levels. Topographically, the country has three major terrains:

- steeply dissected, hilly and mountainous land with altitudes above 300-400 masl (35 to 40% of the total land area);
- level to undulating, pre-mountainous lowlands situated between 10 and 300-400 masl (30 to 35% of the total land area); and
- coastal alluvial and peaty areas (approximately 30% of the land area).

All three types can be found in roughly equal proportions on all the major islands, except for Nusa Tenggara which is almost entirely of the second category.

2.1.2 Climate

Indonesia has a tropical warm and humid climate. Temperature and humidity remain almost constant throughout the year, while insolation, wind and rainfall vary according to season. Average temperatures range from 18-22°C (thermic regime) in the highlands, to 27-28°C (hyperthermic regime) in the coastal lowlands. Relative humidity is everywhere around 80%. The country has a distinct dry season from June to September, followed by a rainy period

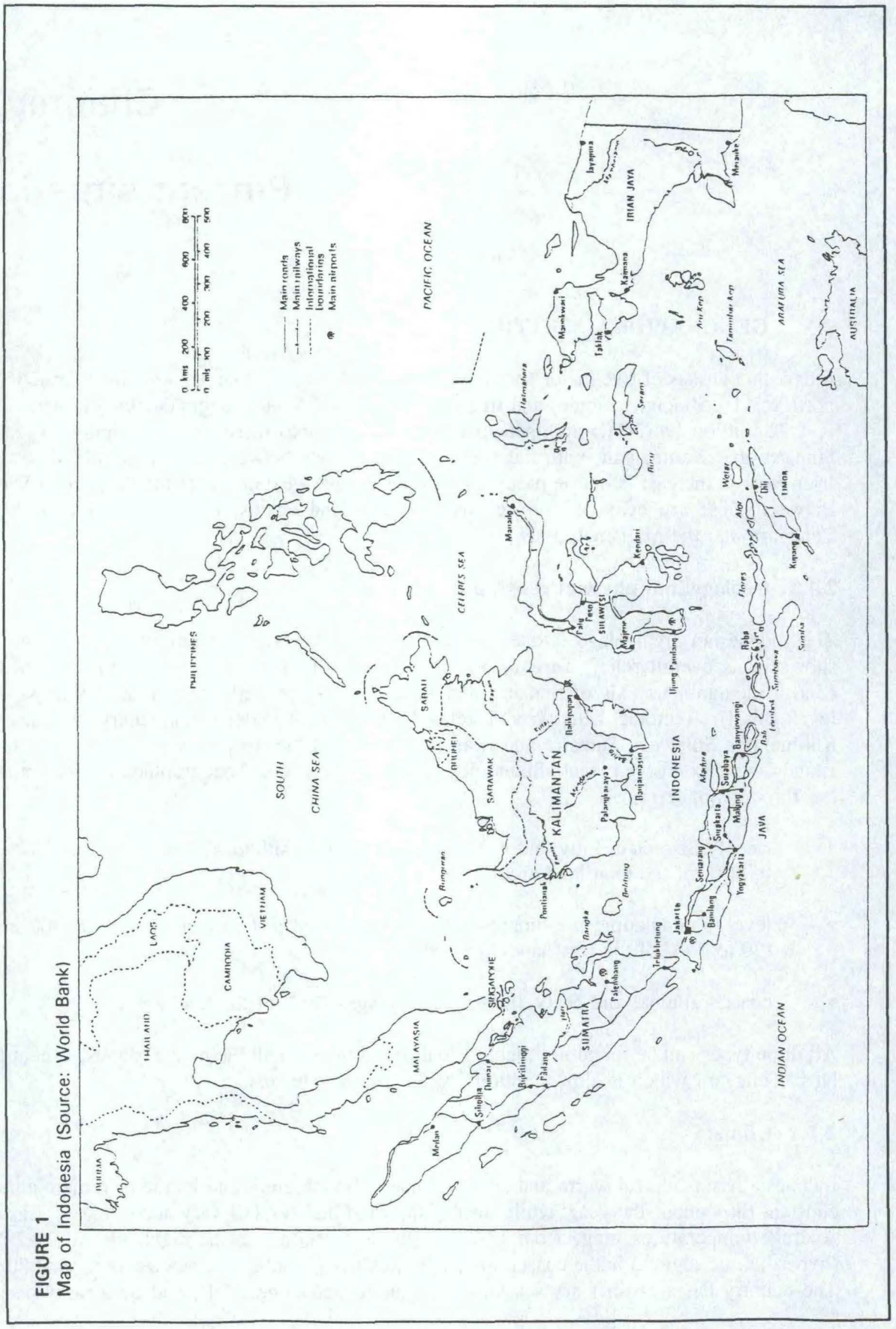

FIGURE 1
Map of Indonesia (Source: World Bank)

from November-December to March-April. In Sumatra, Kalimantan and West Java the dry period is, however, not completely rainless, and there is ample soil moisture over almost the whole year; the climax vegetation for this part of Indonesia is therefore a typical rainforest vegetation, and the area enjoys optimum climatic conditions for growing a wide range of crops, particularly wetland rice. East Java, Nusa Tenggara and parts of Sulawesi are much drier, and are covered by vast grasslands. However, even in those less-favoured areas, rainfed agriculture is possible for at least 4 to 5 months each year, while tree growth is almost continuous.

2.1.3 Vegetation and land use

It is estimated that, of the total available land surface in the country, approximately 60 million ha (30% of total land) are suitable for agriculture. Of this land, nearly 17 million ha were under cultivation in 1975 (MacAndrews, 1986), and had reached almost 30 million ha by 1991. The overall picture of agricultural and forest land use in Indonesia is documented in Appendix 2. Forest land, or land within forest boundaries as defined by the Department of Forestry (discussed further in Section 2.5.4 below), is classified into four major categories: forest reserves, protection forests, production forests and conversion forests. The present rate of deforestation is variously estimated at between 9 000 and 12 000 km²/year. In the past, deforestation to clear land for food crop cultivation and plantation development has mostly affected Sumatra (50% of original forests now lost), but recently also Maluku and Nusa Tenggara (56% lost), Kalimantan (59% lost) and Sulawesi (60% lost) are rapidly losing their forest cover (RePPProt, 1990). Considerable concern currently exists about the inadequate management of natural forests, mainly because too much responsibility is given to the concessionaires, of which there are more than 500 operating in nearly 90% of production forests. Forest cuts are often beyond control, and may well be overreaching the sustainability level. Reliable data on this issue are generally not available. At present, Indonesia's forest resources are mainly concentrated in Kalimantan (21%, against 33% in 1975), Irian Jaya (18%, against 29% in 1975) and Sumatra (17%, against 19% in 1975). In terms of agricultural land use, Java and Bali differ consistently from the other islands by their intensive, year-round, rice cropping, either under rainfed or irrigated conditions, with up to 70% of their land area cultivated in this way, and their high yields of $\geq$4 t/ha/crop. In contrast, shifting cultivation dominates in many parts of Kalimantan and Sulawesi.

Although rice is the staple crop on most islands, cassava, groundnuts, maize and sago are important, especially in areas where rice production is less suitable, or in the eastern part of the country. Soybean cultivation is rapidly expanding, and has now become the most important annual crop after rice. Commercial crops like rubber, tobacco, tea and coffee are extensively grown in upland regions of Java and Sumatra, oil palm in Sumatra, with coconuts (for copra) dominating in Sulawesi and Maluku.

2.1.4 Population and administration

The 1990 census put the national population at 179.3 million, with more than 300 ethnic groups and almost as many local languages. Current projections put the total population at 216 million by 2000, and 231 million by the year 2005 (Department of Information, 1989).

The average population density in 1990 was about 77 persons/km², against barely 16 in 1961. Population distribution within the country is strikingly uneven, with Java and

Madura being among the most densely populated areas in the world (690 persons/km²). In comparison, the outer islands have very low population densities, reaching barely 50 to 60 persons/km² in Sulawesi and Sumatra, 12/km² in Kalimantan, and only 3 persons/km² in Irian Jaya. In 1980, 32.8 million people (22% of the total population) lived in urban areas, and this number — in both absolute and relative terms — has increased and is expected to continue to increase in the future.

Population pressure has to some extent been relieved by a most ambitious programme of transmigration towards the less populated outer islands; in particular to Sumatra, Kalimantan and Irian Jaya. Since 1970 some 660 000 families have transmigrated with government assistance, and at least another 2.5 million people have moved spontaneously.

As a result of a successful family-planning programme, the birth rate dropped from 4.4% in 1970 to 3.3% in 1985, with the corresponding population growth now being 1.8% in Java and 1.9% for the country overall.

Indonesia is a republic, with a President as Chief Executive. The Fifth Development Cabinet comprised 38 Ministers at the time of writing. Next to the national executive is the [National] House of Representatives (DPR: Dewan Perwakilan Rakyat), with whom the Government enacts laws and determines the national budget. The country is administratively ruled through 27 provinces, including 3 special territories, each headed by a Governor acting in the dual role of a Representative of both the people and of the central government. Each Governor is flanked by a Regional House of Representatives (DPRD), vested with law-making authority within the sphere of regional autonomy. At district [kabupaten] and municipality [kotamadya] levels, the Chief Executives are respectively the District Head [Bupati] and the Mayor [Wali Kota]. They have an equal dual status and are assisted by a local House of Representatives, with law-making authority at the local level, subject to restraints imposed by higher law-making bodies.

The state philosophy is *Pancasila*, which is a set of five principles, namely the belief in one supreme God; the unity of Indonesia; a just and civilized humanity; democracy; and social justice. The national Bahasa-Indonesian language is spoken throughout the archipelago and is one of the major bands that ties this ethnically and culturally diverse nation together.

2.1.5 Economy

The average national *per caput* income is $US 560, and the rural household income ranges between $US 450 in Java to $US 600 in Sumatra and Kalimantan (World Bank, 1990). Although being mainly an agrarian country, with an estimated 70% of the population engaged in farming activities, the industrial base is steadily increasing. This is a result of a series of Five-Year Development Plans (Repelita), which have put a gradually increasing emphasis on diversification of economic activities, including services and industry.

Looking at the overall economic picture in relation to soil and land use in Indonesia, the following should be borne in mind:

- agriculture is the dominant economic activity, engaging more than half of the total labour force, and accounting for approximately a quarter of the country's gross national product (GNP);

- two very distinct types of cultivation exist, namely the very intensive land use in Java and Bali, and a much more extensive, shifting cultivation type of land use on the outer islands;
- smallholder production is prominent at nearly all levels of agricultural activity, accounting for the production of almost 60% of rubber, nearly all copra and coffee, and all rice;
- smallholders occupy about 87% of agricultural land, and estates only 13%; and
- landholdings in the country are mainly small, with some 70% of farms less than 1 ha in size.

2.2 SOILS

2.2.1 History of soil investigations

Soil investigations in Indonesia started with the creation in 1905 of the Soil Research Institute (SRI), now redesignated the Centre for Soils and Agroclimate Research (CSAR [Pusat Penelitian Tanah dan Agroklimat]). Although in the early stages much emphasis was laid on chemical and mineralogical studies, due attention was also given to soil genesis and classification. The first schematic map of Java and Madura, at 1:1 000 000 scale, was drafted in 1912. In 1927, a government programme of agrogeological mapping at 1:200 000 was initiated in South Sumatra. Three years later, SRI started a separate survey of Java at 1:100 000. In the meantime, several private agencies began soil surveys, for different purposes and at various scales, all over the country. This multilateral approach, based on different methodologies and terminologies, has seriously hindered the introduction of a uniform soil investigation and classification system, and this problem continues to exist to some extent under the present conditions. It is estimated (Dudal and Jahja, 1957) that about 14 million ha of soils had been surveyed by 1942, but almost none of the work has been published in its original form. However, a comprehensive book by Mohr (1931) — *De Bodem der Tropen in het Algemeen en die van Nederlands Indie in het bijzonder* [Soils of the Tropics in general and of the Netherlands East Indies in particular] — contains many results of the regional soil studies from that period.

At present, soil survey work is carried out by a large number of institutions, including CSAR itself; the various Research Institutes for Estate Crops; universities with Soils Departments, including the Agricultural Faculty (IPB: Institut Pertanian Bogor) in Bogor, Gadja Mada University in Yogyakarta, Brawidjaja University in Malang, Lampung University, etc.; national and international consulting firms; and many others engaged in the Transmigration Programme and other rural development schemes. As a consequence of the diversity of systems used there is some confusion, and so in recent years an effort has been made by CSAR to review existing literature on soils work in Indonesia, with the ultimate aim of developing a bibliographic database on soils, and the publication of a first bibliography and soil map index (Sudjadi *et al.*, 1988).

Soil analyses are carried out by all institutions mentioned above. There is apparently common agreement on methodologies, mainly based on USDA principles. From time to time,

standard test samples for quality control checking are disseminated by CSAR to collaborating laboratories, but quality control in the follow-up operation has not been very evident.

Soil correlation and classification in Indonesia has for a long time been a problem, mainly because of the enormous diversity of soil conditions and of the many institutions and organizations involved in survey work, each with their own approach, methodologies and bias. A first review of classification work in the country was attempted by Edelman (1947). The National Soil Classification System, introduced by Soepraptohardjo and co-workers in 1961 (Soepraptohardjo *et al.*, unpubl), remained in use until the early 1980s. There is now an attempt being made to standardize classification of national soils using the USDA Soil Taxonomy system (USDA, 1975, with amendments to 1990).

2.2.2 Recent soil survey work

In recent years, a number of important soil survey and land-use studies have been undertaken, with direct relevance to a national soil policy. In particular, the Regional Physical Planning Programme for Transmigration (RePPProt) study (1984-89), the Land Resources Evaluation Planning (LREP) project (Phase 1 in 1986-90; and Phase 2 in 1990-1996), and the new CSAR national soil map at 1:2 000 000 are germane.

The national overview of land resources (RePPProt, 1990), published by the Bina Program/DG Settlement Preparation of the Ministry for Transmigration, in collaboration with the Land Resources Department of the UK Overseas Development Administration, is a synopsis of eight regional studies undertaken between 1984 and 1988 by RePPProt. Although in the first instance conceived as a tool to meet the direct requirements for site selection and planning of Government of Indonesia settlements in the outer islands, this study has become a valuable information resource for overall development and macro-planning at national level.

The RePPProt study contains an atlas with 14 thematic maps at a scale of 1:2 500 000 and five additional volumes with descriptive and analytical information, together with 237 maps at 1:250 000 for Sumatra; West, East and Central Kalimantan; Irian Jaya; Maluku and Nusa Tenggara; Sulawesi; and Java and Bali. In this desk study, the soil is only one of the many components of the mapping unit, which was, moreover, mainly defined by interpretation of existing documents and extrapolation through remote sensing techniques, but without additional ground truth verification. Efforts were nevertheless made to present a soil map of the country, including 35 mapping units defined in terms of dominant and associated soils, with main descriptions and classifications based on the USDA Soil Taxonomy system (USDA, 1985 edition).

All RePPProt information is stored on the Bina Program Microcomputer using Wordstar 2000, SUPERCALC 4 and SYMPHONY software files, but it is obvious that, although the RePPProt study constitutes an excellent tool for macro-planning at national level, it will always be of limited use for direct project implementation at regional scales.

The LREP map of Sumatra at a scale of 1:250 000 is a land unit and soil map produced by the LREP Soil DataBase Management Team. LREP is a technical cooperation programme between the Government of Indonesia and the Asian Development Bank (ADB), executed by CSAR in collaboration with a consulting firm, and supervised by the National Coordinating Agency for Survey and Mapping (Bakosurtanal).

Phase 1 of this study covers some 46 million ha in Sumatra and its outer islands. It includes 45 colour maps and explanatory booklets with detailed descriptions of land units. The map legend is based on geomorphic units, initially delineated by remote sensing imagery interpretation and subsequently defined in terms of soils properties by field observations and analytical data from type profiles. Its concept is closely related to previous Indonesian landform, land systems and unit systems (Desaunettes, 1977; RePPProt, 1990) without being too confusing. The study also incorporates all available information from known previous studies, including about 450 soil surveys, and RePPProt archival data. Hence LREP land units and soil maps are to some extent complementing the former RePPProt map of Sumatra, and this is obviously not contributing much to a consistent approach for non-soil-scientists or users such as Bappeda personnel, who are now liable to be confused by two different data-sets for the same resource information.

All geographic as well as primary soil profile information (e.g., profile descriptions, analytical data, etc.) is available in digitized form, but it is not clear how easily this information can be obtained by third parties. The ultimate aim is to link this network to a geographical information system (GIS) using the software package, based on the LECS-2 Land Evaluation Computer Program, developed by FAO project AGL/INS/44 and based on the principles of the FAO Framework for Land Evaluation (FAO, 1976).

A LREP Phase 2 project, also coordinated by Bakosurtanal, is intended to continue the establishment of a national database, but at the more detailed scale of 1:50 000. This study will provide additional information to define more accurately the criteria for crop requirements and specific cropping pattern research (see also Section 2.2.3 below). In fact, while LREP Phase 1 allowed overall planning at national and provincial levels, the follow-up LREP Phase 2 project will make recommendations for specific land use types at kabupaten level. As a result, 41 priority areas, totalling 3.71 million ha, have been selected in 18 provinces scattered over the country. Location and extents of these priority zones depend mainly on specific planning intentions in the respective regions. The project, which was due to start in 1992, includes a training component for some 100 regional staff from provincial planning agencies (Bappedas), universities and extension services.

The new CSAR soil map of Indonesia that is in preparation is a compilation of all information available up to 1992. It has a legend of 172 units, defined in terms of associations of sub-orders, *sensu* USDA Soil Taxonomy (1990 edition), and correlated with the National Indonesian Soil Classification (Soepraptohardjo *et al.*, unpubl). The document is intended to extrapolate the experiences gained in former studies in Indonesia and to promote correlation of soils using a pedogenetic approach. The document is very technical and needs interpretation by a soil scientist before it can be properly used for planning purposes. One may, moreover, wonder if the information compiled in this map will effectively meet the requirements for establishing a land suitability map, from which ultimately the effective soil potential and carrying capacity of the soils can be derived. The map (scale 1:2 500 000) and the accompanying report are in preparation, and early publication is foreseen.

In general, it can be concluded that as a result of the number of studies already carried out, and of the mapping history, the lowland soils of Sumatra are relatively well known and characterized, while for major parts of the outer islands and East Indonesia, where access is

difficult and the potential for development is limited, there is only scattered information available.

The situation is less clear in terms of soil inventory methodology. A confusing mixture of principles and methods are currently in use in the country, with varying degrees of differences with respect to concepts and terminology. Initiatives to standardize methodologies and terminology are being undertaken by CSAR. The recent acceptance of a national standard soil classification can be considered as a first step in the right direction.

2.2.3 Land suitability evaluation

Almost no systematic land evaluation work was carried out prior to 1980, with the exception of some work for estate companies, which commissioned soil studies for particular purposes such as suitability surveys for oil palm, rubber or sugar cane, and for the Ministry of Transmigration, dealing with area investigations for new settlements in the outer islands. Soil studies at SRI (now CSAR), with emphasis on crop suitability evaluations, were only introduced in the early 1980s by a UNDP/FAO project, which developed a Land Evaluation Computer System (LECS) program in 1983. This LECS-1 software package is still the basis for present land evaluation research at CSAR. Updating of growth requirements for some 20 crops and different management levels has since been achieved in a LECS-2 version, but little or no validation of data and results has yet been made. This should be done at the farmer-field level. LREP Phase 1 has used the LECS-2 program and holds crop suitability maps in the form of computer printouts for Sumatra. LREP Phase 2 is expected to refine and adapt the crop requirement data, and to provide feedback for validation purposes. In the near future, results from ongoing research work on soil conservation, fertilizer use efficiencies and farming systems may be incorporated in the system.

There is obviously a need to set up a common land evaluation system, which should be used by all agencies in the country dealing with land resource mapping and evaluation.

2.2.4 Soil conservation and catchment area management

Soil erosion in Indonesia is a major problem. Areas particularly sensitive to soil loss and requiring special conservation care are the sloping, intermediate uplands with volcanic ash-based soils, and soils derived from old sedimentary rocks composed of alternating permeable and impermeable layers.

Soil conservation activities in the country have been conceived within the broader framework of catchment area management programmes. Of the 72 million ha of catchment areas under study, approximately 11 million ha — although other sources refer to 13.2 million ha — are considered to be in a critical condition[1], and another 100 000 ha — some sources refer to up to 400 000 ha — is being added each year in the absence of action being taken to reverse the degradation. Main causes for this are the continuing population pressure and unadapted, inappropriate land uses, without proper concern for conservation practices.

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1 Critical land in this context is defined as an area on which the soil is temporarily incapable of supporting permanent vegetative cover, or of regulating its water regime, or both, due to erosion or any other natural or human-induced cause.

In Sumatra, where the population and deforestation are relatively low, erosion rates range between 0.03 and 0.87 mm/year; in Java, with high population densities and intensive deforestation of marginal lands, erosion rates are about 20 times higher, and this has an obvious adverse downstream effect, with increasing siltation of reservoirs, contamination of drinking water supplies, and reduced efficiency of treatment plants.

Since the beginning of the Repelita cycles in 1969, land rehabilitation activities have received high priority at national level, with the catchment area being considered the unit of management. The 1976 Presidential Decree (Inpres) for Regreening and Reforestation is the basis for soil and water conservation activities in the country. It is implemented through an integrated programme involving the Ministries of Forestry, of Agriculture, of Public Works, of Finance, of Home Affairs, the State Ministry of Population and Environment (KLH: Kependudukan dan Lingkungan Hidup)[2], and the National Development Planning Agency (Bappenas). The budget allocations to the project, which are an indirect indicator of the priority given to it, showed an increase in spending from Rp 600 million in Repelita I (1969-74), to Rp 25 500 million in Repelita II (1975-79), to Rp 150 000 million in Repelita III (1979/80-1983/84), dropping to Rp 40 000 million in Repelita IV (1984/85-1988/89) in the face of national budgetary constraints. Additional, external, funding was also provided by ADB, USAID, World Bank and FAO/UNDP for integrated approaches to Upland Agriculture and Conservation (UAC) projects in a number of catchment areas in Java and Bali (Citanduy, Jratunseluna, Brantas, Wonogiri, and Upper Solo Basin).

The catchment area management programme is now concentrated on some 36 to 39 (sources vary) priority catchment areas throughout the country, but with most emphasis on Java and Bali (13 catchment areas) and Sumatra (10 catchment areas). The most intensive implementation of soil conservation activities will occur in 22 super priority catchment areas (including all 13 in Java and Bali, and 6 in Sumatra) due to the high level of infrastructure investment in their respective downstream areas. In connection with this study, a team of research workers of CSAR and Gadja Mada University (Yogyakarta) has produced a Potential Soil Erosion Hazard Map of Java and Bali, at 1:1 000 000, emphasizing the geographical importance of the potentially critical, semi-critical, critical and very critical areas in those islands.

Important feedback can also be expected from the ongoing UAC projects in Central and East Java, and from the related Sustainable Upland Farming Systems (SUFS) research. The purpose of this integrated approach is to develop capacities for producing technologies which promote soil conservation at the same time as increasing farm productivity and farmers' incomes.

Soil conservation is now mainly handled by related Ministries and other agencies, i.e. the Ministry of Forestry, Agriculture , Home Affairs and NGOs. The implementation of the programme is assigned to provincial and district governments through the nationwide Inpres Regreening and Reforestation programme. Project managers are appointed by the Governor and Bupati. Farmers implement the projects in the field under the direction of rural community organizations at village level. Methods used in the programme, which applies to both regreening and reforestation projects, rely on vegetative or structural techniques, singly

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2 Since 1993, State Ministry of the Environment.

or in combination. The regreening projects operate on agricultural land or in areas which will not be designated as state forest land; reforestation projects are those on present or future forest land.

2.2.5 Other relevant soil and land-use investigations

As soil and land use are dealt with by a large number of institutions and agencies in Indonesia (as discussed in Section 2.4.1 below), it is impossible to provide a comprehensive overview here. However, the following are considered as having direct relevance for a national soils policy.

The Soil Fertility and Productivity Research Group at CSAR carries out soil and plant analyses for fertilizer recommendations, with a high capacity laboratory for such routine work. It is directly involved in fertilizer use efficiency activities, based on the evaluation of the nutrient status of the land and on specific crop requirements. The group provides specific fertilizer recommendations for the different agro-ecological zones as a function of cropping systems and yields. Although information on this topic is still limited, the Research Group is fully aware of the adverse environmental effects of overconsumption and inadequate use of fertilizers, mainly in Java.

The Agroclimate Research Group, established within CSAR, is now at the stage of compiling basic information on the parameters affecting crop production and yields in the country. It aims to establish a national agroclimatic database to be used as an input to land evaluation for land-use planning. However, no direct result can be expected from this work in the short term.

Both research teams are involved in the Crop Zoning Programme, and have actively participated in the Working Group on Agro-Ecosystem Research (Kepas: Kelompak Penelitian AgroEkosistem), which takes an interdisciplinary approach, based on soil survey information and fertility recommendations from CSAR, combined with research results obtained from farming systems studies. The philosophy of the Farming Systems Research Group, established for this purpose at the Central Research Institute for Food Crops, is that adapted farming systems provide maximum food production at the same time as taking proper care of the soil. So far, recommendations have been formulated for swamp reclamation and upland agriculture — areas of activity which are among the government's priority items for further development in the next Repelita.

The object of the Crop Zoning Programme is to identify cropping patterns adapted to specific environmental conditions, as well as increasing production through the introduction of new crops or improved crop cultivars, through better land management and an ecologically sound extension of cultivated areas. Hence these activities and the results thereof may well contribute to a better definition of the soil potential and related carrying capacity in the major agro-ecological zones of Indonesia.

2.2.6 Soil types and soil potentials

Soils and soil potential in Indonesia are largely determined by parent material characteristics, climatic pattern and weathering intensity.

The slightly weathered soils of riverine and estuarine plains are most productive. They are of above-average fertility and are frequently used for intensive rice production, especially on Java and Bali. Of similar high value are the lower slopes of volcanoes, where moderately weathered and fertile soils on mixed alluvium, lavas and lahars can also be utilized for either rainfed or irrigated crops, depending on the availability of water. The higher slopes of recently-active volcanoes are often covered by fresh ash deposits, which weather rapidly and are capable of supporting intensive highland agriculture and horticulture, e.g., many parts of the uplands in Sumatra (Takengon, Brastagi, etc.), Java (Cipanas, Lembang, Dieng, etc.), and Bali (Bedugul).

All the outer islands have soils which are deficient in some way. In the drier, eastern parts of East Java and Nusa Tenggara many soils have a high calcium carbonate content, or show vertisol properties which make them difficult to cultivate. In the lowland alluvial plains of Sumatra, Kalimantan and Irian Jaya there are vast swamps of deep, acid peat, edged with saline clays. Raised slightly above those waterlogged areas are extensive, undulating to rolling and hilly plains, with deep and well-drained soils that provide a good growing medium in physical terms, but the substrata have obvious chemical constraints. These are strongly weathered and erodable soils, and most of the fertility is often concentrated in the organic topsoil. Subsoils are strongly acid and leached of nutrients; they commonly have high aluminum levels, which adversely affects yields. Loss of topsoil through erosion, or loss of the organic layer by exposure to the sun following land clearing or arable cropping, quickly reduces the fertility level of these soils.

Other soils, of even lower agronomic value, are those that have developed over materials such as ultrabasic rocks, limestones, quartzites or sandstones, as well as terraces, beach-sands, peat lands and coarse sand deposits of mountain rivers. All have an imbalanced nutrient status, in addition to common problems of shallow depth, stoniness, excessive or poor drainage, etc. These, and the raw, undeveloped and shallow mountain soils, are widespread locally throughout the country.

A more detailed description of the soils of the major islands is given as Appendix 3.

2.3 MAJOR GEOSYSTEMS

Geosystems, in the sense used here, correspond to broad geographical units which constitute an entity in terms of dominant soils and climates, land-use patterns and socio-economic conditions. Their identification and characterization provides a convenient categorization that allows the specific strategies needed for implementation of a national soil policy to be adapted to the particular conditions of each region. Broadly speaking, seven geosystems can be distinguished.

- Java and Bali are characterized by very fertile volcanic soils in the lowlands, and by easily eroded, less fertile soils in the uplands. High rainfall over the year allows extensive wetland rice production, either under rainfed conditions (West Java) or under irrigation (Central and East Java, Bali), with high yields (3 to 4 t/ha or more for each crop). Population densities are high; the average size of farmholding is low; and there is strong competition for land, including for non-agricultural uses. Intensive erosion, limited access to supplies and markets, and inappropriate farming methods

TABLE 1
Major land resource categories in the various geosystems (Source: Adapted from Soekardi, 1989)

Land resource category	Geosystem (areas in '000 ha)						Total area
	Sumatra	Java, Bali, Madura	Kalimantan	Sulawesi	Maluku, Nusa Tg	Irian Jaya	
Cold land	-	-	-	-	-	408	408
Steeply sloping land: —							
— below 500 masl and strongly dissected	4 432	3 576	3 993	2 597	4 047	3 141	21 786
— above 500 masl and moderately dissected	814	1 250	8 055	3 337	4 500	12 284	30 241
— above 500 masl and strongly incised	9 992	1 646	10 471	9 797	2 437	3 606	36 148
Shallow land	48	244	525	368	1 328	321	2 834
Poorly drained land	6 087	2 357	4 274	1 687	852	6 780	22 037
Land with coarse-textured soils	328	172	803	160	217	158	1 838
Land with heavy, cracking-clay soils	-	589	-	44	209	-	842
Land with severe fertility limitations	14 847	1 717	17 742	1 286	453	6 603	42 647
Land with saline or sodic soil limitations	457	128	521	183	476	408	2 173
Land with acid sulphate soil limitations	858	65	1 011	221	237	1 718	4 110
Peat land	6 289	3	4 943	150	-	4 698	16 083
Constraint-free land	2 738	1 472	1 197	741	1 489	1 758	9 395
Rivers, lakes and other	470	-	413	152	54	317	1 405
TOTAL	47 361	13 219	53 946	18 922	16 299	42 198	191 944

have resulted in a generally lower standard of living in the highlands as compared to the lower areas.

- Sumatra has highly weathered tropical soils with poor nutrient status in the uplands, and large swamp areas in the lowlands. It also has extensive lowland areas with acid sedimentary rocks. Rainfall is high over the whole year. Estate cropping with rubber, oil palm, etc., and extensive timber exploitation dominate, at the expense of food production. Population density is low and there is little competition for land. Transmigration settlements produce rice, but primarily for subsistence.

- Kalimantan is dominated by highly weathered tropical soils on the uplands, and hydromorphic lowlands with tidal swamps. Rainfall is mostly high and well-distributed

over the year. Timber exploitation dominates in the inland areas; extensive rice schemes occur in the lowlands. Mining is important. Population densities are low and there is no competition for land. Shortage of manpower can be a local problem. Transmigration settlements are scattered over the island.

- Sulawesi has a very complex soil pattern, including highly weathered and poor tropical soils on the uplands, with more fertile lowland areas. The climatological diversity is high. Annual rainfall is moderate, and the dry season is locally important. Population is unevenly distributed, as is also the pressure on land. Agricultural production is based on a combination of food crops — including wetland rice and dryland, non-rice crops known locally as *palawija* — and estate cropping (coffee, sugar cane and oil palm).

- Nusa Tenggara is characterized by moderately fertile soils on old sedimentaries and limestones. Rainfall decreases towards the East, with an important dry season, limiting production to only one crop per year. Water availability is the dominating factor in agriculture, and recently there has been a strong tendency to replace food crops that have a high water demand, such as paddy rice, by more economic and market-oriented products. Cattle-raising is important, especially in West Timor.

- Maluku is dominated by highly weathered soils although there are some volcanic islands. Rainfall is high over the year, without a pronounced dry season. Population density is low and so is the pressure on the land. Sago is the common staple food. Timber exploitation is important.

- Irian Jaya is dominated by highly weathered, poor, tropical soils, and has a rough topography in the central mountain range. It also has extensive wet tropical lowlands. Sago is the main staple crop. Population density is usually low, except in some fertile inland valleys; in most areas, however, there is no competition for land. Transmigration settlements are scattered. Timber and mining activities are relatively important.

Table 1 summarizes areas of land resource categories in the major geosystems.

2.4 INSTITUTIONS

2.4.1 Institutional responsibilities

Institutions and agencies which, at national level, deal with soil and land use affairs, ranging from soil survey and data collection to land titling and policy making, are numerous in Indonesia.

In general terms, the core agency for soil survey and data collection in the country is CSAR in Bogor, but many of its activities are either complemented or overlapped by others, in particular the Soils and Geography Departments of various universities, as well as BPN through its mapping division, Bakosurtanal, and the national and international consulting firms involved in projects for the Departments of Agriculture, of Forestry, of Public Works, of Transmigration, etc. All of these carry out work in soil survey and analysis, land suitability evaluation, soil conservation, and so forth.

A common practice observed in recent years is that non-departmental agencies, such as BPN, Bakosurtanal and others, which due to their administrative position are mandated to coordinate activities of CSAR and other institutions, have now started to involve themselves in soil survey and related activities without having the full scientific background and technical expertise to do so. Such a situation is likely to increase the general confusion over terminologies and the lack of standardization of soil information, as discussed in more detail in Section 3.4.1 of this report.

In terms of development of soil policy, an important role is allocated to the State Ministry of Agrarian Affairs/BPN, LH/Bapedal and the State Ministry for National Development Planning/Bappenas. The latter has mainly a coordinating function, and its role is largely implemented through the National Development Planning Agency (Bappenas: Badan Perencanaan Pembangunan Nasional) which, although being an independent body and reporting directly to the President, is working closely with the State Ministries. Bappenas deals mainly with the conceptual aspects of planning, including land-use planning, and has links with the different sectorial Ministries, as well as with BPN and with the Spatial Planning Working Group. Bapedal is a recently established agency for the implementation of environmental impact assessment (AMDAL: Analysis Mengenai Dampak Lingkungan) as a tool for sustainable development and pollution control in the country.

The Ministries of Agriculture, of Forestry, of Public Works, and of Mining and Energy have an operational responsibility for the different sectorial aspects of soil and land use. All of these line agencies have links with Bappenas, through which most projects with national and international funding are channelled for budget allocations by the Ministry of Finance. Similarly, the Ministry for Transmigration is responsible for the Government of Indonesia Settlement Programmes in the outer islands, and for this it receives advisory inputs from consulting firms, as well as from other ministerial departments.

Bakosurtanal is a non-departmental body with special tasks referring mainly to base mapping, but it occasionally is involved in soil and land-use studies, as indicated above.

The Ministry of Home Affairs channels most of the national policy decisions for implementation at provincial and district levels through the Bappeda structures. For technical or sectorial matters, the Bappedas can call on provincial offices [kanwils] of the different line ministries and BPN. Hence, the Ministry of Home Affairs has mainly a functional responsibility.

The impact of the Ministry of Education and Culture within the framework of this study is mainly limited to the training of university graduates, who are to establish, disseminate and implement the future soil policies. Additionally, some of the research aspects in the fields of soil survey, classification, land evaluation and soil conservation, are also dealt with at university departments.

The National Spatial Use Management Coordinating Board is a newly created body, which has been coordinating the implementation of the Spatial Use Management Law 24/1992. The Coordinating Board is now concentrating on preparing the guidelines and regulations for a full implementation of this Law. It is expected to take the lead in preparing the first National Spatial Plan under the new law, and in reviewing the Plan in conjunction

with the Five-Year Planning cycle. Regional Spatial Planning teams have been formed at some provincial and kabupaten levels, with corresponding functions.

The specific mandates of these agencies, in so far as they deal with soil and land issues, and the institutional arrangements for coordinating their activities in their various spheres of responsibility — both horizontally at national level and vertically between national and lower levels of government — are examined in more detail in Sections 2.5.3 and 2.5.4.

2.4.2 Development assistance projects

A large number of development assistance projects have been implemented in Indonesia, most of them administratively coordinated by Bappenas, but some with direct links with the sectorial or line ministries, such as, for example, the Ministry of Transmigration. These prominent, externally-assisted projects (together with their supporting agencies) with a soil conservation or land-use component operated under the umbrella of Bappenas or the Ministry for Transmigration include:

- Provincial Area Development Programme on steep-land use, traditional irrigation and agricultural development in Aceh, West Java; Bengkulu, South Kalimantan; and Nusa Tenggara (USAID, 1979-87);
- Yogyakarta Rural Development Project (IBRD, 1980-89);
- Agricultural and Environmental Development Programme for the West Pasana area, West Sumatra (GTZ, 1982-88);
- Aceh Area Development for salinity, soil protection and drainage structures (Government of the Netherlands, 1982-89);
- Agricultural and Irrigation Development of Citanduy area (USAID, 1983-88);
- Sulawesi Integrated Development Project (CIDA, 1984-90);
- Central and East Java Upland Agriculture and Conservation Project (USAID + IBRD, 1984-93);
- LREP-Land Resources Evaluation and Planning project for Sumatra, coordinated by Bakosurtanal and the BPN (ADB, 1985-91);
- Nusa Tenggara Agricultural Support Project (AIDAB + ADB + IBRD, 1986-91)
- Nusa Tenggara Integrated Area Development Project on food crop development, dryland agriculture and land conservation and rehabilitation (AIDAB, 1986-91);
- Nusa Tenggara Agricultural Development Project for Irrigation, Land and Water Conservation (ADB, 1989-95);
- Sulawesi Regional Development Project on Critical Land Rehabilitation and Conservation (ADB, 1990-95);

- Yogyakarta Upland Area Development for slope stabilization and dryland agricultural development research (IBRD, 1991-96);

- the various IBRD, IFAD or ADB-sponsored resettlement projects for transmigration, based on various fundings, since 1977.

In addition, there have been some bilateral technical assistance projects, including:

- Environmental Management Development in Indonesia (EMDI), operating within the Ministry of State for Population and Environment, sponsored by CIDA-Canada (1983-ongoing), and aimed at upgrading environmental management capabilities through institutional strengthening and human resource development;

- the New Zealand-supported soil and land mapping project, linked to the agricultural upland conservation scheme in the Upper Solo basin;

- the inter-university cooperation projects for soil survey and soil fertility assessment, sponsored by Belgium, and based at CSAR-Bogor (1975-85) and Gadjah Madja University in Yogyakarta (1986-ongoing);

- the Swamp Development Project of the South Korean Governmental Aid Agency, including feasibility studies and detailed engineering design in Pemali Floodplain, Bandar Lampung, Manado, etc.

Indonesian and foreign-sponsored NGOs are mainly active in community development activities. These often include soil conservation studies, irrigation design or assistance in farming systems, and are in particular operated by organizations like Alfa-Omega, Yayasan Dian Desa, Yayasan Indonesia Sejahtera, or Plan International.

2.4.3 Government and public awareness

Government awareness of soil and land issues, and of the need for ecologically-sound and sustainable soil use, is important. Indonesia has a long-standing commitment on environmental issues, with LH being active for the last decade.

At national level, LH provides strong leadership and is represented on almost all committees which deal with land issues. The Basic Forestry Act 5/1967 has created protected forest zones or has imposed rules limiting production in other areas. As a result of lessons learnt from the environmental damage resulting from the first phases of the transmigration programme, more attention has now been focused on environmental issues in the resettlement programmes.

Law 4/1982 on the Basic Provisions for the Management of the Living Environment, Government Regulation 29/1986 on the introduction of Amdal (environmental impact assessment), as revised by Government Regulation 51/1993, and Presidential Decree 23/1990 for the establishment of Bapedal, are all strong indications of government willingness to introduce the principles of sustainability into the nation's activities. All new companies and factories starting activities in the country must now comply with the new AMDAL regulations.

In the public arena, environmental concerns are aired in the national press, and the Indonesian Environmental Forum (WALHI) has campaigned over the last decade to raise public awareness and to build an increasing environmental consciousness.

At provincial and kabupaten level, however, both official and public awareness are definitely much weaker, and often depend on the direct involvement of individuals rather than on a well-defined policy.

Finally, sustainable land use at the farmer level sometimes does not exist, for two main reasons: first, in a society where food production and subsistence are the primary daily concern, little or no room is left for long-term speculations without direct guarantees for a better living; and, second, because almost no enforcement exists, either legal or moral, to implement regulations or to punish offenders.

In fact, although impressive results have been obtained in government-sponsored erosion control demonstration plots, they rarely last because too often the land users do not understand why the work is done. Usually these undertakings are seen as government activities, which have been planned and installed by the government, and farmers see no reason to maintain them at the end of the project unless paid or forced to do so.

2.5 LEGISLATION

2.5.1 Law-making in general

Based on the Independence Constitution of 1945, the general framework of Indonesia's government has been progressively elaborated, so that today a comprehensive structure distributes functions, powers and duties between the four levels of government — national, provincial, district or municipality, and village. In the process, the early emphasis on centralized controls has given ground to a policy of strengthening the authority and capacity of government below the national level. In the field of development planning, since the mid-1970s, planning boards and coordinating committees have been operating at the lower levels of government, and representative assemblies and executives reflect — at province, district and village levels — the government organs found at the national level.

The supreme body under the Constitution is the Peoples' Consultative Assembly (MPR: Majelis Permusyawaratan Rakyat), which meets every five years to determine the broad guidelines of state policy (Figure 2). The MPR is made up of the elected members of the [National] House of Representatives (DPR: Dewan perwakilan Rakyat), plus other members appointed under regulations. It elects the President, who is the Executive Head of Government in charge of its day-to-day administration. The President appoints ministers, and makes statutes with the approval of the DPR. The DPR may itself submit draft statutes, but these require the President's ratification to become law. The practice is for statutes to lay down only broad principles on the subject at hand, and for the details and machinery for the law's implementation to be handled by an accompanying Elucidation, and later Regulation and Decree. A large body of law derives from such executive action.

At provincial level there is a corresponding organization (Figure 3). The Governor is appointed by the President, on the advice of the Regional (District or Provincial) House of

FIGURE 2
Structure of Central Government

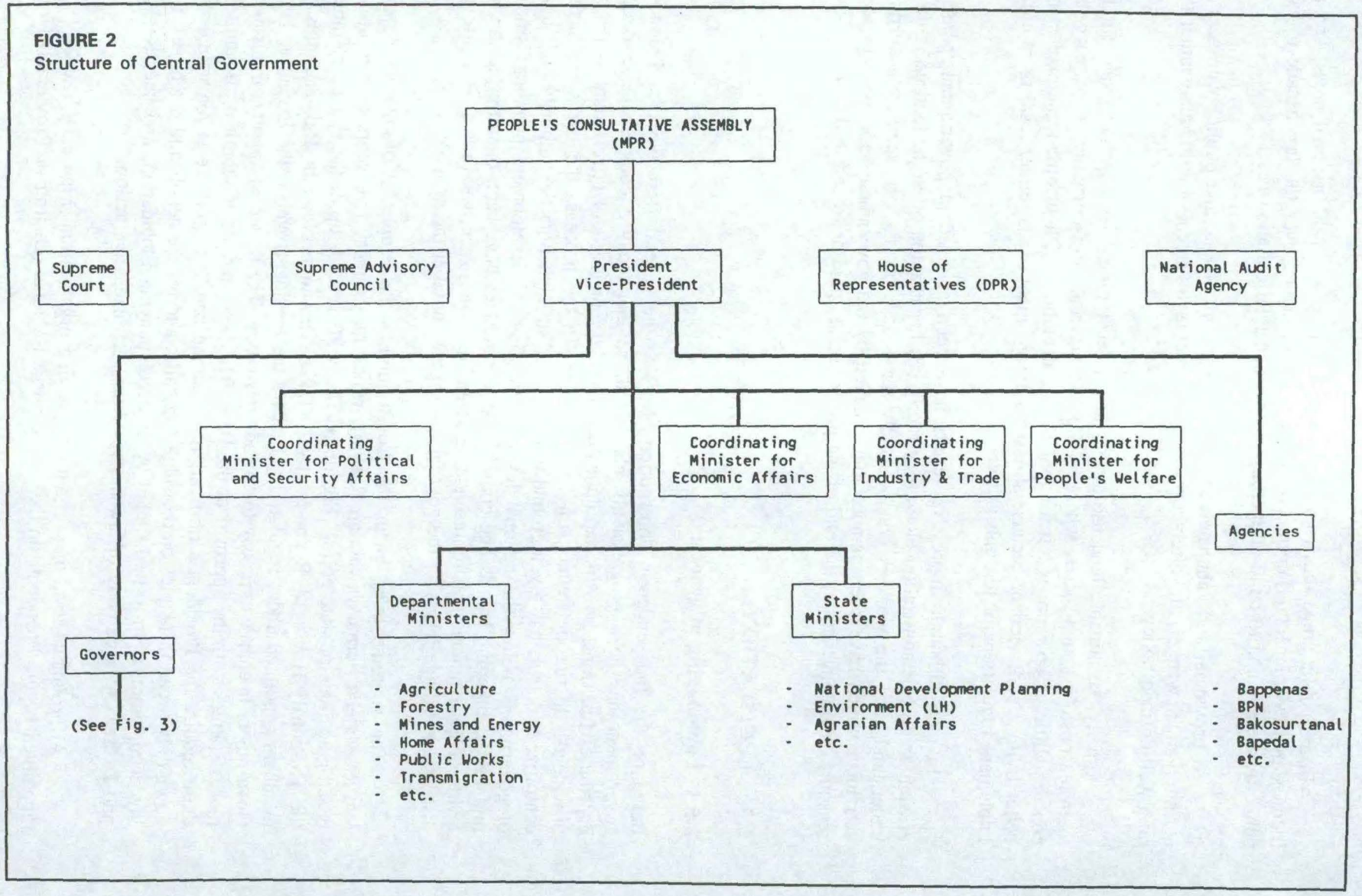
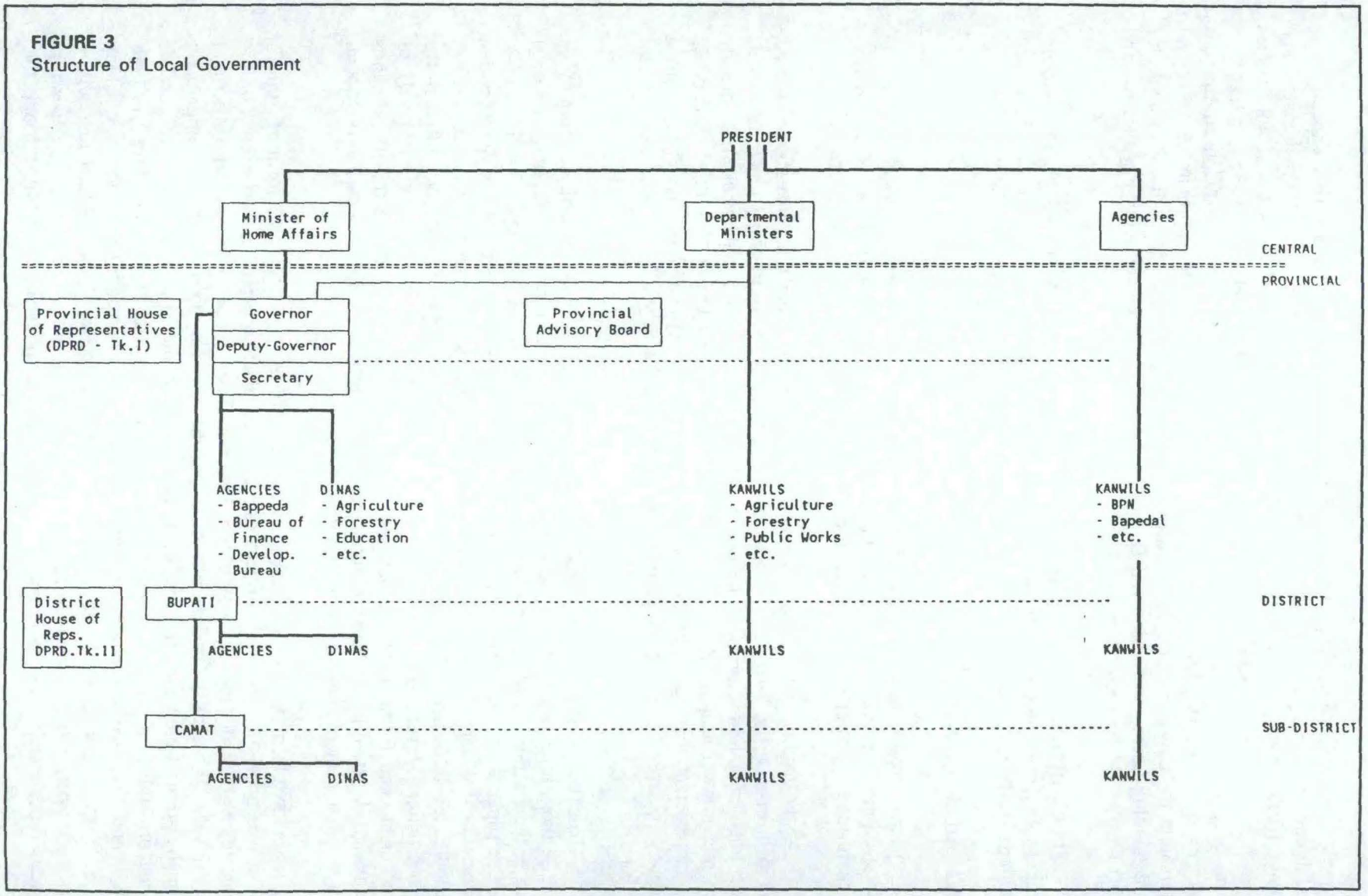


FIGURE 3
Structure of Local Government



Representatives (DPRD). This body works with the Governor in an advisory capacity, and collaborates in making regulations. Similar arrangements are found at district [kabupaten] and village [desa] levels (although the village bodies have no law-making powers), with bodies at each level being responsible to the corresponding authority at the next higher level. In terms of laws, a general hierarchy of legal authority emerges as follows: (i) Constitution; (ii) Decrees of MPR; (iii) Statutes, made by the President with the approval of DPR and equivalent to 'Laws' in English; (iv) Government Regulations, made by the President, for implementing Laws; (v) Presidential Decrees; (vii) Provincial Government Regulations; and (viii) District Government Regulations.

In the light of this broad concept of law and conceptual framework of legal powers, the laws which are important for a National Soil Policy can be examined under three main headings, namely administrative law, land law, and resource management law.

2.5.2 Administrative Law

Two specific aspects need to be noted under this heading: arrangements for distribution of responsibilities between agencies at the national (i.e., horizontal) level, and (vertical) mechanisms for power-sharing between the national and lower levels of government.

At the national level, Ministries or Departments are either Coordinating Ministries, State Ministries or Ordinary Ministries. State Ministries have overarching functions, but no direct implementation responsibilities or apparatus. In general, the mandates of Ministries are spelt out in laws: usually Ministerial Decrees, but sometimes Decrees by the President. In this incremental way, a large and complex bureaucratic system has developed, with a tendency for areas of authority to overlap. This is particularly felt at lower management levels.

Under the Basic Law on regional administration (5/1974), local government authorities exercise those powers which are granted to them by the central government, and they must manage their affairs in accordance with regulations made at national level (Morfit, 1986). The key supervising authority is the national Ministry of Home Affairs, which oversees and supports local government agencies and acts as a go-between in relations between national and lower levels. Since 1981, there has been a push for 'bottom-up' planning, although the role of national-level agencies in granting the exercise of authority to lower levels of government, and formulating the policies which guide the use of that authority, remains paramount. A network of officials ensures that national agencies are represented at provincial level through kanwils, and at district level.

Meanwhile, provinces have their own administrative capacity in the form of 'dinas', i.e., offices providing sectorial services (agriculture, education, public works, etc.) within the province and under the authority of the Governor. They, too, can be found at district and lower levels. Whereas kanwils are funded by the national government and implement nationally-administered programmes, dinas are funded by the local government concerned, and perform functions only on its behalf. Duality is present here as well, however, for both kanwils and dinas are accountable to both the head of the administrative service they belong to (i.e., respectively national and provincial), and to the head of the political unit within which they operate (i.e., the Governor in a province or the Bupati in a district), depending on what functions they are performing. The principal characteristic running through this

complicated system is that it is a hierarchy of power, and while controls are applied downwards and sideways, they are never applied upwards.

Clearly, the distribution of powers outlined above, between agencies at the national level, and between the national and lower levels of government, could not function without effective coordinating mechanisms, and a number exist in the Indonesian system. In the first place, there is the central planning system, with its successive Five-Year Development Plans (Repelitas) based on the Broad Guidelines of State Policy (GBHN: Garis-garis Besar Haluan Negara) passed by the MPR. The Repelita is prepared by the powerful Bappenas, and is made up largely of government development programmes, providing directives for the development process but not a detailed blue-print for implementation. For the government sector, the details are spelt out in annual National Budgets, but the Repelita sets the broad context for activities in both the government and private sectors. At the provincial and the district levels corresponding arrangements are made, with Repelita Daerah being formulated by Provincial and District Development Planning Agencies (Bappedas: Badan Perencanaan Pembangunan Daerah), but in their case constrained by the national priorities, as set out in the GBHN and the Repelita, and implemented by the National Budget. It is a system for coordinated planning, but one which depends heavily on direction and funding from the top.

Another coordinating mechanism is the national civil service. Under the operative law a clear delineation of powers is drawn between the different levels of government and the different agencies, and careful provision is made for how authority is devolved to lower levels (MacAndrews, 1986; Morfit, 1986). Thus, a provincial government is given full authority to administer its own area according to the overall laws of the country, for which purpose functions can be transferred from the national to the provincial government [decentralization]; the provincial government can be authorized to exercise national government functions [co-administration]; or there can be a full delegation of decision-making powers in an area to the provincial government [deconcentration]. With a single civil service, all of whose members are committed by the concept of mono-loyalty to the implementation of government policy, the appearance is given of a highly structured framework, with an emphasis on unity, the common interest over individual rights, mutual assistance, consultation (often informal), and decision-making by consensus — all of which are features which commentators have attributed to traditional Javanese culture.

To its credit, the system has sustained national stability and law and order, handled large-scale development programmes, and managed major shifts in government policy. The present need for a greater devolution of powers over the management of land, forests and other natural resources to village and community level will test again the delicate balancing act being played out between the goals of strong central control and effective local participation. New demands will be placed on the bureaucratic mechanisms for coordination of policy-making and implementation.

2.5.3 Land law

With its heavy reliance on agriculture, the sustainable use of land is vital to the Indonesian population, and control over land has been a political as well as an economic issue of the highest order since well before the formation of the State. The Independence Constitution of 1945 installed the underlying philosophy of the new land tenure system, whereby land and other natural resources were to be controlled by the State, and made use of for (Article 33)

"the greatest prosperity of the people". The accompanying Elucidation emphasizes the clear break from the past, e.g., prosperity of the community is stressed, not prosperity of the individual. In this regard the Indonesian land system is seen as being distinctive from western systems, with their emphasis on individual property rights and freedoms to dispose of land.

The new system was introduced by the Basic Agrarian Law (BAL) which in 1960 was an ambitious charter for land reform, seeking "first of all to do away with dualistic land policies and to ensure greater justice for the small farmer and the landless in access to this resource." Individual rights to land and customary law [adat] rights were recognized and respected, but the social function of land was given first priority in all circumstances. The 1960 law also stated that land had to be registered and that absentee ownership of land, as well as excessive ownership and control of land, was to be done away with. Specific mention was made of maximum and minimum sizes of holdings; the ceiling provisions, as defined in subsequent regulations, were based on population density in the various regions. The law also made reference to the need for "proper utilization and conservation of all land resources." (Tjondronegoro, 1991).

Among implementing regulations were those setting up a land registration and titling system, which constitute two separate steps in Indonesian law, while others were concerned with land redistribution and establishment of Land Reform Committees, with representation from farmers' associations as well as from government departments.

The BAL laid down the basic land rights which the State would recognize (reinstating in the process the centrality of adat tenures), and provided for conversion of existing colonial titles to their closest equivalents under the new tenure system. Only Indonesian citizens could hold the right of land ownership, although all rights were subject to overriding State control, so as to protect the public interest. Thus, unless rights in the land are recognized by law, the State is free to dispose of that land. If a person does have recognized rights, but they are forfeited under the law, the land returns to unfettered State control, free to be reallocated. In a developmental context, the State can authorize a change in the occupation and use of land, although it has no title in the land.

This is not to say that private property rights are ignored: specific provision is made for the payment of compensation if land rights are annulled "in the public interest." But even under western property rights systems, compulsory acquisition of land for compensation is seen as an essential adjunct of a state's sovereignty over its resources. In the Indonesian situation, the State's authority over land transcends ownership, and ensures that the real centres of decision-making over land are located in the executive government. Allocation of resources, and land in particular, becomes a matter of competition between sectorial departments, each seeking to expand its territory, while at the same time protecting it from the depredations of others. It is not a situation likely to produce optimal land use.

The BAL recognizes several forms of titling, e.g., the rights of ownership [hak milik], exploitation [hak guna-usaha], building [hak guna bangunan], use [hak pakai], lease [hak sewa], the right of opening up land [hak membuka tanah] and the right of collecting forest products [hak memungut hasil hutan]. Other secondary rights are recognized, such as the right of mortgage [hak gadai], share-cropping [perjanjian] and of lodging [hak menempati]. There is also a special title for local governments and State-owned bodies, i.e., the right of management [hak pengelolaan].

It should be noted that it is possible to hold one of the main forms of title listed above, either as a result of proving the right concerned in the course of first registration of the land, or as a result of a grant of the right by the Government. By Article 15 of the BAL, all persons and bodies holding land rights are responsible for improving fertility and preventing deterioration.

Registration of title, which is done automatically upon a government grant of land, but in other cases must follow a lengthy procedure beginning with an application, provides the title-holder with strong evidence, backed by the government, of the legal interest in the land. Interests in unregistered land are, of course, always vulnerable to challenge. Much of this land may be being held quite securely under adat law, but there are obvious limitations on its negotiability and use for credit purposes, and, if the land is undeveloped, it is liable to a Government claim that it is unowned. Such may be the case, for example, with forested land which by definition comes under the management regime of the Ministry of Forestry.

The enormity of the task involved in implementing such an ambitious reform programme of land redistribution and title registration has meant slow progress over the last thirty years. The fact that much of Indonesia's land still remains in a transitional state awaiting the determination of an appropriate replacement title in the case of former titles, and awaiting registration in the case of the bulk of adat land, has caused ambiguities. The former dualism between western and adat tenures has been replaced by another dualism between land registered under the BAL and unregistered (mainly adat) land. The enforcement of controls (e.g., on land speculation and absentee landlordism) has proved difficult under an organizational structure which has lacked resources for the task in hand. At the same time, people's title to unregistered land can be easily overridden. To strengthen administrative capacity, the National Land Agency (BPN) was established in 1988. This new body has the mandate for land titling and registration, and a role in land-use planning which has still to be clarified. Meanwhile, Tjondronegoro (1991) has noted that BPN's effectiveness may be compromised by its reliance on the Ministry of Home Affairs for enforcement, and the failure to replace the disbanded Land Reform Committees, which had previously ensured a two-way communication with farmers and thus extended the land reform capacity to the level of the land users.

2.5.4 Resource management law

In 1985 the then existing legal and institutional framework for soil conservation in Indonesia was reviewed, and a draft Soil Conservation Act was produced for Government's consideration (FAO, 1987). Given the recent date and comprehensiveness of that review, the main task for present purposes is to draw attention to its relevant findings, and update the information to take account of later developments. Each of the major resource sectors of forestry, mining and water has its own basic law, and, more recently, cross-sectorial laws for environmental protection and land-use planning have been introduced.

With minor exceptions, all forests in Indonesia are held and controlled by the State "in trust for the people." Under the Basic Forestry Law of 1967, a general plan for forest resources development and conservation was prepared, whereby forests were classified as:

- protection forests, being mainly forests on steep slopes or at higher elevations, which must be protected for soil and water conservation purposes;

- production forests, being those to be used for timber production;
- forest reservations, i.e., nature and wildlife reserves; or
- conversion forests, being forest areas deemed suitable for eventual conversion to non-forest uses.

Exploitation of production forests is subject to concession agreements, which require operators to comply with management plans. Soil conservation is specifically made the responsibility of the concession-holder, although non-compliance does not necessarily mean revocation of the concession. Concession-holders are required to protect forests from human encroachment and damage by fire. At the same time, traditional rights of neighbouring communities to collect forest products are to be respected. An expansive view of what qualifies as forest land has led to conflicts between the Ministry of Forestry and villagers, and also to conflicts with other government agencies (notably the Ministry of Transmigration). Meanwhile, the Department of Forestry preserves its territory by a requirement that any conversion of forest land to other purposes must be replaced by at least the same area of newly-planted trees. Many calls have been made over the years for a better definition of forest land, and a more useful system for the classification of forests. Enforcement of logging controls in the forest legislation is notoriously weak, and probably the basic law requires review to bring it into line with more modern perceptions of the multiple roles of forests and the potential for improved management, including through community participation (Richardson, 1990).

Mining, including oil and natural gas production, is subject to the Basic Mining Law of 1967. The environmental impact of mining is obviously considerable, from the violation of the earth's surface and vegetation down to the underground hydrology, and through the deposit of overburden and tailings on land and into rivers and seas. Conflicts arise between the interests of mining on the one hand and forestry and agriculture on the other (Donner, 1987). The Basic Mining Law requires the holder of a mining licence to be responsible for ensuring the preservation of soil in the area affected by the licence, but, as with forestry concessions, it seems that revocation of the licence for breach of this requirement seldom occurs. The sectorial law itself is seriously lacking in effective environmental safeguards, so to the extent that safeguards exist, they must be found elsewhere.

The prominence of irrigated ricelands [sawahs] in Indonesian agriculture has given rules for water distribution a long history. Much of the regulation issues from local government, covering such matters as cultivation plans, water allocations, maintenance of waterworks and drainage systems, and penalties for the inefficient use of water. The Basic Water Law of 1974 makes provision for soil conservation, including through reforestation and erosion control. The Ministry of Forestry started work in 1987 on a draft Law on Soil and Water Conservation, but this was later suspended in view of the Government's preparation of the Law on Conservation of Living Resources (see below). While this Law, introduced in 1990, would give some protection to soil and water, it does so only as part of plant or animal habitat, and only in zones declared as nature conservation areas or sanctuary reserves. The new Law is thus not a law for soil conservation, however, the new Spatial Use Management Law calls for the erection of government regulations concerning land use management. This could make use of the 1987 draft Law on Soil and Water Conservation.

With the appearance of a succession of sectorial laws during the 1960s and early 1970s, each with their battery of implementing regulations, coordination was becoming a

problem, and in 1976 a Presidential Instruction was issued to Ministries for coordination in the fields of agrarian affairs, forestry, mining, transmigration and public works. It did not, however, produce a noticeable improvement. Since the early 1980s, a new range of laws has appeared, concerned not with single economic sectors, but with the environment generally. The first of these was the Basic Environment Law of 1982, which imposed a duty on the whole public to prevent and abate environmental damage, supported by stiff penalties for abuse (up to ten years imprisonment). Licences granted in future by the Government for the operation of 'enterprises' were to be conditional upon the licensee not impairing the "capability of the living environment to support continued development." The generality of the words used by the Law in imposing these duties has led to doubts being expressed over their enforceability, for example in the case of farmers cultivating and irrigating their land, sugar estate operators, timber concession holders and persons grazing stock on pasture lands (FAO, 1987).

The then newly-created (1978) KLH had the function of assisting the national coordination of institutions involved with environmental matters, and of improving government's environmental performance as a whole. KLH, now LH, has no line agency responsibilities, and therefore it was pointed out that, in carrying out this extremely ambitious task, the Ministry is limited by its lack of official authority over other ministries, by its lack of influence over the budget process which generates line agency priorities, and by its own organizational structure, shortage of technically trained staff and small budget (World Bank, 1990). To boost its executive capacity, a pollution monitoring and control agency (Bapedal) has been established by Presidential Decree, with wide-ranging powers, including the ability that may result in the taking of polluters to court. As well as pollution control, Bapedal is responsible for hazardous waste management and AMDAL.

Regulations made in 1986 and 1988 provided for the obligatory preparation of Amdals for all projects likely to have a "significant impact" on the environment. This too is an ambitious undertaking, and there is an obvious danger that weak implementation will damage the credibility of the Amdal process. In this context, the World Bank (1990) has suggested considering a phased introduction of the process, with particular emphasis being placed on establishing viable environmental institutions at the provincial level.

Most ministries now have an environmental assessment unit, and there is a greater appreciation of the fact that the environment is not just the responsibility of one department, since all ministries are affected in some way by ecological deterioration (Hardjono, 1991). The general impression seems to be that the policies and legal structures for environmental damage control are basically in place, but that the key test will be whether the controls are consistently enforced. The main vehicles for enforcement are intended to be through control over the issuing of the permits and licences necessary for any major development project to proceed in Indonesia. The threat of their suspension or cancellation for failure to comply with environmental safeguards could be an effective deterrent, but this will largely depend on the attitude of the sectorial department concerned. In this context, it may be recalled that Bapedal itself has no policing powers, so it is up to the agency which issues the permit or licence to enforce satisfactory environmental standards, and this may not prove to be a reliable system for enforcement.

In 1990 the Law on the Conservation of Living Resources was passed. Its three main purposes are protection of life support systems, preservation of plant and animal species, and

sustainable utilization of living resources (Article 5). Provision is made for preservation to take place in different types of sanctuary reserve, while sustainable use is the goal in different types of nature conservation areas. There are heavy penalties for changing the natural integrity of reserves, degrading their functions, or acting inconsistently with "the function of utilization" in nature conservation areas. Vague as these formulas are, they only apply to areas declared under the Law. No provision is made for meaningful participation by villagers living in such areas, and the Law in general takes an old-fashioned approach to nature conservation.

While government has been attempting to restore the balance where environmental damage has already been done, and to prevent further degradation, another major initiative in resource management at the macro-level has recently emerged in the form of the Spatial Use Management Law, in the course of being enacted at the time of the present mission. The BAL in 1960 had called for preparation of a national land-use plan, but like much of that Law's broad reform charter this goal remained largely unrealized for over thirty years. Land-use planning was in fact being undertaken piecemeal by a very large number of agencies, leading to many inconsistencies and conflicts. A major problem arose from the Ministry of Forestry's land classifications system, which committed land to certain purposes upon the basis of the four forest types noted above, and thereby frustrated optimal land use from either an economic or environmental point of view (World Bank, 1990). Meanwhile, competing demands on land tended to be solved on an *ad hoc* basis (e.g., by Presidential Decree), as the need arose (FAO, 1987).

Faced with a virtual impasse as a result of the fragmentation of land use planning responsibilities, the Government set up a ministerial-level commission, chaired by the Minister of State for National Development Planning/Head of Bappenas and including the head of BPN and several Ministers, to review institutional and policy issues related to spatial planning. The result of their work is the Spatial Use Management Law, gazetted on 13 October 1992. As is the law-making practice in Indonesia, the new Law is largely confined to laying down the broad principles and procedures for land-use planning, leaving the detailed provision for its implementation to be handled by later regulations. The scheme of the legislation faithfully follows the familiar Indonesian hierarchy of authority. There are three levels of Spatial Plans — national, provincial and district or municipality. The National Spatial Plan lays down the basic strategies and policy directions for space utilization nationwide, identifying the areas designated primarily for environment protection, those for cultivation, and special areas of "strategic importance." The Provincial Spatial Plan is an "elaboration" of the National Plan into strategies and spatial "structures" for the province, while the District Spatial Plan elaborates the provincial Plan into the actual implementation strategies for the district. A national Minister (yet to be identified) will be responsible for coordinating the whole operation, and, presumably, for overseeing preparation of the National Plan. At provincial level the Governor has overall responsibility, and at district level the Bupati. Planning at each level is to be conducted by the Government "with community participation", but it is to be based on the "provisions of applicable legislation" (Articles 12 and 13). Any necessary further guidelines and procedures are to be spelt out in Government Regulations.

The new Law makes clearer-than-usual provision for the effects of the Plans. They are first of all a guide for formulating land-use policies at the next lower level; for integrating development between sectors; and for the location of public or private sector investment. At

district level, where actual implementation of the Plans' contents mainly takes place, they are to be used as the basis for issuing development location permits (Article 22/4) and, in a welcome move towards more prescriptive law-making, by Article 26/1, any location, building or activity permit issued in contravention of a Plan is "null and void." The plans are quite long-term — 25 years for the National Plan, 15 years for the Provincial Plan and 10 years for the District Plan. They are to be reviewed as part of the Five-Year Planning cycle, and in general a change in an area's function (e.g., from protection to cultivation) can only take place in the course of such a review (Article 29). There are still many 'grey' areas which need to be clarified, hopefully by the set of Regulations currently being prepared. Until these emerge, it is not possible to judge how far the Law will achieve its objectives of integrating land-use planning, and gaining broad community participation in the planning process. Also, it remains to be seen whether the instruments for enforcing spatial planning, such as those identified by the World Bank (1990), e.g., licensing, zoning and taxation, will be integrated and simplified, as recommended. One agency must take the lead in coordinating regional planning and mediating land use disputes. At the time of writing, this lead agency had not been identified, pending a decision on which Minister will be responsible for overall coordination of the new Law's operation.

Chapter 3

Problems and policy issues

3.1 INTRODUCTION

Soil policy refers mainly to technical, institutional and legal issues. Because in Indonesia the population pressure is of overriding importance in all the nation's activities, due attention has also to be paid to the social dimension of the policy.

Technical issues deal mainly with soil and land-use inventories and assessments, terminology, soil management and reclamation aspects. For each of those, both research and implementation conditions have to be considered. Institutional issues include the further development and updating of policy, the development of strategies, programmes and projects, and the identification of requirements and implementation of programmes for research, education, training and extension. An institution may hereby fulfil more than one function, while under other conditions several institutions can be engaged in the same function. Legal issues cover the effectiveness of existing legislation, including both the law itself, its enforcement, and the need for changes. Appropriate legislation must, moreover, be backed up by educational measures of various kinds, designed to reach all sections of the community, explaining the ideas behind the policy, as well as by regulations for implementing the legislation. In Indonesia, the informational aspects are generally covered by the Elucidation of the Law.

3.2 SOCIAL ISSUES

The high population pressure in Java, Madura Bali and Lombok, and the rather low settlement density in the outer islands, as noted in Section 2.1.4 above, have resulted in completely different land-use patterns and varying environmental disturbances in the various areas.

In Java and Bali there is competition for land, and landholdings are small (< 1 ha/family). Lowland areas are intensively cultivated and farmland is frequently lost to city expansion. In a search for new land, less fertile uplands are cleared from forests, and steep slopes are taken into cultivation without adapted soil conservation practices.

In the outer islands, where population densities are low, agriculture is comparatively limited, although it often operates over large surfaces through shifting cultivation. This practice, together with inadequate controls on timber exploitation, exposes large areas of land and is consequently the cause of important erosion phenomena. A major problem is soil exhaustion through the continual cropping of unfertilized fields.

3.2.1 Urban development and encroachment on agricultural land

Natural population growth and movement from rural to urban centres will mean that most of the expected 2.3 million entrants to the labour market each year must be absorbed by the cities. Employment generation is therefore mainly to be sought in the development of services and industry, as no more absorption is possible in Java's agriculture.

In 1980, 22% of the population already lived in urban areas. Major cities in Java were expected to double in size between 1980 and 2000, and this will result in encroachment on first-quality farmland, primarily sawahs. At present, it is believed that about 50 000 ha/year are lost to city expansion — a situation which obviously affects land prices in periurban areas and encourages speculation. Hence, many small farmers in the neighbourhood of expanding cities are prepared to sell their lands, and there is no regulation to prevent this evolution.

City and industrial expansion create additional problems of pollution, sewage and waste disposal. These will be discussed in more detail in Section 3.3.

3.2.2 Traditional farming systems

In Java and Bali, subsistence farmers are forced to cultivate more and more of the less fertile and erosion-sensitive uplands in order to survive. At the same time fields are being abandoned due to soil erosion and fertility depletion. This has resulted in illegal forest clearing and the cultivation of land on steep slopes. The poor farmers in those areas, most of whom have not completed elementary school, usually pay little attention to soil and water conservation practices, and this results in both gradual loss of soil productivity in the uplands and increased flooding and siltation in the lowlands.

In the sparsely populated rural areas of the outer islands, the chief agent of environmental disturbance, and of increased soil erosion in particular, is traditional shifting cultivation. As population densities rise in these areas, there is a corresponding tendency to shorten the fallow period. Land is used more intensively, and the natural processes of soil regeneration are not given time to operate.

In addition, increased pressure on the forest cover of the outer islands comes from the Transmigration Resettlement Programme and by the intensive timber exploitation which, according to a 1990 World Bank report, is now causing between 900 000 and 1 million ha/year of forest clearing.

The main reason for erosion and soil loss is therefore human activity. As a result of these inappropriate farming systems, an estimated 4.4% of the total land area in Indonesia is in a seriously eroded or critical condition.

3.2.3 Actual strategies and programmes

A successful programme of family planning has reduced population growth to almost 1.9% nationally, but even so there is need for increased production in order to maintain food self-sufficiency. This need increases at a rate greater than the crude population growth rate, as living standards will continue to grow and average food requirements per caput will increase. Moreover, the government's long-term objective of creating an agricultural surplus

to provide the basis for establishing agro-industry in the future emphasizes the short- and mid-term demands for such an increased agricultural output. Strategies and modalities for their implementation have to be conceived in order to increase agricultural production without either further encroachment on forest cover or causing related disturbances in the ecological balance.

The rate of encroachment on agricultural land for city and industrial expansion is estimated to be about 50 000 ha/year. Government efforts to compensate for these losses are mainly concentrated in the Land Development Programme, coordinated by the Directorate for Land Development and Land Rehabilitation, of the Ministry of Agriculture. This programme has received highest priority in the past three Repelitas, but the targets were not always met. While 700 000 ha were to have been developed in Repelita III (1979/80-1983/84) and Repelita IV (1984/85-1988/89), only 387 834 ha were effectively completed. In Repelita V (1989/90-1993/94) another 307 593 ha of the target of 375 000 ha were completed by December 1993.

Apart from the compensation for lost acreage, there is the problem of lost production. Most sawahs converted into non-agricultural uses are, in fact, high-quality lands with a total cropping intensity of 180 to 250%, and an annual output of paddy of 7 to 10 t/ha. The newly developed land has in general a much lower yield potential — at maximum, 5 to 6 t/ha/year. In the process of land conversion and land development there is thus an average net production loss of some 100 000 t/year of paddy.

The land development procedure involves several steps, either of a technical (soil inventory, availability of water for irrigation, infrastructure works), social (technology and land status), or administrative nature. Implementation involves coordination at all levels: at national level through a guidance from the Ministry for Agriculture; at provincial level through the Bappedas' and Governor's technical offices; and at kabupaten level through local Bappedas' and Bupati's technical working teams. Insufficient coordination is often the reason for limited success of operations.

The problems of unadapted farming systems are mainly related to the limited education of the upland farmers in Java, and to the nature of the traditional shifting cultivation system in the outer islands. Lack of technical knowledge and the distance from markets result in poor living standards for farmers. Under such conditions, concern over soil conservation practices is obviously secondary to basic food production and survival.

Against this background, the approach and achievements of the Jratunseluna Upland Conservation Watershed Project (Winrock Int., 1992) constitute a good example of integrating social and technical aspects of a soils policy for protecting the upland catchment areas in Java. This project has several components, but maximum attention was given to developing appropriate systems to allow for increased farmers' incomes in combination with the promotion of conservation technologies.

After it had become clear that a purely technical solution to soil conservation had little prospect without direct farmer's involvement, emphasis was placed on the improvement of existing farm models and family labour input. As a result, two models are now proposed: one model adapted to wetter areas and based on wetland rice, followed by rice and a palawija crop; and a second model for the drier areas, including a palawija crop (soya or peanuts),

followed by lowland rice and palawija. Livestock, involving mainly chicken and goats, contributes to a large extent to farmers incomes in the drier East and Central parts of Java. The national rice production has exceeded the country's need and made rice cultivation less attractive. The proposed model for soil conservation in upland Java is now more focused on the development of fruit tree and animal husbandry.

The social dimension in Indonesia, related to high demographic pressures and the overall national objective of safeguarding food self-sufficiency, will continue to be a major factor, overriding all other concerns in the future soil policies and the environmental impact aspects of sustainability. This is considered further below.

3.3 TECHNICAL ISSUES

3.3.1 Soil erosion

Soil erosion is a physical process that is affected by inherent soil properties, slope, rainfall and vegetative cover. Soil erosion is most prominent in Java, but occurs also in the outer islands, mainly in south Sulawesi and Nusa Tenggara, where it is the result of shifting cultivation and local grazing practices. Table 2 provides an indication of the extent of eroded land in 1984/85. It is believed that, since then, as a result of intensive soil use and mismanagement, an additional 100 000 ha/year (although some sources cite between 300 000 and 500 000 ha/year) have been becoming critical land.

TABLE 2
Extents of critical land in 1984

Island	Critical land area ('000 ha)		
	Agric.	Forest	Total
Sumatra	2 169.8	996.1	3 165.9
Java/Bali	1 076.1	139.8	1 251.9
Kalimantan	294.2	901.8	1 196.0
Sulawesi	914.0	958.7	1 873.5
Nusa Tengg.	1 163.6	364.3	2 110.6
Maluku	310.7	281.5	592.2
Irian Jaya	37.0	73.2	110.2
Indonesia	5 948.9	4 315.4	10 264.2

Source: Forestry Statistics for 1984

The magnitude of soil erosion is very site-specific and varies greatly with the agro-ecological and socio-economic conditions of each area. A study commissioned in the early 1980s by the Ministry of Public Works indicated alarming erosion rates in a number of catchment areas, and these data might be used as valuable indicators for the most affected catchment areas in the country. Another source showed that the highest erosion rates were mainly associated with traditional cultivation practices in the highlands (topsoil losses of 34 to 80 t/ha/year), compared to only 17-18 t/ha/yr under shifting cultivation (Hamilton, 1986, cited by Bambang Sukartiko, 1988).

At present there are many types of land disturbances occurring in Indonesia which are directly related to resource extraction. Presently there is little or no effort to reclaim derelict surface mines to their original soil quality or capability, and applications for proposed mines lack information on the physical and chemical characteristics of the soils, topography, material handling procedures and reclamation plans. Surface mining often leads to soil erosion and soil degradation which reduced the ability of the land to produce agricultural crops or forest. The soil quality has often been degraded resulting in a reduction of soil capability. For these reasons, an adequate soil resource inventory should be conducted, prior

to any surface disturbance and reclamation achieved at a level where the postdisturbance soils have similar or even better soil quality or capability than the predisturbance soils.

Although a lot of work has been undertaken in the past 20 years, soil erosion remains a serious problem in the country. The theories are known, but there has been little or no practical impact on the local population, mainly because demographic pressure, poor living standards and the fight for food security in the uplands override all other — i.e., technical — considerations.

Industrial development, particularly in the island of Java and allocated forest area inherited from colonial times, has resulted in the reduction of agricultural lands that forces the increasing agrarian population to cultivate the steep land in upstream areas that should properly be utilized for conservation purposes. The effort to overcome this matter through a transmigration programme has been outpaced by the relatively high population growth. This matter should be properly addressed by land reallocation of forest lands and industrial land use conversion tax to assist the public in searching for new agricultural land outside Java.

3.3.2 Siltation of reservoirs and irrigation systems

Upland soil erosion and subsequent sediment transportation result in substantial economic losses and social disruptions for the downstream communities. Siltation of reservoirs affects the lifetime of dam sites and decreases energy capacities, jeopardizes irrigation systems and pollutes water supplies; ecological damage is to be expected to downstream fisheries and aquatic vegetation.

Table 3 illustrates capacity losses due to sediment deposition in several reservoirs in Java. It has also been stated (Bambang Sukartiko, 1988) that sediment rates in Sutami and Wonogiri dams in Java were expected, at the planning stage, to be 0.25 and 1.15 mm/year respectively, while they actually became 3.03 mm/year (1974-77 period) and 8.58 mm/year (1983) respectively.

TABLE 3
Some examples of sedimentation rates and capacity losses in reservoirs

Reservoir	First used	Sediment deposition (mm/year)	Original capacity (million m³)	Capacity loss (%/year)
Cacaban	1956	218	90	2.4
Jatiluhur	1964	45	3 000	0.1
Seloredjo	1970	209	62	1.2
Karangkates	1972	460	343	2.0

Source: Bambang Sukartiko, 1988

The use of forest land for either transmigration settlements or mining purposes, and the conversion of agricultural land to settlements, industrial areas, road construction or other activities — commonly without proper conservation design — also contribute to the high sediment loads in lowland watercourses.

The problems of siltation and damage to waterworks are the responsibility of the Ministry of Public Works. Hence, this department is currently represented in the intersectoral programmes on catchment area management, regreening and reforestation, and rehabilitation.

3.3.3 Landslides and mass movements

Landslides and mass movements result from a combination of factors, including the geological substratum, slope and rainfall as major physical factors, and by human activities related to land clearing and improper soil management practices; tectonic activity will increase the hazards of mass movements. As a rule of thumb, terrain with more than 30% slope should best be left under forest, or be used for tea cultivation.

The importance of landslides in Indonesia is demonstrated by the fact that between 1979 and 1992 some 1 755 landslide victims were recorded. In terms of material losses, landslides ruined 2 014 houses and 508 public buildings, buried 3 750 ha (9 300 acres) of agricultural land, killed 1 441 head of cattle, and destroyed 25.3 km of roads (Directorate of Environmental Geology press communication, 1992).

The overall responsibility for landslide prevention lies with the Directorate General of Human Settlements [Cipta Karya] of the Ministry for Public Works. The Directorate for Environmental Geology, Ministry of Mining and Energy, is mandated to investigate, map and monitor landslide-prone areas and to issue technical recommendations for alleviatory measures. The RePPProt (1990) study recommended more research into the causes of slope instability under various conditions, as well as into the mechanisms of landslide formation.

3.3.4 Waterlogging and flooding

The total area of land with poor drainage conditions is estimated to be 22 million ha. The Ministry of Public Works refers often to a figure of 39 million ha, but this apparently includes swamplands. The bulk of the area of land with poor drainage conditions is in Sumatra, Irian Jaya and Kalimantan. This land, although possibly suitable for wetland rice production, suffers from irregular flooding and has unreliable production.

A Swamp Research Project, coordinated by the Research Centre for Food Crops and CSAR, has developed adapted management techniques for four common types of swamplands. An intensive swamp development programme is now under way in the country. According to information recently released by the Ministry of Public Works, some 5 million ha of a potential 15 million ha have already been reclaimed for agricultural and other purposes. In recent years parts of the peat areas have been exploited for energy and compost production. The use of peat lands needs more study.

3.3.5 Salinization and alkalinization

Land with saline or sodic limitations is estimated to be approximately 2 million ha, and is fairly equally distributed over the country (Table 1). In Java and Bali there is about 127 000 ha, but it can be expected to increase in the future as a result of increased pumping of shallow groundwater for urban and industrial use, resulting in a corresponding rise of saline groundwater tables. Little or no research has yet been done on this aspect of soil degradation in Indonesia.

3.3.6 Potential acid sulphate soils

Soils with acid sulphate limitations cover more than 4 million ha in the country (Table 1), mainly in Irian Jaya (1.7 million ha), Kalimantan (> 1 million ha) and Sumatra (850 000 ha). Some of this land has been converted into fish ponds. Reclamation for wetland rice production is possible, but only on condition that the soil is not allowed to dry and that jarosite formation is avoided. Potential acid sulphate soils constitute a unique biotope, characterized by a mangrove vegetation. Reclamation of these soils is very delicate, and there are numerous examples worldwide where such reclamation has been a failure. These areas form good natural breeding places for shrimps and other crustaceae, and some of those sites should therefore benefit from being accorded the status of natural protection areas.

3.3.7 Soil nutrient depletion

Soil nutrient depletion is a natural process under conditions of high leaching. It is exacerbated by cultivation of land without proper fertilization. The area of land with severe nutrient limitation is estimated to be 42.6 million ha (Table 1), mainly located in the high rainfall areas of Sumatra (14.8 million ha), Kalimantan (17.7 million ha) and Irian Jaya (6.6 million ha). Aluminium toxicity frequently results from mechanical land clearing which removes the topsoil. The areas correspond generally to Haplorthox, Psamments or Psammaquents, or Aquod soils on the soil map.

Soil nutrient depletion can to some extent be overcome by artificial fertilizer applications. However, every effort must be made to avoid the nutrient status dropping below the critical level at which aluminum toxicity begins to seriously affect crop production. Regrettably, this has already started to appear in some Sumatran soils.

CSAR has an extensive research programme on soil fertility evaluation and monitoring. It also studies fertilizer use efficiencies and advises on (mineral) fertilizer recommendations. Most of this research has, however, been oriented towards sawah soils. In practice, few research results have yet been channelled to farmer level, mainly because of the weak extension effort and of the shortage of fertilizer supplies in the villages, in particular outside Java.

Fertilizer demands are completely different on the rich volcanic and intensely cultivated soils of Java and Bali as compared to the soils of the outer islands. Despite conclusive results on fertilizer use efficiencies on various types of soils and under different agroclimatic conditions, a uniform fertilizer application seems to be common in most of the country. The problem in overcoming soil nutrient depletion in Indonesia is obviously more related to a shortage of supplies than to a lack of knowledge.

3.3.8 Soil pollution and waste disposal

Soil pollution may come from different sources. Among those, agriculture, mining, and urban and industrial activities are the most important.

The intensive use of mineral fertilizers in the sawah soils of Java and Bali has had a serious impact on soil and water pollution levels. The increasing amounts of N and P fertilizers in the soil and water systems result in eutrophication, excessive algal growth and

adverse effects on fish stocks and aquatic plant growth. CSAR has recently started collaborative research on heavy metal pollution, but still there is little awareness of this problem in the country.

In the past decade, Indonesia has made great progress in reducing the adverse effects of pesticides, and its programme to introduce nationwide integrated pest management has been quoted as a good example of sound environmental management, for which the country has received international recognition and acclaim.

During the 1970s and early 1980s Indonesia relied on broad-spectrum pesticides, supported by price subsidies, to reduce pest outbreaks and support rice production. As in many countries, heavy pesticide applications destroyed natural predators. As a result, a previously innocuous insect became a significant pest, and by 1986 it seriously threatened the rice crop in Java. Once the problem was recognized, the Government banned 57 broad-spectrum pesticides, reduced pesticide subsidies and developed emergency extension programmes, such that by 1986/87 the ecological balance had been re-established.

With an estimated 7.5 million ha (and almost half of this in Bali and Java) under sawah cultivation, the negative effect of methane production on Global Warming is not to be neglected. Little awareness exists of this problem, with little systematic research yet undertaken on this topic.

Except for the newly-established Bapedal, which has only very limited technical capacity, no centralized activities concerning the problem of soil pollution and industrial waste disposal were identified. Several organizations nevertheless deal with various aspects of the problem. The Division for Urban and Rural Environmental Geology, of the Directorate for Environmental Geology, carries out inventories, and monitors and evaluates the preservation of environmental data for urban, rural and mining areas. The EMDI project in KLH is currently establishing environmental standards, including soil quality criteria for contaminated sites, and hazardous and toxic substance management.

From interviews with the various agencies, it seems clear that, although no criteria for soil pollution have yet been established in Indonesia, active discussions on the matter are proceeding. The recent introduction of Amdal (environmental impact assessment), imposed as a prerequisite for new industrial plants to be installed, creates proper conditions for a rapid acceptance of soil pollution standards. Activities in this respect would by preference be coordinated under the umbrella of LH and Bapedal.

3.3.9 Actual strategies and programmes

Strategies and projects dealing with technical issues in Indonesia concentrate in the first place on the important problem of soil erosion and related siltation processes; hazardous landslides and mass movements are more site-specific and can to some extent be associated with soil losses in general. All require soil conservation practices.

Soil conservation in the country is mainly implemented through the Inpres Programme on Regreening and Reforestation. It deals more in particular with agroforestry, private or community forest plantations, and with the setting up of model farms for *in situ* demonstrations of soil conservation and agricultural intensification practices; the latter include

terracing and waterway constructions, including the use of drop structures or check-dams, as well as vegetative techniques for maximizing soil cover. Basic conclusions obtained from pilot projects carried out up till now have indicated that the top-down approach, with the technology simply handed over by researchers and extension workers, is unlikely to be successful. Active and real involvement of farmers in the identification of production constraints, possible solutions and the evaluation of those solutions is an absolute necessity for success, and this goal can obviously only be achieved through the introduction of adapted farming systems.

Technology for the reclamation of soils affected by salinity, alkalinity and acidification is available internationally, and should not be the subject of duplicative research. The implementation of this technology is, however, largely dependent on the extension services, and in this respect major improvements in the transfer of knowledge and training are needed (See also Section 3.4.5).

Studies on soil pollution and waste disposal now come under LH and Bapedal. Extensive experience is available from research work and case studies in developed countries, in particular in the European Community and North America. Transfer of knowledge from those experiences should be strongly encouraged in order to avoid duplication of research. The EMDI project, with the technical assistance of the School for Resource and Environmental Studies, Dalhousie University, Canada, is fully involved in this exercise. Other initiatives in this domain may follow.

3.4 INSTITUTIONAL ISSUES

3.4.1 Mandate and effective activities

The overview and institutional responsibilities of the various agencies dealing with soil survey, soil conservation and land issues were discussed in Section 2.4.1. From that it is clear that many of them deal with soil matters, although not mandated to do so *per se*. This situation is because of:

- the relative vagueness with which many of those mandates have been formulated, leaving ample space for interpretations according to local circumstances and ambitions of the agencies;
- the fact that as a result of high demands for soil inventories and the inability of CSAR to meet those demands, opportunities were created for other agencies to enter the market;
- the (mainly external) funding involved offers institutes an incentive to increase their income and to acquire additional expertise and training through an active participation in such programmes and projects; and
- the lack of any effective quality control, allowing almost anybody with a basic knowledge of soil science to become involved in such activities.

In terms of soil survey and data collection, the core agency is CSAR, which has the mandate to provide all types of soil data. Due to limitations in budget, personnel and planning flexibility, it has not been able to meet all demands, and therefore, part of the land resource inventory work has been taken over by the Soils and Geography Departments of universities, and even by the National Mapping Agency. Moreover, BPN has traditionally been involved in mapping operations, and as such it has gradually incorporated soil data collection in its regular programme.

At present, CSAR has almost lost its status as the lead agency for soil data collection in the country, and, when it comes to national or international tenders, some universities can compete successfully with CSAR and other agencies.
In terms of soil conservation work, the following agencies are active:

- the Directorate General for Reforestation and Land Rehabilitation, Ministry of Forestry, and especially the Directorate for Soil Conservation;
- the Directorate General for Food Crops, Ministry of Agriculture, especially the Directorate for Land Development;
- the Research Group on Soil and Water Conservation within the Agency for Research and Development, Ministry of Forestry;
- the Research Group for Soil and Water Conservation within the Agency for Research and Development, Ministry of Agriculture;
- the Directorate for Planning and Environmental Affairs, Ministry for Transmigration;
- the Directorate for Land Use, National Land Agency; and
- a number of universities.

Most of these agencies are technically linked to, or depend for their funding on, the Inpres Programme for Reforestation and Regreening, although some projects receive external funding in addition, either for full project implementation or for one or more components. The problems of soil conservation in Indonesia are mainly related to misuse and poor management of the land by farmers (unadapted farming systems, forest cutting and fires, shifting cultivation, etc.), but soil conservation is nevertheless mainly concentrated in, and within the mandate of, the Department of Forestry. In addition, activities of other departments and sub-national Governments may touch soil conservation inasmuch as policies, plans and programmes made in implementation of their specific mandates affect the use of land resources. In fact, soil conservation can be viewed as a subject of potentially concurrent concern of various branches of government, acting under the authority of separate programmes and legislation.

In terms of suitability evaluation and land use, the confusion is even more apparent. CSAR uses the LECS-2 computer model for evaluating the land-use potential for a number of crops, but as it is aware of the lack of any proper validation of the model under field conditions, it remains extremely careful in disseminating its results. Various university departments and the Ministry of Transmigration make suitability evaluations by matching crop

growth requirements with land resource data, but as no uniform agreement exists between scientists on those requirements, the results of those exercises are not always reliable. BPN is also producing so-called soil-capability maps on the basis of a set of criteria that includes slope, texture, erosion hazard, effective depth and drainage, but which do not reflect modern approaches and methodologies in this field.

3.4.2 Coordination and standardization of data and terminologies

The multiplication of agencies involved in projects and programmes, with one or another of the Departments in the leading role, and emphasizing different components according to specific structures, nature of external funding or scientific approaches, is neither effective nor efficient in providing results of appropriate quality. Moreover, this leads to a confusing situation for the users, and in particular for those who have no technical background in soil science. This is reflected at different levels:

- in the difficulties users experience in trying to locate an institution to supply the data needed, leading ultimately to the conviction that such data do not exist or are not available in the country, and that it is therefore necessary to set up a new, additional, network under their own authority;

- in the situation whereby technical terms have different meanings depending on the source and the context wherein those terms have been used; and

- in the obvious incompatibility of data, or contradiction in conclusions, because of the variety of definitions and criteria used for measurement and interpretation, each often being a function of the individual agency concerned.

Against this background, the need for standardization of soil data collection procedures and technical terms in Indonesia is both obvious and urgent. Soil scientists in the country adhere to different schools of thought, depending on where and when the staff was trained. Moreover, much technical achievements and knowledge come from projects and programmes through external funding and implemented by different agencies, consultants or individuals, each with their own methods, terminologies and bias. Bappenas coordinates much external funding in terms of administration, but has paid little attention to technical matters in terms of methods and terminologies. Standardization as such has therefore been virtually absent in these surveys, while quality control was not centralized, if exercised at all.

In terms of methodological approaches for producing soils inventories, there exists in the country a confusing pattern of principles and methods, differing to various degrees with respect to concepts and terminologies. There is also a need for a commonly accepted land evaluation system, which should be used by all institutes dealing with resource mapping and evaluation in the country. Basic principles of such a system have already been developed by FAO and should be implemented as a follow-up of the currently-used LECS-2 computer program. Before this can be done, land evaluation ratings have to be validated by field observations. For this exercise, yield production figures over several years are needed for a range of crops, grown in different agro-ecological zones. The on-going LREP Phase 2 study may provide the needed inputs for this work. Moreover, a lot of information collected through former research projects on cropping and on farming systems may prove to be of use in this work.

Standardization of natural resource information will ultimately provide the basis for the establishment of a national soil data bank and strengthened soil monitoring. This implies that all data should be presented in a format that can be easily transferred to the database. At the same time, CSAR should also be able to amend its data structures as needs arise. To further promote the development of such a nationwide Indonesian soil database, all parties involved in soil survey should be provided with manuals, describing survey methodologies at various scales, and with the PC-based software that is necessary for data entry and processing.

3.4.3 Reliability of data

It has often been indicated in reports and in interviews that resource data in Indonesia are not always reliable. At different points in Chapter 2 of this report, basic information was seen to differ consistently depending on the source. There are several reasons for this.

- Inaccurate terminology leads to different data referring sometimes to slightly different subjects, and this difference is often overlooked by non-technicians. Thus, the extent of poorly drained soils as indicated on the soil map is not the same as of swamplands, which is the common criterion used by the Ministry of Public Works in reclamation activities.

- Because not all agencies accept each other's information, disputes arise. Hence, the area with 'forest status', as interpreted by the Department of Forestry, is contested by other agencies, and does not correspond with effective forest cover.

- Target figures are often not distinguished from data actually observed in the field.

- There is either no proper quality control, no cross-checking of data, or both, so that errors are not easily detected.

A more careful attitude towards the accuracy of information collected and supplied for dissemination is a prerequisite for an adequate planning base, as the final outcome of policies and strategies relies heavily on the validity of the base data.

3.4.4 Responsibilities for planning and implementation

Overlapping of institutional responsibilities, vagueness of terminologies and lack of standardization in general lead to fragmentation of efforts and to impasses in decision-making. Government itself is well aware of these problems, and since the early 1980s has progressively built up a body of laws and institutional arrangements aimed at addressing environmental concerns on a cross-sectorial basis for development planning. The introduction of the Spatial Use Management Law and the creation of Bapedal are clear indications of the efforts in this context.

These moves towards a more cross-sectorial approach in land-use planning and sustainable resource management will, however, have to cope with powerful vested interests already well entrenched in government. Major revenue-earners like forestry and mining have historically made a strong claim on resources, and the new planning system will have to confront at an early stage the current classification system operating in Indonesia, whereby

much of the country is committed to certain land use purposes upon the basis of four crude forest types. This approach has frequently been criticized, most recently by the World Bank (1990), which pointed out that the land classification system "does little to ensure optimal land use from either an economic or environmental point of view." In the case of mining, it seems that environmental safeguards are usually not enforced. Another important pressure group is urban land developers who, if recent experience on the Jakarta sea front is typical, seem to be able to override even the new Amdal requirements without too much difficulties.

Powerful pressures of this nature are a fact of life for governments, but if 'special case' treatments are allowed for types of development which have the greatest detrimental effect on the environment, while the 'strict letter of the law' is only applied to those without power and influence, then the new environmental controls will soon become discredited. To avoid this, one agency must be clearly vested with the authority to coordinate the new regional land-use planning arrangements, and mediate the conflicts over land use which will inevitably arise between agencies.

Once a coordinated planning framework is in place, demands will be put on the next stage, implementation, to see that integrated planning at the macro-level is reliably and effectively carried out in the field. It is generally recognized that this will require considerable institution-strengthening. LH's limitations are that it lacks influence over line agencies, and has little capacity below the national level. BPN depends largely on the Regional Governments for the enforcement of its land use controls. Bapedal is still in its infancy, and has a very wide brief to cover with its limited resources. Unless the protective controls of land-use planning are enforced, the exercise is clearly a waste of time. Given the limitations of government's enforcement machinery, the new approach of encouraging broad-based local participation in implementing government policies should be considered for application to environment protection generally. Until some grass-roots-level enforcement capacity is in place, compliance with land-use controls may be more a matter of choice than of necessity.

3.4.5 Research, education and training

CSAR conducts research and generates valuable information on the nature and extents of soils in the country, mapped at various scales, and carries out chemical soil analyses and studies fertilizer efficiencies; it also participates in collaborative projects on erosion monitoring and soil conservation techniques. The Central Research Institutes for Food and for Estate Crops concentrate mainly on the development of new crop production technologies, and in this function they have provided major inputs to Transmigration Resettlement Schemes and to the Crop Zoning Programme, with intersectorial activities in the Swamp Development Project, the Agro-ecosystems Research Group and the Farming Systems Research Teams. Around these research topics, several university departments have developed links with the centres, either on the basis of personal contacts or through more official collaborative programmes.

A major weakness of much of these activities is the poor channelling of results and recommendations to the end-users. This is partly due to the bureaucratic structures within the respective Departments to which those institutes belong, but probably also to a lack of initiative on the part of the institutes or the researchers themselves in propagating their findings. The fact that many potential users have made complaints about the difficulty of access to such information also needs consideration.

Transfer of knowledge is somewhat better taken care of in the universities, at least in those which have integrated training and research activities. At present, some 50-60 (level S2 and S3) graduates in soil science obtain a degree and are annually available on the market. Most of them find employment in government jobs or with consulting firms and estate companies; few of them go to extension. If, in the future, experienced staff will be needed to develop and implement a national soils policy, the number of graduates has to be increased, and an effort has to be made to adapt the curricula to provide more problem-oriented training.

Education and training at lower levels are very variable, but consistent efforts are being undertaken to remedy this shortcoming. Training and human resources development have now become a major component of most new projects. This is carried out under the form of various types of training courses involving technical officers as well as farmers. As such, RePPProt and LREP (Phases 1 and 2) have a training component whereby regional Bappeda staff are introduced to soil survey techniques, map reading and soil survey interpretations. Similarly, important funds have been made available for teaching local farmers in some catchment area management projects (as for example in the Wonogiri-Upper Solo Watershed Area management project) or through the concept of model farms and expansion areas under the Regreening and Reforestation programme.

Training and development of human resources at farmers' level is in particular aimed at increasing knowledge, skills and experience so as to be able to use and maintaining the products of the projects, so that they will be useful and productive in the future. In implementing these principles, however, problems have occurred with respect to the shortage of qualified instructors and the lack of coordination between different agencies for training, meaning that in practise the training is either sectorial or partial, and is seldom completely integrated. In addition, it has also been suggested that due to the low educational level of most farmers and their low absorption capacity, repetitive training cycles need to be considered.

3.4.6 Extension

Extension plays an important part in the dissemination of policies and techniques to the grass-root level. In Indonesia, extension is operated as a part of the sectoral departments, and too often the lack of coordination between the national departments becomes reflected in the extension activities through the kanwils at provincial and kabupaten levels.

Extension work at farmer level is rather weak, especially outside Java, and this is reflected by the low productivity and poor soil management. The limited success of most soil conservation programmes once the pilot projects have come to an end, coupled with the relatively significant annual increases in critical land areas, are other parameters indicating the poor results of extension activities, and of the impact they have on farmers' customs. Hence, it is obvious that agricultural extension workers need to be more active in instructing farmers, and for this reason the facilities, in particular with respect to mobility and upgrading of their technical knowledge, have to be improved. In parallel, the number of expert staff at the provincial and kabupaten levels often needs to be increased as well (P.T. Andal Agrikarya Prima, 1992).

Finally, the role of NGOs in extension should be emphasized, in particular where they concentrate on the channelling of information and improving access to some production means.

3.5 LEGISLATION

A number of legal issues germane to an improved soil management regime have already been addressed in the preceding section, in particular the need to clarify roles in the land-use planning process and to install an effective system for implementation of land-use plans. The World Bank (1990) in discussing the 'tools' for land-use planning, noted that among a range of instruments for implementing land-use plans were: zoning for specific types of land use, licensing by various agencies involved, and taxation to control land use. These matters will need to be considered in the preparation of regulations for the implementation of the new Spatial Use Management Law, and possibly in adjusting existing laws as a consequence of the new Law's introduction. Other legal issues which deserve special mention refer more specifically to land tenure, change of land use, pollution control and enforcement.

3.5.1 Land tenure

Indonesia's land law and land tenure system were discussed in Section 2.5.3. The fundamentals laid down in the Basic Agrarian Law (BAL) have proven to be resistant to change, and no suggestion is made here for tenure reform. However, the World Bank, in its 1990 Country Study of Indonesia, called for an overall review of land policy, and in the course of any such exercise attention might be given to the desirability of including a standard condition, suitably worded, in the titles for the different forms of tenure, to the effect that holding the title depended upon complying with environmental legal requirements. At least, this should be possible with government grants of title over State Lands, and it has the double benefit of bringing environmental protection requirements to the title-holder's attention, and allowing another avenue for enforcement of environmental law, namely forfeiture of misused land. The BAL does require all landholders to avoid damaging the soil, but this requirement needs to be spelt out more precisely. The actual duties of the landholder should reflect the purposes for which the land can be used, under the applicable land-use plan for the area (see below).

A further general point on tenure is that it is unreasonable to expect people to feel committed to environmental restrictions on the use of land unless they can also feel confident that they will gain the long-term benefits of sound land use. While, as an ultimate sanction, land should be liable to forfeiture, correspondingly it must be clear that good land use practises will be recognized. The tenures recognized and granted by the Government should be for a sufficient period of years, and be sufficiently secure, to encourage planning for the longer term by title-holders. This comment is particularly applicable to farmers.

3.5.2 Change in land use

A system aiming at optimal management of land, while it must prevent new uses which damage the land, must at the same time have the flexibility to allow for changes in land use in response to changing circumstances. It has often been said that, at the macro-level of planning, the present land classification system is flawed, and it is to be hoped that under the

new Spatial Use Management Law the situation will be improved. At the micro-level, too, there will be need for flexibility to change land uses. Provided this is done within the framework of the local land-use plans, the ability to convert land to a better form of use should be readily available.

3.5.3 Pollution control

With respect to the legal framework for pollution control, the World Bank (1990) report states that "the legal structure for an industrial environment control programme is basically in place, and existing regulations and decrees are sufficient to redress the current situation. The next step is to strengthen institutional arrangements for pollution monitoring and control at the centre, and to replicate this and provide enforcement powers at the provincial level." That report also listed elements of a comprehensive strategy to address industrial pollution, and the steps the Government was taking. Again, the main constraints are institutional, and the major needs are for an increased administrative capacity, particularly at provincial and lower levels. This brings up once more the general question of enforcement.

3.5.4 Enforcement

At present, where environmental safeguards appear in such things as logging concessions or mining licences, the words used are so general as to raise doubts over their enforceability (see above). Such controls have little effect, and they must therefore be replaced by carefully worded conditions imposing clear (and reasonable) duties, which can be readily enforced if they are ignored. How they are enforced is a policy matter. Over twenty years ago, after reviewing the then timber 'boom' in East Kalimantan and noting the severe constraints at the provincial level on the operation of central government policy, Manning (1971) wrote: "The ultimate success of future policy will depend, however, on much more than the tightening of legal provisions regulating forest exploitation. Above all, it hinges on the government's capacity to implement new laws, regulations and contract clauses. Here, sufficient political power given to those entrusted with enforcing regulations, and increased administrative efficiency are crucial for the effectiveness of the government programme." The fact that logging practises are still so widely criticized shows that the necessary capacity at lower levels is still lacking.

The draft National Soil Conservation Act (FAO, 1987) aimed at achieving soil conservation by a mix of measures, including by financial and other incentives, extension, education and training programmes, in addition to the usual restrictions and prohibitions. As well as providing for the declaration of Soil Conservation Zones covering land in critical condition, thereby applying compulsory controls to land use in the Zone, provision was also made for the voluntary making of Soil Conservation Agreements between government and land owners or occupiers. The judicial system in Indonesia is still being developed, and calls were made for a strengthening of the legal infrastructure for enforcement, possibly by establishment of special land courts operating as low as the sub-district level (Tjondronegoro, 1991). Whatever the solution, it will inevitably depend upon a greatly-expanded role for public participation, if new environmental safeguards are to be effectively enforced.

Chapter 4

A National Soils Policy for Indonesia

4.1 PRESENT STATUS

Indonesia has a long-standing commitment to the basic principles and concepts of sound environmental management. For the last 15 years the country has had a State Ministry for the Environment, and at regular intervals environmental issues are discussed in Parliamentary debates or hold the headlines in the daily press. The seriousness with which the Government views the environment can also be seen in legislation concerning the Basic Provisions for the Management of the Living Environment (Act 4/1982) or in the establishment of structures and the mandate of Bapedal (23/1990). Further involvement is reflected in the guidelines for the Fifth Five-Year Plan, and in steps to strengthen forest management and to introduce measures for pollution abatement, requiring environmental impact assessment for all major development projects.

With particular reference to soils, the Government has shown its primary concern to stop soil erosion and to rehabilitate critical land through the Inpres Regreening and Reforestation Programme (6/1984) and associated projects, such as the Upland Agriculture and Conservation Programme, the Swamp Development Programme, Crop Zoning Programme, etc.

Soil and land use have, however, become a very complex issue in Indonesia because of the large number of institutions and departments involved. Existing soil policy aspects are mainly sectoral and often result in competing or conflicting situations over land, which tend to be solved on an *ad hoc* basis.

An FAO study on legal and institutional arrangements for soil conservation (FAO, 1987) has pointed out that the BAL of 1960 provides the Central Government with the authority to prepare a national land-use plan, with implementation vested with the regional authorities. However, such implementation provisions for decision making and legal status have never been made. Legislation for some of the sectorial aspects of such planning have indeed been drafted and even adopted, as for example 2/1987 on city planning. This procedure obviously works as long as the designation of the land is not a matter of contention between conflicting interests. Such sectoral and incidental approaches cannot be maintained under conditions of high demographic pressure and competitive land use, as is occurring more and more often in Indonesia.

Against this background, and taking into consideration the magnitude of the problems the country is facing, there is scope for an entirely new approach — one that should include all possible future uses of the land in an integrated manner.

To be fully effective, this approach should allow the allocation of land to various uses, with due account being taken of its effective potential and carrying capacity. The land-use planning process, and the establishment of an overall Land-use Plan, must have a solid legal basis.

This is provided in good substance by the new Spatial Use Management Law of 1992 mentioned earlier in Section 2.5.4. Potential change between present and future land use may result in competition and conflicts. The process of accommodation and compromise – common to all land-use planning procedures – and the resulting selective allocation of space in order to achieve consensus, may not necessarily result in an optimal allocation of land in the purely technical sense.

4.2 ELEMENTS OF A NATIONAL SOILS POLICY

A policy is an act of intention, which lays down the basic principles for achieving long-term objectives. Because of this long-term view, a policy must have a firm legislative background and be fairly consistent, i.e., impervious to change in the short term.

The details of the policy are left to implementing strategies and programmes (or modalities in general), the strategy elements covering technical tools and the steps for achieving the policy goals, while programme elements are specifically related to means of implementation. In contrast to the policy itself, the implementing strategies and programmes may vary with changing circumstances and, hence, should be flexible and able to adapt to new conditions without having to resort to the cumbersome process of revising technical parameters and legislation.

In the case of Indonesia, the long-term development objective is to raise the standards of living and welfare of the people through, among other things, an increase in agricultural production. Such an increase in agricultural production is needed to meet direct food demands and to provide the raw material for an expanding agro-industry.

In the recent past, the objective of food self-sufficiency was mainly met through intensification of existing agriculture and by opening up new cropland at the expense of forest areas. This situation can not continue indefinitely, and must be reconsidered in a new perspective, that of sustainability of production and the preservation of the ecological balance.

Any increase in agricultural production in Indonesia is subject to a number of particular constraining conditions, including:

- the continuous encroachment on cropland (mainly highly productive sawahs) for non-agricultural uses such as urban or industrial expansion;
- the inherent natural or human-induced limitations of the soil itself, particularly in Java's uplands and in the outer islands in general; and
- the continuing use of farming and cropping systems which are not properly adapted to the specific agro-ecological conditions of the area, and hence unsustainable and environmentally unsound in the long term.

4.3 PROPOSED NATIONAL SOILS POLICY

Taking into consideration the long-term development objectives and the particular natural and human conditions in Indonesia, and in the light of international recommendations embodied in the FAO World Soil Charter, in UNEP's World Soils Policy, and in UNCED's Agenda 21, it is suggested that the national soils policy for Indonesia should aim at obtaining maximal and sustainable agricultural production from the land, retaining a fair balance between agricultural and non-agricultural uses, and based on the following four principles:

- land must be used according to its inherent potential and carrying capacity;
- allocation of land to suitable uses, whether for forestry, agriculture, urban expansion or other activities, should be regulated by an overall Land-use Plan, prepared on the basis of both the natural potential of the soil and the anticipated future development needs of the nation;
- implementation provisions regulating the land-use planning process, the legal framework and authority for such planning decisions should be vested with a National Authoritative Body with the authority and ability to override sectorial interests;
- soil conservation practices should be based both on technical — mechanical and vegetative — means, and on direct farmer participation.

This is in line with the new Nation State Policy which states, "There is a need to strengthen and refine efforts in the rehabilitation of forest and critical land, soil conservation, rehabilitation of rivers, swamps, mangrove areas, conservation of natural caves, coral reefs, endangered species of flora and fauna, and improvement of watershed management. Rehabilitation of critical land to preserve soil fertility, springs, and environmental carrying capacity has to be enhanced through soil conservation measures and regreening".

4.4 STRATEGIES AND MODALITIES FOR IMPLEMENTATION

Strategies and modalities for implementing the proposed national soils policy are directly related to the four principles on which this policy is based.

4.4.1 Inherent soil potential and carrying capacity

Soils differ in their nature and composition as a result of variations in parent material, weathering status and geographical position. These inherent soil properties, associated with climatic conditions, determine both the natural vegetation and crop growth potential.

In Indonesia, both the soil types and the climate vary considerably over the country, and hence also the natural soil potential, resulting in considerable variation in cropping systems and production potentials. For a correct understanding of the soil potential and related carrying capacity over all the country, a standardized, nationwide climatic and soil resource inventory is needed, and a unified methodology should be developed for the interpretation of those basic data into soil potential parameters. At national level, the RePPProt study has provided such an inventory, and, within the limitations noted in Section

2.2.2, this work can be used for first screening of nationwide development potential and macro-planning. At a lower, provincial, level, the LREP Phase 1 study has provided a methodological frame for the inventorying of such resource data, but unfortunately this programme covers only Sumatra, and the published information refers only to soil maps and soil descriptions. At the district and village levels, data on soil properties and soil potentials are scattered. LREP Phase 2 is expected to establish the methodology for such an inventory through the mapping of 41 selected areas in the country.

Except for macro-planning at national scale, the basic information required for accurate evaluation of inherent soil potentials is still not available. Modalities to remedy this situation involve four main thrusts:

- clarification of mandates and designation of one single agency for data collection and inventorying of natural resource information;

- establishment of a uniform, nationally-accepted system covering
  - — methodology for data collection
  - — standardization of terminology, and
  - — quality control;

- strengthening of the national programme for soil and climatic data collection; and

- agreement on a common land evaluation procedure for defining the natural soil and land potential for specific utilization types.

Currently at least 13 institutes and official agencies are involved to a greater or lesser extent in soil and land use affairs. Because all of them use their own approach, methods and terminologies depending on their sectoral interests, their information is difficult to access, understand or utilize by any other interested party. The final result is confusion, misunderstanding and excessive duplication of effort. Mandates should therefore be reviewed, and all activities and funding for natural resource data collection should be concentrated into one single agency, or at the most a cluster of institutes under the umbrella of one lead agency. Recommendations in this direction are given in Section 4.5.1 below.

The lack of standardization at present, and the confusing terminologies used, make sound land-use planning difficult, and leaves open the way for *ad hoc* decision making. This should not be allowed to continue in the future. Standard methods for surveys at the various scales need to be established, and a common terminology adopted nationally. All parties involved in soil survey and data collection should be obliged to adhere to the standards, and the same standard criteria should be integral in the terms of reference for foreign-assisted projects. Bappenas, as the (administrative) coordinator of those projects, should act as a watchdog, or should nominate some body to be responsible for exercising the necessary control.

Uniformity in methodologies, in data collection and in terminologies should be a primary concern of all soil scientists. Because of the urgent need for such a common agreement, endless academic discussions on this matter must be avoided. The role of CSAR, and to a certain extent BPN, are addressed in Section 4.5.2. below, together with recommendations for possible action.

CSAR already has a regular programme on soil and climatic data collection nationwide, but those activities are obviously affected by budget and staff limitations. In order to meet the increasing demands for land data, modalities have therefore to be foreseen to achieve an adapted staff allocation and budgeting. Part of this can be covered by the re-allocation of personnel and operational means as a result of the clarification of mandates and activities referred to above. In addition, upgrading of in-house knowledge through refresher courses is recommended. Such courses should preferably be organized within the country and be used as a tool to strengthen and monitor the introduction of uniformity in methodology and terminology. Care should be taken that courses maintain a pragmatic character and that they clearly illustrate the role and impact of natural resource data collection, in view of applications towards land evaluation and land-use planning issues.

No uniform methodology exists in Indonesia to evaluate the natural soil potential and related carrying capacity of the land. At present, land evaluation is operated on the basis of the LECS-2 computer program, but crop growth requirements are not uniformly accepted by the different agencies involved in these studies. Moreover, much of these data have been taken directly from literature, without proper field validation under Indonesian conditions. Recommendations to introduce international knowledge of land evaluation and agro-ecological zoning techniques for direct implementation in the country are given in Section 4.5.4. It should be recalled, however, that once data collection is achieved and methodological approaches confirmed, validation with field observations is needed before proper recommendations on land use potential and carrying capacity can be given. This is obviously not a short-term undertaking, given the enormous impact the required information may have on the future agricultural policies of the nation. Another method of land evaluation was also used at the CSAR. An Expert System has been employed in delineating land resources of most of Indonesia and the results in system production option and crop alternatives have been put into a geographic information system.

4.4.2 Overall Land-use Plan

An Overall Land-use Plan — sometimes also referred to as a Master Plan — is a document which defines the allocation of land to different uses and which, once it is drafted, should only be changed for reasons directly linked to national interests. In practice this means that the Plan is an expression of the national land-use policy within the long-term objectives of the Government, with possible adjustments related to the options in the Repelita periods.

The Plan is primarily based on the natural soil potential and carrying capacity, which constitutes the physical framework wherein alternative scenarios can be taken into consideration. These alternatives, and the selection of the most appropriate land-use type from among them, depend largely on the spatial needs for the socio-economical and political options defined in the Repelita. Because the background material prepared for the drafting of the Plan provides also information on the nature and constraints of the various alternative land uses, the final options retained in the Plan should also take into consideration the full risks of a non-sustainable use, or of measures which do not comply with soil protection in sensitive areas.

An Overall Land-use Plan is obviously a compromise between different sectoral interests and should therefore be prepared by an advisory team of experts, who are independent from any sectorial interest. It will in particular have to make suggestions on the

drawing of borderlines between major land-use types, e.g., forest areas, agricultural land and zones reserved for city and industrial expansion. Interaction between the various interests will need to be fully at play in establishing the Plan, and will probably result in compromise solutions based on consensus, and although these final solutions might not match exactly national development priorities, and would not necessarily result in an optimal use of the land, they will have the virtue of being the best socio-economic use of the land in the long term, within the constraints of environmental sustainability.

The present Land Use Plan for Indonesia does not provide sufficient details, although the Spatial Plans called for by the new Spatial Use Management Law of 1992, described in Section 2.5.4, could fill this gap. Except for the protected forest areas, all other land should be re-evaluated. For the technical aspects, the advisory inputs of the multidisciplinary team referred to above will be required. On land status and mapping data, BPN and Bakosurtanal may be valuable consultants. For the important aspect of soil erosion control and conservation, participation of the nucleus group implementing the Inpres Regreening and Reforestation Programme should be solicited. Other sectors may be required to provide advice or assistance in preparing draft materials, but decisions on the final draft should be vested in the Spatial Use Management Coordinating Board.

4.4.3 Implementation provisions

Because an overall land-use plan is a powerful tool for national soil policy decisions, it should be the responsibility of the Spatial Use Management Coordinating Board that is independent of any special interest or pressure groups which might attempt to modify the primary designation of the land as defined in the Plan.

The role of this Board is to keep the balance between the various, technically sound, land-use scenarios and the long-term national development objectives, and to decide upon the designation of the land in the future. This refers basically to political options and therefore requires the collaboration of high-level decision makers, or at least of a core group of their top advisers. The recent adoption of a National Spatial Use Management Law is an expression of Government of Indonesia concern in this matter, and on the implementation provisions for land-use planning in general.

4.4.4 Soil conservation

Soil conservation remains a major concern in Indonesia. This is due to the sensitivity of many, especially upland, soils to rain-induced erosion, coupled with non-adapted farming practices. Although the problem as such is well recognized, no exact figures are available on its extent and nature, as discussed in Section 3.3.1, mainly because eroded or erosion-sensitive land is too often not distinguished from critical or degraded lands (whatever — or whomsoever's — may be the definition of those), and these terms have different meanings for the various agencies involved in soil conservation work. This situation leads to a first recommendation to localize and monitor the extent of eroded and erosion-prone lands. A collaborative undertaking, based on remote sensing techniques (Bakosurtanal) and the interpretation of available soil maps (CSAR for example) may provide a relatively rapid answer to this problem.

Abatement of soil erosion through soil conservation practices is implemented through a number of agencies (see Section 3.4.1 above) working under the umbrella of the Inpres Regreening and Reforestation Programme. They all apply classical methods, using either vegetative or mechanical means. Conclusions from ongoing pilot studies indicate that purely technical solutions generate little result if not based on direct farmer involvement and poverty alleviation.

In the same context, it has often been stated that despite efforts in soil conservation over nearly 20 years, the extent of critical land is still increasing in the country. It may therefore be better to recommend concentration of efforts on preventing soil erosion, rather than trying to cure areas which are already badly affected. This prevention should be directly linked to the introduction of adapted cropping and farming systems, coupled with assistance in socio-economic aspects, particularly in areas where subsistence farming dominates. Results obtained from the Upland Agricultural and Conservation projects in Central and East Java confirm the success of this approach. Although no data could be obtained from similar research on shifting cultivation systems in the outer islands, it is believed that equally positive results can be obtained by first improving the living conditions of the farmer, and then awareness of sustainable cropping patterns with indirect soil protection can be created.

From the legal point of view, it should be recalled that the BAL and the title of ownership clearly stipulate the responsibility of the farmers to keep the land in good condition, but that no measures for enforcement of this law have ever been applied. In the future, and in the light of the growing concern over environmental issues, it is highly recommended that measures to avoid soil damage (if not specific soil conservation activities) should figure in all land-use plans, and in all land tenures, concessions, contracts, licences, permits or other dispensations of government allowing access to land. A specific Law on soil conservation was being contemplated by the Ministry of Forestry in the late 1980s, but progress was suspended in view of the emergence of the Law on Conservation of Living Resources. It is understood that consideration of a law on soil and water conservation is now being revived, and indeed the need for special measures to protect critical catchment areas has not been met by the Law on Conservation of Living Resources. The draft Soil Conservation Act prepared with FAO assistance in 1987 is a simple law which, in offering a range of different measures for combatting soil erosion, provides a sensible balance between incentive and deterrence, facilitation and prohibition. Some minor adjustments would be necessary to take account of the introduction of the Spatial Use Management Law, but otherwise the draft should be considered for early introduction. However, the information from the 1987 draft Soil and Water Conservation Law can be used in the preparation of government regulations concerning land use management.

4.5 RECOMMENDATIONS FOR FOLLOW-UP ACTIONS

The previous sections have dealt with the principles of the national soils policy and with the main strategies and modalities for implementation. This final section describes in limited draft form a number of programmes and projects, which may be of direct relevance in initiating national action.

4.5.1 Definition of mandates and responsibilities

It has been shown above that, at present, many organizations, agencies, institutions and other bodies deal in one way or another with soil issues, but that none of them provides the answers for overall policy making; moreover, this has led to a lack of standardization and to confusion. It is therefore suggested that as soon as possible the Government of Indonesia should screen the mandates and responsibilities of institutions to ensure cooperation and avoid overlapping responsibilities. Procedures and methods should be standardized and adhered to. It is recommended that:

i. The Centre for Soil and Agroclimate Research (CSAR), which besides its research function should also become a service centre for all issues dealing with soils in the country. CSAR will then:

   — collect data on soils and soils potentials;
   — take the lead on the standardization of terminologies (Section 4.5.2);
   — will prepare the formats and standards for the establishment of a national soil data bank (Section 4.5.3); and
   — be actively involved in land evaluation and soil conservation activities (Sections 4.5.4 and 4.5.5).

ii. The National Land Agency (BPN) is responsible for data collection in terms of land-use, tenure and ownership rights, titling and registration, as well as for the legal aspects of those. Land capability mapping and evaluation undertaken by BPN should conform with the standardized procedures, methodologies, terminologies and formats.

iii. Bakosurtanal should take the lead for map preparation and computerized data handling, as well as the production and dissemination of maps and raw data. Bakosurtanal should not get involved in the interpretation or amendment of data and should conform with the standardization mentioned above. Measures should also be taken to provide interested agencies with simple access to these data.

iv. The Ministry of State for Environment should be responsible for setting up policies and standards (e.g. soil ambience quality standards).

v. The Environmental Impact Management Agency should be responsible for monitoring, management, and control of soil pollution.

vi. The Ministry of Forestry c.q. Directorate General of Reforestation and Land Rehabilitation should be responsible for coordinating preventive as well as rehabilitation measures regarding soil degradation.

vii. The Ministry of Agriculture, c.q. Directorate General of Food Crops and Horticulture, should be responsible for coordinating land rehabilitation outside forest areas.

The recommendations do not mean that other agencies or institutions can no longer be involved in soil and related data collection and interpretation. This should, however, only be done on the condition that the standardized methods and terminologies are used.

4.5.2 Standardization of methods and terms

In some previous sections attention focused on the existing confusion in principles and methods with respect to soil and related data collection and interpretations. Urgent action is needed to overcome this problem.

The primary role of the lead agencies referred to in Section 4.5.2 above would be to:

i. introduce standard criteria and approaches
ii. document them into a manual and a set of guidelines, and
iii. enforce their application in future activities.

This means that all institutions dealing with soil issues should be obliged to adhere to those standards, and that for foreign-assisted projects those standard criteria should be integral in the terms of reference.

To obtain standardization and uniformity in terminology and methodologies, CSAR (in collaboration with the relevant agencies) should seek a dialogue with the leading university centres, the Indonesian Soil Science Society, and other interested parties. It is suggested that the finalization of the work should be implemented with the assistance of a highly qualified external consultant, whose role it will be to introduce international experience in this matter and to provide a neutral, but authoritative, voice in the discussion forum.

Bakosurtanal should be involved as a technical observer at all levels of discussion, as it will have to define the format in which data have to be presented, to allow their storage and retrieval in the national database.

4.5.3 National database

A national soils policy requires proper basic information, accurately stored and easily retrievable from a national data bank. The establishment of such a data base has been one of the main objectives of the ADB-funded LREP project. This database is located at Bakosurtanal, which has a full mandate and experience in this matter.

The consolidation and extension of information and expertise should be considered as a high priority for the country, and one to be continued after the LREP project ends. However, it needs to be recalled that the interpretation of these data for land-use planning remains vested with both the CSAR and BPN, which are the providers of the data and which have the proper expertise to handle the information. On the other hand, Bakosurtanal should include in its regular programme the monitoring of land-use changes, and in particular the quantification through remote sensing techniques of important phenomena such as city encroachment on other land, forest clearing and extension of critical land areas.

Because of the interdependence of the three institutions in evaluation of land-use potential, close collaboration between Bakosurtanal, CSAR and BPN should be encouraged, and be considered as the keystone to providing the background information needed for the Overall Land-use Plan.

4.5.4 Common land evaluation procedure

The evaluation of the natural soil potential in terms of alternative land-use types and their inherent production capacities requires the establishment of a scientifically sound, land evaluation approach. Although the basic principles for such an approach are generally known, and to some extent are already applied in the LECS-2 system, no uniform methodology exists in the country, mainly because different institutions apply different criteria and appreciations. Hence there is an urgent need to introduce international knowledge of land evaluation and agro-ecological zoning techniques so as to allow direct implementation in the country. FAO, having worldwide expertise in this field, appears to be the most appropriate institution to assist in this domain.
It is suggested that external donor support be sought for a project to:

- introduce the most appropriate and effective land evaluation methods and to adapt them to the national conditions in order to be able to evaluate alternative land-use potentials in the country;
- develop models and to validate them for direct application in Indonesia; and
- train qualified personnel for an adequate follow up of the introduced expertise.

As land evaluation requires a multidisciplinary approach, it is recommended that implementation of this should not be through one single institution, but should involve a linked interdisciplinary team from appropriate specialized institutes and agencies, comprising all relevant disciplines. From experience gained with other such teams, it is believed that such structures can successfully work in the country.

The expected result of these activities is that a basis be provided for the evaluation of the physical environment, and of the various land-use scenarios to be considered within the Overall Land-use Plan. As such, the multidisciplinary team can gradually become the technical expert group for the Spatial Use Management Coordinating Board.

4.5.5 Soil conservation

Despite the tremendous progress made in soil conservation technology over the past 20 years, the rate at which land degrades into critical condition each year remains too high. Under present conditions, efforts and financial means are too dispersed and there is a need for a more coordinated approach.

The Inpres Programme on Regreening and Reforestation, under whose umbrella most soil conservation activities are carried out, should be given more authority and responsibility. It should also deal with technical aspects, define methodologies and approaches, and make provision for a quicker channelling of the feedback from field experiences. It should define the strategy, whereby technical solutions should be adapted to site-specific soil conditions and be combined with the improvement of existing, or the development of adapted, farming systems. Soil conservation projects should also pay more attention to poverty alleviation as this may be the cornerstone for the long-term success of soil conservation practices. The draft soil conservation act needs to be finalized and enacted as soon as possible.

Foreign-assisted projects, introducing new technologies, should also be requested to conform to existing national methodologies and terminologies. Regular meetings of all project representatives should be encouraged to exchange scientific and technical knowledge and to assist in uniformity of approaches at national level.

4.5.6 Public awareness and involvement at sub-national level

As the principles of a national soil policy have to be implemented at provincial and district level, it is important that sub-national organizations be aware of soil issues and of the impact of adverse activities on sustainable land use. Such awareness is often very weak at this level and should therefore be improved.

An information campaign emphasizing the effects of environmentally-sound land use, overriding short-term sectorial interests, should be started through the media, through personal contacts, by use of incentives, or a combination of these. Local Bappeda members may be considered as a first target group. The dissemination of special, ecologically-sound techniques through extension workers could also be considered. The role of LH in the promotion of these activities is obvious.

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Appendix 1

Persons consulted during the mission

Ministry of State for Population and Environment (KLH), Jakarta

Mr ACA SUGANDHY	Assistant Minister II
Dr R.E. SOERIAATMADJA	Assistent Minister III
Mr A. DJOEKARDI	Deputy Assistent-Minister II
Dra Ardina PURBO	Staff Member

Bappenas

Dr DEDI RIYADI	Staff Member, Natural Resources and Environmental Management and Planning
Mrs INDAH DIANTI KUSUMA	Staff Member, Natural Resources and Environmental Management and Planning
Dr BAMBANG BINTORO SOEDJITO	Deputy Head, Regional Bureau
Dr HINU SUTIHARDJO	Deputy Head, Regional Bureau
Dr BUDHY TJAHJATI SUGIANTO SUGIJOKO	Deputy Head, Bureau Socio-economic and Spatial planning
Mr RUSNADI	Staff Member, Bureau of Agriculture and Irrigation

Bappeda

Mr TRIANTHO	Head, Research Division, Bappeda, Yogyakarta
Mr DJOKO SUTIARSO	Head, Physical Planning Division, Bappeda, Yogyakarta
Mr ARIS RIYANTA	Staff Member, Bappeda, Yogyakarta
Mr RAHAYU	Staff Member, Bappeda, Yogyakarta
Ir SROEWONO	Staff Member, Bappeda, Yogyakarta
Mr DACHLAN MAULANA	Chairman, Bappeda South Sulawesi, Ujung Pandang
Mr D. WODA PALLE	Chairman, Bappeda Nusa Tenggara Timur, Kupang
Mr E.T. SALEAN	Agricultural Adviser, Bappeda Nusa Tenggara Timur, Kupang
Mr A. PATTYNANGDE	Economic Adviser, Bappeda Nusa Tenggara Timur, Kupang

Ministry of Forestry

Ir MOMONG IMRON ROSYADI	Directorate for Soil Conservation, Jakarta
Ir DJUNAIDI	Staff Member, Directorate for Soil Conservation, Jakarta
Dr MUHAMAD YAMIN MILE	Forest Research Institute, Bogor
Mr AMAS SUPRIATNA	Head, BRLKT, Citanduy Watershed Management Project, Pamalayan/Ciamis
Mr.NANDUNG SUMANTRI	Head, Planning Section, BRLKT, Citanduy Watershed Management Project, Pamalayan/Ciamis
Mr DIDI SUPRIANTO	Head, Monitoring and Evaluation, BRLKT, Citanduy Watershed Management Project, Pamalayan/Ciamis

Mr AHMED ASIKIM	Senior Extension Worker, Tasikmalaya Field Experiments, BRLKT, Citanduy Watershed Management Project, Pamalayan/Ciamis
Mr SOENARTO	Staff Member, Seraya Luk Ulo Watershed project, Wonosobo
Ir KRISTANTO	Project Manager, Upper Solo Watershed Protection Project, Wonogiri
Mr THRIDOSO	Head, Technical Planning, Upper Solo Watershed Protection Project, Wonogiri
Mr SUTADI	Programme Planner, ASOCON

Ministry of Public Works, Jakarta

Mr DAVID JEZEPH	Water Resource Policy Adviser, UNDP/FAO project INS/9O/O24
Mr AMWASI IDRUS	Staff Member, Directorate General for Human Settlements

Ministry for Home Affairs, Jakarta

Mr SUDARSONO	Director, Directorate for Urban Development
Mr ZULKARNAIN ZUBING	Director, Directorate for Environment and Development Structures
Mr FASLI SIREKAR	Staff Member, Directorate for Environment and Development Structures
Mr IRWAN IDRIS	Staff Member, Directorate for Environment and Development Structures
Mrs ALINA	Staff Member, Directorate for Environment and Development Structures
Drs SOEBEKTI	Staff Member, Directorate for Environment and Development Structures
Mr SYAMSUL ARIEF	Staff Member, Bureau of Planning and Organization
Mr J. GEBSE	Staff Member, Directorate General for Development Arrangements and the Environment

Ministry of Agriculture

Dr S. MUNANDAR	Head, Subdirectorate for Land Development, Jakarta
Mr MARDI BAGYANA	Staff Member, Subdirectorate for Land Development, Jakarta
Dr KORSI SABAYANG	Head, Subdirectorate for Land Rehabilitation and Soil Conservation, Jakarta
Ir WIDITO	Staff Member, Subdirectorate for Land Rehabilitation and Soil Conservation, Jakarta
Ir SUYITNO	Staff Member, Subdirectorate for Water Management and Irrigation, Jakarta
Mr Martin SMITH	CTA, FAO-executed project GCP/INS/O59/NET 'On-farm water use and management', Jakarta
Dr YUNAN	National Expert, FAO-executed project GCP/INS/O59/NET 'On-farm water use and management', Jakarta
Dr W.M. NASOETION	Head, Subdirectorate for Food Crop Development for Transmigration Areas, Jakarta
Ir S. PURWANTO	Staff Member, Subdirectorate for Food Crop Development for Transmigration Areas, Jakarta
Dr MADE OKA	Staff Member, Food Crops Research Institute, Bogor
Dr J. FRENCH	USAID Research Extension Adviser, Jratunseluna Upland Agriculture and Conservation Project, Salatiga, Ungaran.

Ministry of Transmigration

Mr O. EDDY SURYADI	Head, Directorate for Environmental Affairs, Jakarta
Mr TADJRI L.K. HANAFI	Staff Member, Soil and Water Conservation Division, Jakarta

National Land Agency

Dr SUDJARWO	Deputy Head, Land Tenure and Land Use, Jakarta
Dr MARYUDI SASTROMIHARDJO	Director, Directorate for Land Use, Jakarta
Mr IWAN ISA	Staff Member, Directorate for Land Use, Jakarta
Dr SOEDARIJANTO	Deputy Head, Land Rights, Jakarta
Mr R.M. MANURUNG	Staff Member, Land Rights
Mr S. SITORUS	Head, National Land Agency, Kupang
Mr SUDRI	Staff Member, Land Use, Bogor
Mr MAMAT	Staff Member, Land Titling, Bogor
Mr SUTARDJA	Staff Member, BPN/KA, Jakarta
Mr SUMARYANTO	Chairman, Land Reform, West Java Province, Bandung
Ir SUGIARTO SARGO	Head, Land Use Data Section, Land Reform, West Java Province, Bandung
Ir PRIHATINI	Head, Planning Section, Land Reform, West Java Province, Bandung
Mrs SUKESI	Staff Member, Land Use Section, Land Reform, West Java Province, Bandung

Environmental Development in Indonesia (EMDI) (Canadian-assisted Project), Jakarta

Dr S. MOIR	Spatial Planning Adviser
Dr J. ALDER	Coastal Management Adviser
Drs R.P. SUDARMO	Air Quality Adviser
Dr R. WATSON	Marine Biodiversity Management Adviser
Mr P. NEAME	Amdal Adviser

Soil Research Institute (SRI), Bogor
recently redesignated **the Centre for Soil and Agroclimate Research (CSAR)**

Dr JOKO SANTOSO	Acting Director, Soil Fertility Group
Mr G. SOBOWO	Researcher, Soil Fertility Group
Dr M. SUKARDI	Head, Soil Mapping and Classification Group
Mr ISMANGUN	Soil Mapping and Classification Group
Mr DJAENUDIN	Soil Mapping and Classification Group
Mr KOSUMO NUGROHO	Soil Mapping and Classification Group (Computer applications)
Mrs ERNI SUSAMI	Researcher, Agroclimatology Group
Mrs SOPHIE ABUJAMIN	Researcher, Soil Conservation Group

Ministry of Education and Culture

Dr Ir SARWONO HARDJOWIGENO	Head, Postgraduate Soil Science, and National Expert, Land-use Planning, Bogor
Professor BOEDI HARSONO	University of Indonesia, and National Expert, Legislation, Jakarta
Dr RACHAN SUTANTO	Soils Department, Faculty of Agriculture, Gadja Mada University, Yogyakarta
Dr M. IDRISS	Deputy Dean, Faculty of Agronomy, University of South Sulawesi, Ujung Pandang
Dr NOGO KADIRA	Head, Soils Department, Faculty of Agronomy, University of South Sulawesi, Ujung Pandang
Dr SOBUR	Soil Scientist, Faculty of Agronomy, University of South Sulawesi, Ujung Pandang

Dr SYAMSU BARHIMAN	Deputy Dean, Faculty of Agriculture, University of Nusa Tenggara, Kupang
Dr YAN RAFAEL	Assistant Dean, Faculty of Agriculture, University of Nusa Tenggara, Kupang
Dr W. MELLA	Soil Scientist, Faculty of Agriculture, University of Nusa Tenggara, Kupang

BAKOSURTANAL [National Mapping Agency], Cibinong

Dr JACUB RAIS	Director

Ministry of Mining and Energy

Dr P.H. SILITONGA	Director, Directorate for Environmental Geology, Bandung
Ir TJETJE APANDI	Head, Urban Environment Geology Section, Directorate for Environmental Geology, Bandung
Mr DEDI BISRI	Staff Member, Directorate for Environmental Geology, Bandung

WALHI [Indonesian Forum for Environment]

Mr HANNI ADIATI	Staff Member, Coordination, Jakarta

PANTAI INDAH KAPUK [Waterfront City]

Ir WIRYAWAN	Real Estate and Property Developer, Jakarta

FAO Representation, Jakarta

Mr D. VUJICIC	FAO Representative
Mr ABUL ZAHAB	Programme Officer
Mr LANDI	Administration Officer
Mrs LINA USMAN	National Programme Officer
Mr R. DEMETRIUS	National Administrative Officer

FAO Headquarters, Rome

Dr W.G. SOMBROEK	Director, Land and Water Development Division (AGLD)
Dr R. BRINKMAN	Chief, Soil Resources, Management and Conservation Service (AGLS)
Mr D.W. SANDERS	Senior Officer, Soil Conservation Group, AGLS
Mr R.N. GALLACHAR	Staff Member, Soil Conservation Group, AGLS
Mr F. SEGALA	Staff Member, Soil Conservation Group, AGLS
Mr S. BURCHI	Legal Officer (Land and Water), LEGN
Mr B. APPELGREN	Senior Officer, Water Development Group, AGLW

Appendix 2

Statistical information on some land-related issues

TABLE 1
Land use in Indonesia in 1989 (in '000 ha)

Region	Human settle-ments	Agricultural land use				Forests	Other land uses
		Sawah	Upland	Estate cropping	Home garden		
Sumatra	789	2 006	1 418	6 106	1 231	32 088	3 792
Java & Bali	1 673	3 620	2 597	684	1 075	2 985	825
Kalimantan	197	728	2 285	1 388	441	41 595	8 140
Nusa Tenggara	88	340	648	212	238	4 544	2 123
Sulawesi	415	790	959	911	670	13 696	1 739
Maluku	39	4	182	597	327	6 846	351
Irian Jaya	30	28	919	20	80	35 612	4 791
Total	3 232 2%	7 517 4%	9 008 5%	9 917 6%	4 062 2%	137 366 71%	21 022 10%

Source: National Land Agency, 1991

TABLE 2
Area within forest boundaries (Forestry Department classification) (in '000 ha)

Island	Forest Reserves	Protection Forest	Production Forest		Conversion Forest	Total
			Limited	Fully		
Sumatra	3 684	7 094	7 579	6 821	5 032	30 210
Java & Bali	444	554	0	2 014	0	3 012
Kalimantan	4 101	6 924	11 415	14 234	8 293	44 967
Sulawesi	1 406	3 867	3 926	2 092	1 993	13 284
Maluku & Nusa Tenggara	779	3 229	2 874	1 581	3 444	11 907
Irian Jaya	8 312	8 649	4 732	7 123	11 775	40 591
Total	18 726 13%	30 317 21%	30 526 21%	33 865 24%	30 537 21%	143 971 100%

Source: Deparment of Forestry data for 1986/87, cited by World Bank, 1990

TABLE 3
Approximate total of deforested land in Indonesia up to 1989

Five-Year Plan development period	Area of land deforested (ha), due to	
	Transmigration	Shifting cultivation
Repelita I (1969-1974)	46 300	n/a
Repelita II (1974-1979)	83 000	n/a
Repelita III (1979-1984)	500 000*	n/a
Repelita IV (1984-1989)	750 000*	7 321 000
Total	1 379 300	7 321 000

Notes: n/a = not available; * author indicates these these values are significant underestimates. **Source:** Sinukaban, 1988

TABLE 4
Dragged sediment and erosion intensity in some representative rivers in Bali and Java

Catchment area and rivers	Dragged sediment (t/year)	Erosion intensity (mm/year)
Cimanuk Catchment Area		
Jatibarang	269	1.06
Cipeles (Warung Peti)	8 467	24.85
Cilutung (Dam Kamun)	2 788	7.15
Cikerug (Ligung)	2 161	5.47
Citanduy Catchment Area		
Tunggilis	1 769	6.94
Cimuntur (Battunung)	9 147	26.68
Cijolong (Cikadu)	2 872	8.23
Cikawung (Cimei)	437	1.33
Ciliwung Catchment Area		
Kalibata	179	0.51
Citarum Watershed Area		
Tanjungpura	123	0.35
Cisanggarung		
Cilengkrang	679	2.01
Pemali Catchment Area		
Brebes	1 666	5.59
Bungarwan Catchment Area		
Solo	1 245	5.90
Madium (Ngawi)	1 352	5.41

Source: Central Research and Irrigation Development, Ministry of Public Works, Bandung

TABLE 5
Population ands Population density in Indonesia

Island	Population ('000s)	Persons/km²
Sumatra	36 455	59
Java & Bali	110 350	690
Sulawesi	12 521	55
Kalimantan	9 109	12
Nusa Tenggara	8 386	65
Maluku	1 856	19
Irian Jaya	1 641	3
Total	179 321	77

Source: Central Bureau of Statistics

Appendix 3

A summary description of the soils of the main islands

The soils of north and central Sumatra are dominated by highly weathered Ultisols and Oxisols (Hapludults/Haplorthox), associated with moderately deep Inceptisols (mainly Dystropepts), developed over volcanics (usually of andesitic nature) and clays, sandstones, shales and conglomerates. Entisols are observed on sediments in the east. Lowland units associated with these substrata are mainly Tropaquepts and Tropaquents, occasionally Psammaquents. In central east (Riau and Jambi provinces) and south Sumatra, recent alluvia are often intermixed with extensive peat areas bearing Histosols (Tropohemists).

Java and Bali have been mainly built up by active volcanoes, the higher parts of which are covered by Andosols (mainly Dystrandepts), with Ultisols (Hapludults/Paleudults) in the humid western parts and Alfisols (Hapludalfs) in the drier east. The Alfisols also have characteristic local inclusions of Tertiary and Quaternary limestones and carbonaceous rocks scattered over the islands. On Tertiary shales and claystones, a complex of Inceptisols and Ultisols (e.g., Dystropepts/Hapludults) develops in the west, while Inceptisols/Alfisols (Eutrandepts/Hapludalfs) dominate in the drier, eastern parts. Recent alluvial deposits are often characterized as Inceptisols (Tropepts or Tropaquepts), depending on their moisture status.

In Kalimantan the dominant soils are Inceptisols (Dystropepts) and Ultisols (Hapludults), although varying markedly in nature and properties as a function of their parent material, which are Tertiary sandstones and shales in the centre and east, and Mesozoic or Tertiary volcanic intrusions of granite in the west. On the extensive areas of Quaternary, loosely consolidated sands and gravels in the south, Spodosols (Plagaquods) dominate, with major inclusions of Tropohemists in the peat areas. Scattered outcrops of carbonaceous substrata in the east and southeast are covered by Hapludalfs and Hapludults.

The soils of Sulawesi are predominately Inceptisols (Dystropepts), commonly associated with Hapludults in the southeast and southwest. This soil type hardly reflects however the enormous diversity of parent materials, and their obvious impact on soil chemical and physical properties.

The soils of Nusa Tenggara are mainly Dystropepts, associated in the west (Lombok and Sumbawa islands) with Humitropepts, and in the east (Flores, Sumba, Timor) with Calciustolls, Ustochrepts and Humitropepts. This distribution corresponds to the decreasing rainfall from west (1 500-2 500 mm/yr) to east (500-1 500 mm/yr with a 6-month dry season), as well as with the variation in the geological substrata, ranging from Tertiary and Quaternary volcanics in West Nusa Tenggara, to outcrops of Tertiary and Quaternary limestones (Flores), Paleozoic

sedimentaries, Tertiary sand and claystones or Tertiary/Quaternary limestones/coral reefs (Timor and Sumba) in the east.

The soil parent materials in north Maluku comprise Tertiary and Quaternary volcanics, Tertiary sedimentaries, and ultrabasic rocks, while in south Maluku the Tertiary and older sedimentaries, and metamorphic gneiss, dominate. Soils are primarily Inceptisols, mainly Dystropepts and Humitropepts, over all the area, with inclusions of Oxisols (mainly Haplorthox) in the north and of Mollisols (Rendolls) in the south.

In Irian Jaya the soils of the central highlands are mainly classified as shallow Entisols and Inceptisols (Troporthents and Humitropepts), being a reflection of the strong erosion on these Tertiary and older, loosely consolidated sands and gravels. Towards the north, Dystropepts are associated with Fluvaquents and Tropaquents as major lowland units. In the south, extensive areas of sand and gravel occur, on which recent alluvium and peat have been deposited. Dominant soils are Tropohemists on the peat, Hydraquents in the mangrove area, Tropaquepts on the higher terraces and Paleudults (Paleustults in the drier Merauke area) on the better drained uplands.

Table 1 of Appendix 3 gives an idea of the estimated extents of the major soil types in Indonesia, classified according to the USDA-Soil Taxonomy (USDA, 1990) and to the National Soil Classification (Soepraptohardjo, *et al.*, unpubl.) systems.

TABLE 1
Soils distribution and extents (in '000 ha) according to USDA Soil Taxonomy and to National classifications

Soil unit	Java & Bali	Sumatra	Kalimantan	Sulawesi	Irian Jaya	Nusa Tenggara	Maluku	Total
Histosols *Organosol*	25	6 781	6 469	--	10 875	--	--	24 150
Entisols *Alluvial*	2 581	6 238	5 644	1 363	2 575	281	488	19 170
Entisols/Inceptisols *Regosol*	1 660	831	150	294	--	688	294	3 907
Mollisols *Rendzina*	38	394	--	138	369	13	719	1 671
Vertisols *Grumosol*	1 481	--	--	56	--	263	--	1 800
Inceptisols *Andosol*	844	2 725	1 225	156	--	94	12	5 056
Alfisols *Mediteran*	1 681	--	--	2 938	106	3 068	50	7 843
Inceptisols/Oxisols *Latosol*	3 081	6 788	4 469	2 856	356	313	519	18 382
Ultisols *Podz. Mer. K.*	325	15 950	14 525	1 494	12 001	--	3 231	47 526
Spodosols *Podosol*	--	931	4 081	--	--	--	--	5 012
Undifferentiated complex	2 069	6 725	17 437	9 800	15 918	2 319	2 162	55 822
Total	13 774	47 363	54 000	19 095	42 200	7 038	7 475	190 946

Notes: USDA Soil Taxonomy classification (USDA, 1990) in roman type; National soil classifications (Soepraptohardjo *et al.*, unpubl.) in *italics*.