

4.5 Public Concerns in the Donor Basins

The results of public campaign meetings carried out by TEAM JV in each sub-district (Tambon) to inform local people of the Kok-Ing-Nan Project as part of the EIA studies are summarised below. After each item, how and to what extent this issue has been resolved is presented in *italics*.

(1) People Along the Kok-Ing Diversion Route

- Concerns about the mode, amount and timing of compensation for land and property.

The EIA Report presents the results of detailed studies, with extensive surveys and public consultations, to identify land and resources affected and of calculations of the initial compensation figures, as per prevailing governmental regulations. During the next stage, when detailed surveys will be carried out, negotiations should be undertaken with the project-affected people at an early stage, through tambon-level land committees to be set up to streamline the land acquisition and compensation process.

- Many suggestions for the development of small-scale irrigation projects in the Kok basin including along the Nam Mae Lao, using water from the KIN diversion canal so that local people derived a direct benefit from the project.

The EIA Report identifies potential irrigation areas along the Kok-Ing diversion alignment. These need to be detailed at an early stage.

- People are very worried about the potential effect of the diversion canal construction on the existing Peoples' Irrigation Systems (PIS). These concerns relate to flood flow, loss of water supplied to PIS, temporary use of their land during construction period, and structures across the diversion canal.

The EIA Report has not addressed these impacts adequately. The JICA Feasibility and environmental studies in Phase II have addressed these issues in some detail and have proposed mitigation measures. The results should be incorporated into the EIA Report. The environmental measures incorporated in the project facilities planning include:

- Design of the water level in the open canal is 2 m below ground level so that the existing irrigation and drainage canal may cross over the diversion canal.
- Crossing by syphon is not adopted due to hydraulic losses and potential maintenance difficulties.
- Provision of bridges and crossing structures along the diversion canal to maintain good communications between the villages

(2) People Along the Ing-Yot Diversion Route

- People are quite disappointed about the route and the planned structures as they will not be able to access the diverted water, as it generally within tunnels and cut-and-cover conduits. The tunnels and conduits are deep below the ground surface. People were asked to propose other water resources development projects in the area, to identify additional irrigation projects expressly for their benefit.

The EIA Report has identified potential irrigation areas along the Kok-Ing diversion alignment, including areas in the Lower Ing basin. These need to be detailed at an early stage.

- Serious concerns were expressed regarding tunnel spoil material quantity, quality, disposal and effects on land and water resources.

The EIA Report addresses the issue of finding suitable sites for the tunnel spoil material disposal but does not provide details on how these sites will be designed and managed. This will need to be undertaken during the detailed design stage. The possibility of using the tunnel spoil material as a resource for the benefit of the donor basins has been studied by the JICA Study Team in Phase II environmental studies and elaborated in this report. These issues need to be incorporated into the EIA Report.

- Concerns in the Lower Ing regarding water shortages in the dry season due to misconceptions about possible diversions in the dry season from the Ing River for maintaining environmental flows.

This issue has to be addressed by providing better information to the public about the project, together with assurances that water diversion will only occur during the wet season and that minimum flows in the Lower Ing Basin will be conserved through the use of telemetry systems.

(3) People in Nam Yao Basin

- In the Nam Yao area, the terrain is hilly and mountainous, except near the river confluence with the Nam River. The people are very concerned about losing their land, especially those people in the proposed Nam Yao reservoir area. They requested assistance in finding suitable land for resettlement.

The EIA Report has identified locations for a 'land for land' compensation package. These are outlined in the summary of the EIA Report, presented in the accompanying Supporting Report

- Many people have been misinformed that the government is going to charge for water taken from the Nam Yao River. Some said that the project's main purpose is to divert water for electricity generation at the Sirikit Dam.

This issue has to be addressed by providing better project information to the public.

- Nam Yao River access and safety.

The EIA Report records that information has been disseminated to people on the Nam Yao River Improvement. The Improvement is necessary to accommodate the greatly increased flow during water diversion. The information included:

- *the width of the river at a particular reach (at each km.),*
- *how the river is going to be improved, by dredging, widening and building some retaining weirs;*
- *how the Project will be operated so that the diversion will be stopped in the event of impending flood in the Nam Yao or Nan River.*

However, the EIA Report itself does not provide any details on the access and safety considerations during high flow conditions in the Nam Yao River in the wet season during project operation. Ladders are mentioned, but these are hardly a safe means of accessing the river. Details concerning this are to be found in the project facilities plan description in the JICA feasibility studies and need to be incorporated into the EIA Report.

- Ban Na Nun #1 villagers are very concerned that the additional diverted discharge will inundate their agricultural lands used for growing tobacco plant in the dry season.

This issue has to be addressed by providing better information to the public concerning the design of project facilities to control flooding.

- Concerns about compensation and resettlement were expressed.

The EIA Report presents the results of detailed studies, with extensive surveys and public consultations, to identify land and resources affected and of calculations of the initial compensation figures, as per prevailing governmental regulations. During the next stage, when detailed surveys will be carried out, negotiations should be undertaken with the project-affected people at an early stage, through tambon-level land committees to be set up to streamline the land acquisition and compensation process.

- The forestry workers from the existing DANCED project asked about potential problems relating to sedimentation and potential impacts on existing aquatic plants.

Sedimentation impacts and measures have been addressed in the EIA Report.

- Benefits through irrigation development in the Nam Yao basin

Six small-scale pumped irrigation projects, with a total area of approximately 2,300 rai, have been proposed for use by riparian inhabitants along the Nam Yao River. The EIA Report has identified potential irrigation areas along the Nam Yao riverbank. These need to be detailed at an early stage.

4.6 Thai and International EIA Guidelines

The EIA Report prepared by TEAM largely follows the 1979 NEB guidelines and conforms to the suggested format. However, the new OEPP guidelines also require consideration, and it is important to produce a document in line with current practice and expectations of the agency responsible for the administration of EIA in Thailand.

(1) Consideration of Alternatives

One very noteworthy requirement of the OEPP guidelines is a section on "Consideration of Alternatives". No such section is included in the EIA Report.

This refers firstly to consideration of the 'No Project' alternative and of 'Alternative Project(s)' to the proposed KIN Project, and the requirement to present a justification of why the KIN project is being considered. A brief mention of an alternative trans-basin diversion project by EGAT is included at the beginning of the EIA Report. However, there is no information as to whether alternative project options like Improved Participatory Water Management Approaches in the Chao Phraya Basin have been considered and compared with the KIN Project - a costly, complex dam and tunnel trans-basin diversion scheme. This issue is important given the prevailing situation in the Chao Phraya basin, where increasing water shortages are experienced for paddy cultivation and where irrigation water utilisation and management practices are critical issues subject to much debate.

The consideration of an 'Alternative Project' becomes all the more important when there is seen to be limited benefit to the donor basins, and when benefits to the end users in the Chao Phraya basin are also unclear, questionable and subject to innumerable assumptions. Economic development of the northern region is a national priority and the region's resources need to be considered for best use for

its own development. The EIA Report does present preliminary details of potential irrigation development (wet season only) for an area of 45,800 rai in the KIN basins, through installation of fourteen pumps on the diversion canal route and pumping water to the irrigation development areas. However, the benefits to the donor basins of this sub-project need to be evaluated and it established whether they would make a significant contribution to the donor basins' economic development.

The JICA Feasibility Study Report presents detailed information and analysis in the donor and beneficiary basins concerning the river basin characteristics, the socio-economic conditions including existing agricultural conditions, water resources development and management, and water demand projections. This is followed by a justification for the KIN project through the project 'Identification' and 'Necessity'. Alternative trans-basin diversion plans (limits on water resources development in Upper Chao Phraya Basin, alternative trans-basin diversion studies in the past, and the water agreement for development of the Mekong Basin) have also been discussed as part of the KIN Project 'Identification' and 'Need'. These details need to be incorporated into the EIA Report.

This report presents details of several supplementary environmental studies conducted with the objective of maximising benefits to the donor basins. Various measures, strategies and projects concerning watershed management, PIS, fisheries, aquatic ecology and freshwater biodiversity, tunnel spoil material utilisation and the setting up of a Donor Basin Sustainable Development Fund (DBSDF) have been proposed for the KIN area. Details of these supplementary studies need to be incorporated into the EIA Report to further the concept of 'supporting projects' to the KIN Project, for environmentally sustainable development and equitable sharing of potential benefits between the donor and beneficiary basins.

Furthermore, the EIA Report does not present the alternative project facility configurations (siting, type, route), the environmental aspects considered, and the environmental advantages of the selected alternative. This is important as the EIA Report will be evaluated by OEPP and international funding agencies and should be considered as a stand-alone document, presenting all environmental considerations that have been assessed in each project phase. Table 4.4.1 presents this information as prepared by the JICA Study Team.

The JICA Feasibility Study Report also presents details of mitigation measures that have been incorporated into project facilities, selection and design. These are summarised as follows:

(a) Kok Intake

- Siting of the Kok intake on public land, thus eliminating the need for land acquisition.
- Design of the Kok intake at the low level of 388 m, thus reducing the danger of inundating Muang Chiang Rai.
- Planning of a large (10 ha) intake bay in front of the intake gates to act as a sedimentation basin. The sediment that accumulates in the intake bay will be removed by dredging on a regular basis.

(b) Kok-Ing Water Diversion Canal

- Selection of the open canal route to minimise land acquisition and avoid resettlement of villages and people.
- Design of the open-canal water level at 2 m below the ground surface, so that the existing irrigation and drainage canals may cross the diversion canal by some form of bridging structure. The possibility of crossing the canal using a siphon has not been adopted because of hydraulic losses and potential maintenance difficulties.
- Provision of bridges and crossing structures along the diversion canal to ensure continuation of access and communication.

- Design of the canal in culverted sections in higher areas, rather than open canals that would require acquisition of larger areas of land.
- Allocation of a small volume of the diversion water to the existing farm area in the Tak and Ing basin, which currently suffer water shortages in the dry season.

(c) Ing Diversion Weir

- Selection of the project site for the Ing diversion weir 2.8 km upstream of the Thoeng bridge (Road 1020), thus avoiding resettlement and land acquisition problems.
- Creation of a pond behind the weir when the Ing weir is inflated that will not only allow the storage of irrigation water but also enable fish culture.
- Diversion of 175 m³/sec of river runoff during the wet season, thus helping alleviate the magnitude of the existing inundation problem in the area along the Ing river.
- Allowing the runoff in the Ing-Lao to flow freely down the Ing river for the benefit of the downstream area in the lower Ing basin, rather than being diverted.

4.7 Environment Management

It is useful also to evaluate also how the TEAM JV EIA Report meets international donor agency guidelines as both technical assistance and financial assistance may become necessary if the project moves on to detailed design and implementation stages. International donor agency guidelines stress the requirement for sensitive handling of 'Resettlement and Compensation' issues of project-affected persons (PAPs) who lose land, housing or other resources, thereby potentially affecting their livelihood. Participatory consultative approaches are stressed and general requirements are that the Project should provide the PAPs with a better quality of life than they enjoyed without the project. Assessment of cumulative impacts of projects, policies and programmes collectively, and a proposed project's contribution to sustainable development are all necessary elements of any EIA.

Most guidelines would also require the EIA Report to include as a minimum an outline of an Environmental Management Plan (EMP). The EMP provides for the management and mitigation of environmental impacts identified in the EIA Report for the construction, operation and decommissioning phases of the project. No outline of the EMP is presented in the EIA Report. A suggested outline is presented below that will require further elaboration during the detailed design stage.

(a) Environmental Management Plan Outline

Background

The EIA should include an outline Environmental Management Plan (EMP) for the management and mitigation of environmental impacts of the construction, operation and decommissioning of the project facilities. The plan should include:

- a demonstration of sound environmental management practices;
- identification of all licensing and approval requirements; and
- an outline of a monitoring programme and procedures for reporting results.

The plan will act as an environmental operations manual for the environmental management and operation staff of the Proponent Agency RID. It will also be an advisory document to regulatory authorities. Consequently, it will be updated as required.

Separate EMPs will be prepared by the Construction Contractors (CCs) (referred to hereafter as EMP-CCs) for environmental management of construction-stage impacts of individual

construction sites. Elements of a typical EMP-CC are presented below after the outline of the EMP

All EMP-CCs to be prepared by the various CCs will be an integral part of the project EMP.

Construction Stage

The management plan outline for construction of the project facilities is given below. The EMP-CCs will be prepared in accordance with the development consent conditions and in consultation with the relevant authorities and community groups in the project area, including:

- Office of Environmental Policy and Planning (OEPP);
- Pollution Control Division;
- Royal Forest Department;
- Department of Highways;
- Provincial and district planning offices;
- Department of Mineral Resources;
- DEDP;
- Electricity Generating Authority of Thailand;
- Department of Fisheries;
- Peoples Irrigation System (PIS) representatives; and
- NGO and community groups.

The EMP for construction of the project facilities will address the following:

- development approval conditions (these may be imposed by OEPP as part of the EIA approval);
- working hours;
- noise control;
- traffic;
- dust control;
- management of excavated and tunnel spoil material;
- waste disposal measures;
- erosion and sediment controls;
- re-vegetation and site rehabilitation methodology;
- any approvals or licenses required; and
- monitoring requirements.

The last item, environmental monitoring requirements, has been presented in the EIA Report by TEAM and is also summarised in the *Supporting Report*.

Operation Stage

The environmental management of the KIN Project operations and maintenance will involve many factors differing in both origin and location. As such, a site-specific Environmental Procedures Manual will need to be prepared to describe monitoring and operating procedures, as well as assigning environmental management responsibilities to specific positions within the management structure. The manual will also establish procedures for project security, complaint reporting and contingency plans to be followed up in the event of an emergency. Key areas for which the manual needs to detail procedures include:

- water management;
- land management and rehabilitation;

- waste management;
- environmental monitoring;
- rehabilitation monitoring;
- environmental reporting and administration;
- environmental training and awareness;
- administrative procedures; and
- emergency response.

The EIA Report and Section 3.4 of this report present the environmental monitoring requirements for the project's operation stage.

Project Area Security

Site security will be an important component of the EMP. The plan will detail fencing, access arrangements and inspection programmes. Contact details and staff responsible for liaison will be detailed as well as visitor management and registration procedures.

Contingency Planning

Conditions may arise that require a specific response to prevent or mitigate an environmental impact during construction of the project facilities and operations. In order to prepare for this, a range of anticipated contingencies and predetermined corrective actions will be specified in the EMP, including responsibility. Some typical examples are:

- release of fuel or oil from machinery leading to contamination of waters; removal or isolation of source, use of absorbent booms to remove oil, and make necessary repairs may be corrective actions under the responsibility of the Site Supervisor;
- excessive dust emissions causing nuisance might require the use of sprays or other measures that may need to be implemented by Site Supervisors.

Complaints Procedure

As a result of increased community awareness of the environmental impacts of the Project, it is extremely important to document and manage complaints in a consistent and thorough manner. This will also ensure that the resolution of issues and community concerns is achieved as soon as possible.

The EMP will detail procedures for receiving and acting on complaints and the appropriate chain of reporting and responsibility. Procedures for managing complaints may include:

- establishing a 24-hour complaint hotline;
- recording complaint details; and
- documenting resolution of complaints.

(b) Elements of the Construction Contractor's Environmental Management Plan (EMP-CCs)

(a) *Site Installation and Services*

- Scope of Work;
- Contractor's Site Office, Stores, Warehouses, Materials Yards, Concrete and Material Processing Plants, Workshop of construction equipment;
- Materials Testing Laboratory;
- Communication Systems;
- Site Communications;

- Communication Systems in Underground Works;
- Outside Communications;
- Service Vehicles;
- Camps for Contractor's Employees;
- Medical Care Facilities;
- Power Supply and Illumination;
- Water Supply;
- Sanitation and Sewerage;
- Waste and Garbage Disposal;
- Fencing and Site Security;
- Inspection and Monitoring; and
- Final Clean-up.

(b) Environmental and Safety Precautions

- Safety Programme and Its Implementation;
- Safety Standards;
- Personal Safety Equipment (General and for Underground Works);
- Rescue Team;
- Illumination and Earthing (General, Illumination of Underground Works, Earthing, Wet Work Areas, Control of Electricity Discharges);
- Maintenance of Traffic and Safety on Public Roads;
- Storage and Transport of Explosives;
- Blasting (if used; General and Underground Works);
- Ventilation of Underground Works (General, Underground System);
- Control of Dust, Silica and Noxious Gases in Underground Works;
- Provisions for Train Traffic in Underground Works;
- Fire Precaution;
- Dust Abatement; and
- Pollution of Springs, Groundwater, Streams and Rivers.

4.8 Technical Adequacy of EIA Report

The present section evaluates the adequacy of the TEAM JV EIA Report. The EIA Report presents a baseline environmental data concerning environmental aspects compiled through secondary data review, field surveys, investigations and sampling programmes for various parameters. There is a baseline data for carrying out the assessment and most environmental components' existing conditions have been well studied. This information has been used to evaluate the impacts due to the proposed project facilities and mitigation measures have been proposed.

The proposed trans-basin diversion project is very complex in terms of the range of proposed structures in varying topographic conditions. The construction period of the project would be anything from seven to twelve years, perhaps longer, for construction of all of the planned project components. All this entails complex environmental impacts both positive and negative.

Impacts also vary according to the considered project component and environmental parameter, and in many cases these are inter-related. OEPP in its Guidelines stresses the importance of determining the severity of impacts whether negative or positive, to humans in each element. In other words, the social environmental impacts and adequacy of public consultations as well as public opinions of affected people are extremely important.

The TEAM JV EIA Report largely classifies and analyses the impacts in various project stages as to whether they are temporary or permanent. Limited parameters are assessed bearing in mind the construction schedules and implementation. Mitigation measures take many forms:

- Consideration in determining project facilities' route alignment and siting. This is a form of avoidance or minimisation of negative environmental impacts. Table 4.4.1 presented some of these considerations.
- Incorporation of environmental protection structures or modification of project structural facilities design. This is a form of minimisation and control of negative impacts. The JICA Feasibility Study presents details of mitigation measures that have been incorporated into project facilities selection and design. These were presented in section 3.2. The JICA Feasibility Study also presented preliminary designs of various project facilities, including several with environmental considerations. These include:
 - crossing structures such as culverts in the Kok-Ing diversion canal section;
 - a regulating pond, and the protection of the river bed and banks near the Ing diversion weir and Ing River;
 - a culvert and a syphon in the Lao diversion canal section; and
 - a spoil bank and a drainage system along an access road in the Ing-Yot tunnel section.
- Compensation for irretrievable losses. This refers to items like houses, trees, crops and land that are discussed in detail in the EIA Report.
- Alternative or additional development projects (also termed 'associate projects') such as reforestation projects, watershed management projects, and livelihood development projects for project-affected people, donor-basin economic development projects, etc. These are forms of compensatory measures, targeting long-term, indirect and, very often, intangible negative impacts. They are necessary for meeting equitable social development objectives, and to achieve sustainable development of natural resources. These have been discussed in earlier sections of this chapter.
- Mitigation measures during project construction. These specifically address the wide range of construction-related impacts. A large number of these mitigation measures would be incorporated in the Construction Contractor's EMP-CC documents concerning construction management and supervision. Other aspects addressed by these mitigation measures would include issues such as controlling in-migration, and an appropriate complaint-management mechanism for environmental problems arising out of construction activities in affected villages and communities. The EIA Report has detailed these mitigation measures for each environmental parameter and project facility type and location.
- Operation stage related mitigation measures. These have been presented adequately with respect to most parameters in the EIA Report.

The EIA Report discusses construction and operation stage impacts and mitigation measures adequately for most environmental parameters. Compensation measures for land, houses, trees and crops are also well detailed for irretrievable resource losses such as land, forest and trees.

The following comments concerning specific environmental parameters, some of which are referred in the previous section 4.3, need to be noted:

- **Groundwater** – The significance of the impacts of tunnelling and excavation of deep channel sections on the groundwater resources is understated. There are both shallow and deep aquifers to be found along the diversion route and many of these feed the streams, rivers and springs in the mountain areas.

The Phu Sang waterfall area is close to the Ing-Yot tunnel. The basis for assessment of groundwater-related impacts is expert value opinion and does not seem to be correlated with the baseline information presented. The relationship between shallow alluvial aquifers and the flow of surface stream and rivers has not been studied. This is important because of hydraulic influences. Groundwater de-watering and disposal into surface streams during construction of the tunnel and deep excavation channel areas and related impacts on local water users need to be detailed and mitigation measures formulated. These aspects need to be studied in detail in subsequent stages.

- **Hydrology and surface water quality** – Water pollution resulting from tunnel construction is produced by groundwater seepage, drilling water and wastewater from construction labour force camps. Only the last is identified in the impacts and mitigation measures section, in the form of the recommendation for treatment of wastewater prior to discharge to nearby water bodies. Water seepage in tunnel construction due to groundwater is common and it is very difficult to construct a tunnel without discharge of water. Adequate treatment plant to control acidity and sediments resulting from tunnel construction would be necessary before discharge into surface waters. These aspects need to be studied in detail in subsequent stages.
- The impacts on water resources due to construction or improvement of access roads to adits 4,5 and 6, which have perennial streams flowing near or along the planned access roads should be adequately addressed, referring to the existing road condition.
- **Aquatic ecology and fishery resources** – The significance of negative environmental impacts is largely understated. Measures for regeneration of aquatic life are not given. This would be necessary as in many sections of the diversion route, such as the Nam Yao River training area, the benthic organisms would be significantly affected by the project actions and the construction period is quite long. Issues such as project facilities being a barrier to fish movement are should be adressed.

Fisheries impacts are generally studied by using the results of fish and macro-invertebrate surveys to establish possible impacts on fisheries through disturbance of the food chain. Further, it is necessary to determine how project actions in various sections of the KIN alignment would disturb or influence habitat, or otherwise impact fisheries resources.

- **Forest resources** – The impacts due to construction or improvement of access roads on the forest resources of the area are not assessed adequately. These impacts in terms of providing improved access to forests previously difficult to reach have great significance in both project construction and operation stages due to the strong demand for wood for home fuel.
- **Water use / irrigation** – The impacts on existing water use of water resources in the right of way (ROW) of the KIN facilities are assessed not to be significant so long as adequate temporary drainage facilities are provided during the construction stage. However, it is not known how and from where the water demand is to be met for various construction activities, especially in the dry season when the majority of construction works are proposed. These activities include tunnel drilling, canal excavation works and project facilities construction works. If the existing water resources near the ROW of the diversion project are to be used for construction purposes, impacts on existing users would be significant. There are no estimates of water demand for construction of the KIN project. These aspects require study to formulate more concrete mitigation measures to minimise the impact on available water resources.
- **Social and economic issues** – While impacts due to the loss of agricultural land and consequent income loss to project affected persons in the donor basins have been determined, measures in terms of policies and projects aimed at improving donor basin development, economy and social well-being are limited. Without proper consideration of these issues, public acceptance of the project in the donor basins will not be easily achieved.

The following specific project works and their impacts and mitigation measures have wide-ranging implications on several environmental parameters. These have not been understood or elaborated well in the EIA Report:

- Tunnelling-related impacts of construction (including access roads and spoil material stockpiling areas) particularly related to impacts on surface water quality and drainage, and on groundwater, at all tunnel inlet, outlet and adit locations.
- Site management of all locations proposed to be used for stockpiling or disposal of spoil material resulting from canal excavation and from tunnelling.
- The Impacts of the Nam Yao river-training works, particularly those related to the human and social environment (e.g. use of the river for domestic, livestock, navigational and fisheries purposes) and impact on aquatic ecology.

4.9 Further Action/ Work

Firstly, consultations with OEPP are necessary as a first step to obtain feedback on the EIA Report and all works carried out by the JICA Study Team. Based on OEPP's comments and on those presented above, RID needs to further refine the EIA Report. The final EIA Report has to consolidate and bring together all information into one stand-alone volume, so that it can be submitted formally to OEPP to initiate the EIA approval process. This will also facilitate submission of the EIA Report to donor agencies if the need arises at a later date.

Secondly, if the EIA gets approval (with or without conditions) from OEPP and the project goes into the next detailed design phase, further environmental studies by RID should be focused on detailing environmental mitigation measures, the outlined EMP, and in refining the proposed environmental monitoring. The environmental monitoring has to relate closely with the mitigation measures and EMP, as well as to the available budget. The institutional and management requirements within RID also need to be defined at this stage and training determined.

Thirdly, RID needs to further improve its public awareness programme in areas where there are significant impacts. This is to control the spread of misleading information and to make people aware of the various steps that are being taken at the different project stages and of the supporting projects being planned to minimise negative impacts and increase benefits.

5. *SUPPLEMENTARY STUDIES*



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5.1 Watershed Management

(1) Introduction

Thailand is currently facing problems associated with natural resource management and degradation of environmental quality including loss of forestry resources and biodiversity, soil erosion, siltation of rivers and watercourses, saline intrusion of aquifers, pollution and increased flooding. The problems are partly caused by social and economic change, which has been particularly significant during the last thirty years. Changes include population growth and rapid economic growth, which has accelerated the rate of utilisation of natural resources, while the availability of non-renewable resources, has become increasingly scarce.

One of the most significant changes in Thailand in the last twenty-five years has been change in land-use and the conversion of naturally forested areas to agricultural land. Forest cover in Thailand has decreased from approximately 53% in 1961 to less than 26% in 1995. The depletion of forest areas has mainly been caused by the conversion of forested areas to agricultural land to provide subsistence food for the rapidly increasing population as well as agronomic expansion for commercial crops.

A large proportion of the change in land use has been the conversion of forested areas in the valleys and lowland plains for development of paddy fields for the production of rice and the development of areas for the cultivation of vegetable crops. However, a significant change in land use has also occurred in the more sensitive upland areas, leading to increased soil erosion and increased volumes of more rapid run-off, particularly on steeper slopes.

(2) Watershed Degradation

The impact of watershed degradation is evident both at source, in upstream areas and on downstream areas. Inappropriate land-use activities result in reductions in overall water yields from catchments, increased soil erosion and increased surface run-off. This in turn causes a decline in soil fertility, which is manifest by reduced crop yields. Effects include the increased evidence of dry season droughts as less water is absorbed into the soil profile during periods of precipitation, and of wet season flooding and increased siltation of rivers and reservoirs. The changing hydrology of catchments has far-reaching economic consequences on downstream water availability for agricultural, industrial and municipal requirements, for power generation and transport. In addition all of the effects described have associated impacts on quality of life, income and property.

The Department of Land Development (DLD) has estimated that 26% of Thailand is either severely or very severely eroded where the extent of annual soil loss exceeds 20 tonnes per rai per annum. Factors, which determine the rate of soil loss and watershed degradation, include:

- the nature and extent of the soil parent material (sedimentary, metamorphic or igneous);
- the extent of exposure of the soil surface (through land clearance or burning) to precipitation;
- and
- the type of land use or activity.

Soils that are derived from sedimentary parent material are more susceptible to erosion than those from metamorphic or igneous parent material. Burning and clearing exposes the soil to erosion, as there is little vegetation cover to reduce the impact of precipitation. Burning also reduces the build up of organic matter in the soil and accelerated erosion may occur even under partial tree cover.

Exposed soil is also more vulnerable to erosion due to excessive run-off. The movement of water over the soil surface is not slowed by the presence of vegetative matter and the surface water has greater capacity to entrain soil particles as it flows downhill. The rapid movement of the water reduces infiltration, which also has the downstream effect of creating flashy run-off patterns and stream flows following precipitation which accelerate bank erosion in watercourses.

Declining crop yields are associated with removal and leaching of plant nutrients and a decline in the organic matter content of the soil which adversely affects its moisture and nutrient holding capacity. Erosion and loss of topsoil further exacerbate these effects. The decline in soil fertility occurs even more rapidly with the shortening of crop rotations, as there is little time for soil recovery between crops.

In upland areas, hill-tribe people have settled and have relied mainly on land use practices such as shifting cultivation (slash and burn) or swidden agriculture. In the past, cultivated lands in the upper watershed areas were mainly managed for the production of subsistence food. However, in the last few decades, cultivated land has been expanded and intensified for the production of commercial cash crops, which has caused rapid loss of forestry resources. The loss of forest areas has not only caused soil erosion and increased run-off but also contamination of surface waters and groundwater from pesticides and fertilisers used in crop production.

Traditional forest and watershed management systems have existed for centuries, particularly in Northern and North-eastern Thailand and have included the management of sacred forests (<100 rai), communal woodlands (50 - 1,000 rai) and watershed forests (1,000 - 10,000 rai) as well as the existence of organised local people's irrigation systems. The changes in water and land use in Thailand, and their associated impacts, cannot be simplistically attributed to shifting cultivation practices in upper watershed areas, exacerbated by increased production of cash crops for income generation. Moreover, the changes reflect more adequately the cumulative effects of the transformation of highland areas and hill-tribe agriculture due to a range of factors including:

- illegal logging and over exploitation of forestry resources as a direct consequence of commercially motivated timber extraction as part of the Royal Thai Government's earlier strategy for accelerated economic growth;
- the Royal Thai Government's opium substitution programmes which have resulted in increased water demands within the upper watershed areas to irrigate temperate crops and which have contributed to additional forestry losses rather than promoting forestry conservation;
- accelerated contact between hill-tribe villages and urban and regional centres through the development of transportation networks have led to resource use beyond the former sustainable subsistence-level exploitation; there is a clear link between the establishment of infrastructure and levels of commercial activity and erosion;
- increasing urban and cross-border trade opportunities which have influenced farmers' choices in the adoption of cultivation of major cash crops;
- continued movement of hill-tribe peoples and in-migration to upper watershed areas exacerbated by in-migration of additional people from neighbouring countries; and
- National claims on upper watershed areas for the purposes of education, recreation and the conservation of the natural environment which continue to have significant impacts in terms of restricting land-use by local communities.

These factors have contributed to widespread land degradation in upper watersheds in Thailand, which have cumulatively resulted in reductions in annual water yields and the consequent negative externalities on downstream water users and inhabitants.

In addition, a range of other factors have contributed to overall degradation of Thailand's watershed resources including:

- uncontrolled burning and forest fires as a result of slash and burn cultivation, burning to flush out animals during hunting or just malevolent fire lighting not only damages forest trees, but destroys ground cover and leads to combustion of the organic component of the soil leading to damage to soil structure, soil erosion and increased run-off;
- poorly planned and managed road construction in upland areas which is a major source of soil erosion and sedimentation;
- exploitation of mineral resources and poor rehabilitation of mining areas, particularly open-cast mining areas; and
- over-grazing, particularly in upland areas, which leads to reduction in ground cover and soil compaction which reduces infiltration and increases run-off.

(3) Definition of Watershed Management

There are many definitions of the term watershed and similar terms with allied meanings such as catchment and river basin. In order to establish a common basis for the spatial setting and scope of watershed management it is necessary to define the meaning of the term *watershed*.¹ In the context of this report a watershed is defined as the entire catchment area of a watercourse from the headwaters to the downstream boundary and includes all the components located therein, including all land, water and ecological resources.

Within a natural balanced watershed, natural interactions between living and non-living resources are in equilibrium. Any activity causing damage in one part of the watershed may produce adverse effects in another part. It is for this reason that ecological resources require to be managed in an integrated manner with the physical resources. It is equally important to recognise that humans are part of the watershed system and cannot be separated from it. Human activities in the environment may have very significant effects. Therefore watershed management requires consideration of natural, social, economic and technical factors together.

Watershed Management may be defined as the management of watershed resources in a holistic and sustainable manner to protect and rehabilitate land, water and associated ecological resources, while recognising the need to advance economic development and quality of life.

(4) Watershed Classification as a Tool for Watershed Management

Thailand passed laws in the 1970's which set strict controls on the cutting of timber and exporting of teak, which aimed to conserve government forestry reserves and to prevent further continued watershed degradation. The enforcement of this legislation has not been successful. It has been estimated that if the rate of deforestation continues forest reserves could vanish completely by early in the next century.

¹ It is interesting to note that in Thailand the term *watershed* is often used to reference upland areas near the head of the catchment and the RFD's Watershed Management Division may be literally translated as "upland rehabilitation division".

The loss of forestry reserves, severe drought and floods and issues relating to exploitation of mineral resources, resulted in the identification of a need for watershed classification as a vehicle for land and water resources planning and management for sustainable socio-economic development. The first watershed classification programme was approved by Cabinet resolution on 28/5/85. The Royal Thai Government adopted the National Watershed Classification regulation on 21/2/95.

The major objective of the watershed classification system is to formulate land use plans for the conservation and sustainable use of natural resources. Watershed classification has been described as the macro land-use-planning tool in Thailand for the sustainable development of water resources.²

The classification is based mainly on consideration of physical characteristics such as slope, elevation, landform, geology, soil type, and forest cover and is based on a grid of 1 km² cells. More recent empirical modelling techniques have indicated the importance of, and need to address socio-economic parameters in order to improve watershed management in Thailand.

The watershed classification and associated recommended land-use classes are described in the Table 5.1.1. below.³ After Cabinet approval, all government agencies concerned must follow the measures and recommendations of land utilisation applicable to the appropriate classification.

Table 5.1.1. Land-Use Recommendations for Different Watershed Classifications

Watershed Class	Characteristics and Major Land-Use Recommendations
WSC 1A	Protection forest and headwater source areas at higher elevations and steep slopes. Primary headwater areas should remain under permanent forest cover.
WSC 1B	Similar to WSC 1A but some areas cleared for agricultural use or occupied by villages. Primary headwater areas require soil and water conservation (SWC) measures, replanted to forest or maintained in permanent agro-forestry.
WSC 2	Protection and/or commercial forest at higher elevations with steep slopes. Landform less erosive than WSC 1A or WSC 1B. Secondary headwater areas may be used for grazing or certain crops with SWC measures.
WSC 3	Uplands with steep slopes and less erosive landforms. Areas may be used for commercial forests, mining, grazing, fruit trees or certain agricultural crops with SWC measures.
WSC 4	Gently sloping lands suitable for row crops, fruit trees and grazing, with moderate need for SWC measures.
WSC 5	Gentle to flat areas used for paddy fields or other agricultural uses with few restrictions.

(5) Watershed Management Programmes

Over 20 Government Departments and Divisions have responsibilities relating to watershed management.⁴ However, the Royal Forestry Department plays a key role, particularly in management of headwaters or head watershed areas (see footnote 1). This is primarily because a large proportion

² Tangtham, N. (1996), *Watershed Classification: Macro Land Use Planning for the Sustainable Development of Water Resources*.

³ Office of the National Environment Board (undated), *Watershed Classification in Thailand* OEPP, MOSTE, Bangkok.

⁴ Coffey MPW/World Bank (1996) *Northern Watershed Management Project*.

of these areas are forestry reserves, National Parks, and Wildlife Sanctuaries, which are the main responsibility of RFD.

According to the watershed management classification promulgated by Cabinet Resolution, approximately 18% of the country (c. 58 million rai) has been classified as WSC 1 and about 8% (27 million rai) has been classified as WSC 2. Therefore, over 25% of the country is classified as a head watershed area.

Watershed Class 1 is protected or conservation forest and must be strictly maintained as a headwater source. Immediate reforestation programmes must be implemented where forest resources have been lost. Many strategies have been developed to protect such areas. However, LANDSAT imagery from 1993 indicates that over 2.75 million rai of forestry areas designated as WSC 1 have been encroached.

RFD has established many initiatives to manage watersheds and has nearly 200 watershed management units throughout the country. The main activities of these units are described below:

- Reforestation - reforestation has been carried out on areas denuded by shifting cultivation, with efforts mainly focused in the Northern Region. The main policy for watershed rehabilitation is through natural re-vegetation supplemented by enrichment planting. Main activities include fire prevention, protection against encroachment, and replanting.
- Grass Introduction - Vetiver grass has been introduced for soil and water conservation purposes in the last five years and has been encouraged on road verges, eroded soils, adjacent to reservoir shores, and in areas where slash and burn agriculture is practised.
- Check Dams - check dams have been constructed on many watercourses to retain water flow, entrap transported sediment, increase soil moisture and enhance riparian vegetative growth.
- Community Development - nearly one million people live in head watershed areas in Thailand and it is not possible to prevent habitation in such areas. Participatory watershed management has been introduced as a mechanism to enhance community participation in sustainable watershed management.

(6) The Requirement and Objectives for Watershed Management in the Donor Basins

The influence of watershed management on aspects of soil and water conservation has been discussed earlier in Section 5.1. Watershed management is particularly significant for the "donor basins" in the project area, as without sustainable management of these basins the very viability and future sustainable life of the Kok-Ing-Nan Project might be compromised, due to changes in the natural hydrology of the river systems. In order to assess what watershed management strategies are required to ensure sustainable watershed management in the donor basins it is necessary to assess the current status of land management in the donor basins.

The Office of Environmental Policy and Planning (OEPP) has developed an overall target for sustainable land use in Thailand based on case studies of watershed management conducted on different representative watersheds, including Mae Taeng, Chern, and Khlong Yan. The overall targets developed by OEPP are listed in Table 5.1.2.

Table 5.1.2. OEPP Sustainable Land-Use Criteria Target Values.

Land Use Category	Target area
Forested areas	50%
Agriculture	35%
Community	5%
Water body, grass and shrub	5%
Roadway and barren land	5%

OEPP has also developed a rudimentary classification system to establish the status of forestry resources in any watershed. The different categories are described below:

- *Equilibrium* - forest coverage over 2/3 of total watershed area;
- *Warning* - forest coverage between 1/2 to 2/3 of total watershed area;
- *Caution* - forest coverage between 1/3 to 1/2 of total watershed area; and
- *Critical* - forest coverage less than 1/3 of total watershed area.

The existing land use in the study area of Kok, Ing and Nan (Yao) Donor Basins as compared with the OEPP sustainable land use criteria are shown in Table 5.1.3.

Table 5.1.3. Existing Land-Use in Kok-Ing-Nan Donor Basins as Compared to OEPP Target Values.

Land Use Category	OEPP Target Value (%)	Kok Basin (%)	Ing Basin (%)	Yao Basin (%)	Kok-Ing-Nan (%)
Forestry	50	32.4	48.7	75.0	47.3
Agriculture	35	57.7	48.9	13.7	47.1
Community Areas	5	0.8	0.1	0.0	0.3
Water Bodies, Grass & Shrub	5	9.1	2.3	11.2	5.3
Roads/Barren Land	5	<0.1	<0.1	0.1	0.0

In order to attain the land use targets of OEPP to achieve sustainable watershed management, the following targets need to be adopted.

- Forest status in Kok and Ing Basins are at caution level according to the OEPP definition, whereas the Nan Basin is at equilibrium status. Overall KIN (Kok-Ing-Nan) "donor basins" are at a caution level, requiring reforestation and regeneration especially in Kok and Ing Basins where at least an additional 17.6% (32,292.5 ha) and 1.3% (5,166 ha) of forestry is required in order to attain the national target of 50% forest cover. Substantially more reforestation is necessary to achieve 'equilibrium'.
- Unsustainable agricultural land management is major issue in many parts of the "donor basins" and approximately 8.5% of the total KIN donor basin area suffers from moderate to severe soil erosion (5-20 tonne/ha/year), requiring soil conservation practices to be adopted over an area of at least 55,976 ha. Agro-forestry and sustainable agricultural improvements, particularly in Kok and Ing Basins, should be targeted at least 22.7% (41,650 ha) and 13.9% (55,237 ha), respectively to achieve the target of 35% agricultural land use.

(7) Case Studies of Watershed Management in Kok-Ing-Nan Project Area

In order to more fully understand the different issues relating to watershed management across the project area a number of basins were selected for detailed studies. The basins were selected for a combination of reasons that are described below.

The GIS analysis exercise undertaken separately⁵ included an evaluation of the status of land degradation across the project area. The analysis was undertaken by estimating potential soil erosion rates using vegetation cover data derived from remotely sensed data, and soils and other characteristics from existing data sets. The output of the analysis characterised the project area in terms of average potential soil loss from each sub-basin. In order to assess what the main watershed management issues present in the project area were, these basins were targeted on the basis that the high potential soil loss rates identified by the GIS analysis were indicative of unsustainable land use practices.

The comparison of soil erosion in the various sub-basins (total 230) has shown that 210 sub-basins have either least severe, less severe or moderate severe class of soil erosion (see Table 5.1.4.). These basins may be considered as relatively low risk in terms of soil erosion severity hazard. The remaining 20 sub-basins are under more severe, most severe or critical class of soil erosion, and out of these 6 are located in the Kok basin, 8 in the Ing basin, and 6 in the Yao basin. The spatial distributions of these basins are shown in Figure 5.1.1.

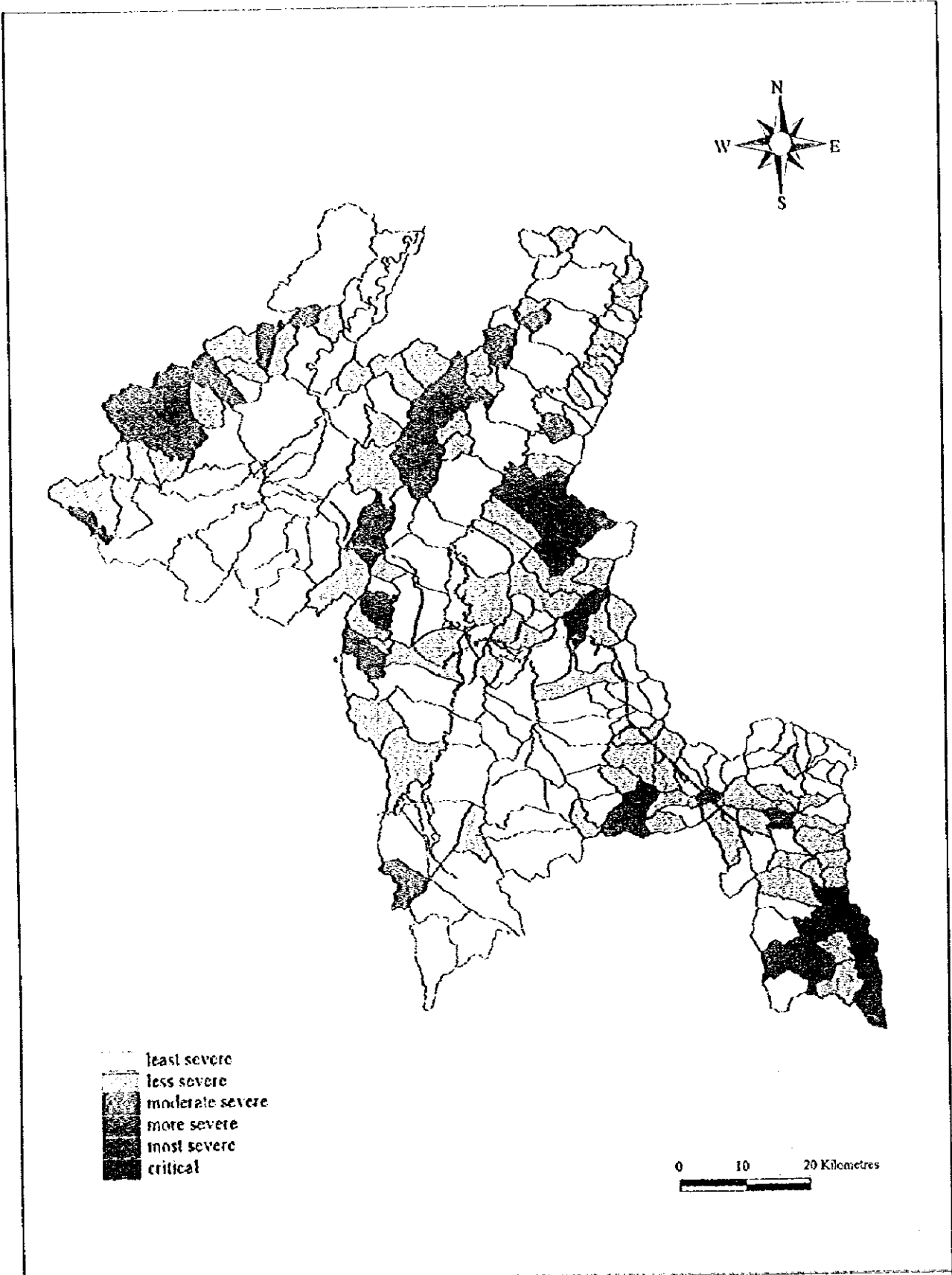
Table 5.1.4. Average Soil Erosion Levels of Various Sub-Basins (calculated from GIS)

Soil Erosion Rating (ton/ha/yr)	Hazard Class	Total Number of Sub-Basins	Number of Sub-Basins in Kok Basin	Number of Sub-Basins in Ing Basin	Number of Sub-Basins in Yao Basin
< 1.0	Least severe	109	24	68	17
1.0 – 2.0	Less severe	74	14	45	15
2.0 – 3.0	Moderately severe	27	3	20	4
3.0 – 5.0	More severe	15	4	7	4
5.0 – 7.0	Most severe	3	2	1	0
> 7.0	Critical	2	0	0	2
	Total	230	47	141	42

In the Kok basin, sub-basins were further targeted to include basins with steep upland slopes and areas where hill-tribe villagers were practising slash and burn or swidden agriculture, as this type of agriculture may have devastating effects on soil and water conservation. Management of upland areas by hill-tribe villagers is also markedly different to the land management practices undertaken by more traditional lowland Thai methods.

The Ing basin is characterised by a much larger area of low-lying flat land than the Kok or Nan basins and as a consequence has much lower soil erosion rates and has only one sub-basin where the GIS indicated that potential soil loss exceeded 5.0 tonne/hectare/year. A basin was therefore selected very close to the project alignment that was also known to practice sustainable forest management. The sub-basin was selected as an example of a basin where watershed management practices were more sustainable and to assess the reasons for adoption of such practices.

⁵ The methodology and results from the GIS analysis are described in full in the supporting report.



ENVIRONMENTAL STUDY
 THE KOK-ING-NAN WATER DIVERSION PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 5.1.1. Potential Soil Erosion Average for Each Basin

In the Nan basin, potential soil erosion rates are also very high and the practice of slash and burn agriculture by hill-tribe villagers is prevalent in many areas. The sub-basin selected in the Nan basin was chosen because of the high potential soil loss values indicated by the GIS analysis and additionally because the sub-basin identified falls within the participatory watershed management programme of the Upper-Nan Watershed Management Project.

Based on the above semi-quantitative approach, three study basins were identified for detailed assessment. The locations of these study basins within the overall KIN study area are illustrated in Figure 5.1.2.

Recent Changes in Government Policy Relevant to KIN Case Study Sub-Basins

There have been some changes in government policy on natural resource management during recent years, and the recent legislation and continued national debate will have implications for future watershed management in the project area. Of particular relevance to the selected case study areas are:

- the completion of local elections for the establishment of local administrative organisations in the selected areas;
- Cabinet resolutions of 17, 22 and 29 April, 1997 which resulted in the Department of Local Administration (DOLA) collecting data on areas of agricultural production within National Forest Reserves, with a view to permitting continued agricultural land use but prohibiting extension of areas under cultivation;
- approval of the new Thai Constitution in November 1997 which empowers local communities to have greater control of local management of natural resources; and
- the existence of many conflicting cabinet resolutions on watershed classification and forest land-use zoning, because of the failure to rescind conflicting resolutions.

These changes may affect the recommendations relating to future watershed management activities since the debate is on-going and some legal experts consider that some of the latest cabinet resolutions may violate aspects of the new Constitution. All of these changes together with the previous legislative rules and laws have been considered in making recommendations for the watershed management programme.

(b) Kok Case Study - Watershed Management

Figures illustrating land-use, and slope distribution in the Kok Study Basin (*Chiang Rai*) are given as Figures 5.1.3 and 5.1.4.

Existing Needs Assessment

Selected villages assessed in this component of the study are described below:

- *Ban Ruam Mit, Tambon Mae Yao, Amphoe Muang, Chiang Rai*

The village is situated on the bank of the Mae Kok River, occupying a total area of 1870 rai, of which only 400 rai is utilised for agricultural production. The village has a population of 557 divided between 113 households. Approximately 80 households are engaged in agriculture, of which approximately 60 households cultivate rice with farms occupying 1 to 5 rai. These farms consist mainly of terraced paddy fields and the average rice yield is approximately 650 kg/rai.

The main non-farm occupation is tourism. The village is involved in the Kok River raft tour circuit, which provides a supplementary or an alternative source of income to farming for some members of the village.

- *Ban Huay Mae Sai, Mu 11, Tambon Mae Yao, Amphoe Muang, Chiang Rai*

Huay Mae Sai village is located on the upland slopes of the Kok River catchment. The village covers an area of approximately 1200 rai, of which 800 rai is used for agricultural production. The village has a population of 682 persons divided across 111 households. Most of the households are engaged in agriculture, with 56 households cultivating rice, the remainder growing cash crops and fruit trees. The village also benefits from local tourism from Kok River tours and trekking.

Existing Bio-physical Conditions

The distribution of land in different watershed classes and the relative land use for the Kok (*Chiang Rai*) Study Basin is summarised in Table 5.1.5. In this study area almost 88 % of total area is covered by forest. Less than 10 % is utilised for agricultural production or water resources development. The upland crops cover about 6 % and an area of 2.8 % or about 418 rai of riparian land is used for paddy. The total residential area represents about 1.03 percent or about 154 rai. Of the study basins selected for case studies the Kok study basin is the most mountainous and has the highest proportion of steep slopes, with small areas of slash and burn or swidden agriculture on the middle and upper slopes.

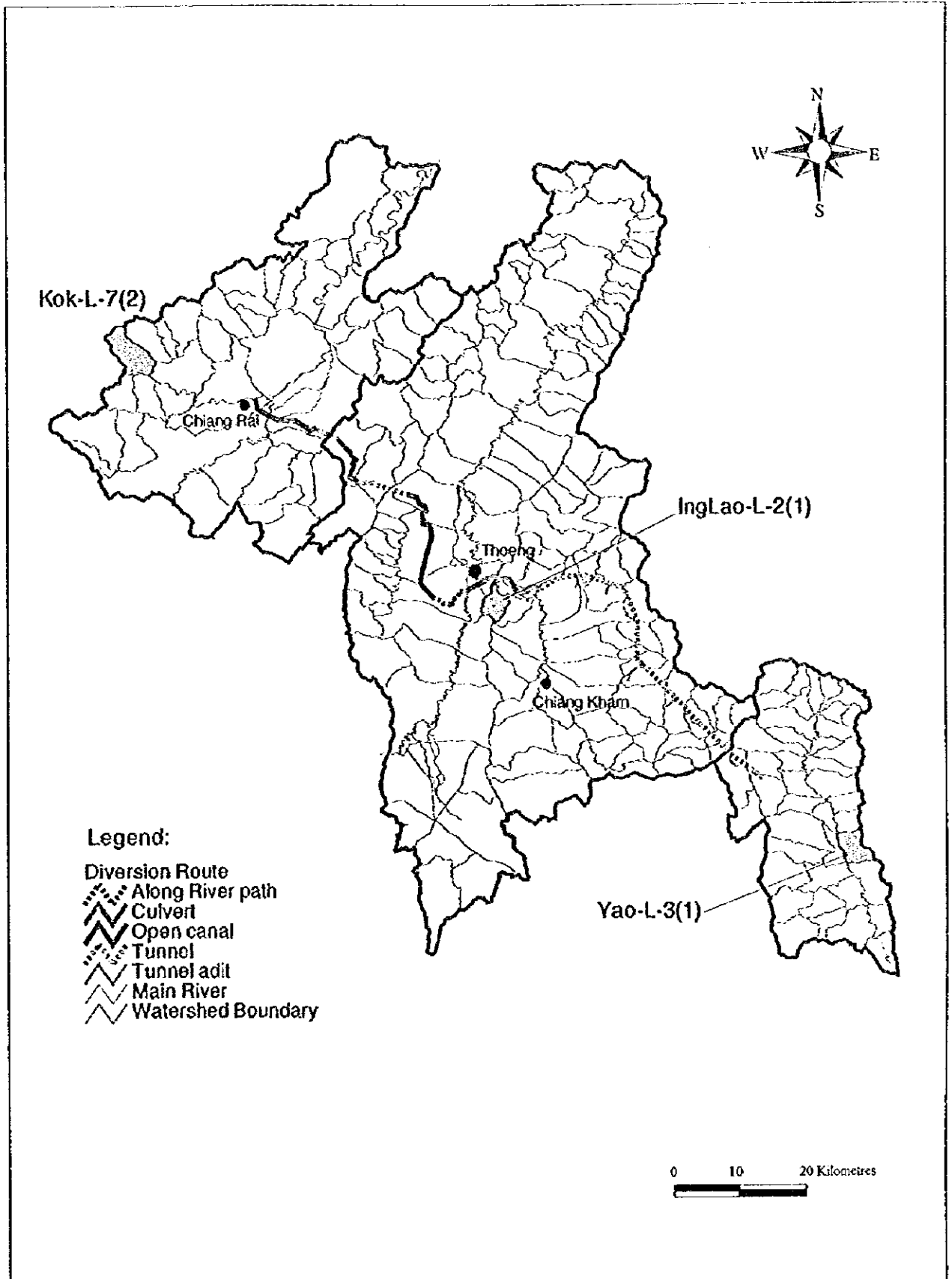
From field observations, soil erosion in the study area was estimated to be low except that stream bank erosion appeared significant. There is a relatively large forest area remaining in the study area consisting mainly of dry dipterocarp with some dry-evergreen and mixed deciduous forests growing in areas largely unfavourable for crop cultivation. Dry dipterocarp forest is also a good source of non-timber products such as mushrooms and various kinds of herbs. This is another reason why people have protected this area and managed it to retain a larger proportion of natural forest.

With only one percent of study area or about 154 rai used for residential areas or villages, population density is low. The ratio of the area of land utilised for agriculture against that used for settlement or village area is approximately 9:1. In addition, the ratio of the area of land under forestry against the area of land used for agricultural land is also approximately 9:1. These figures imply that adequate areas of forestry, land to support agriculture and for potential future village extensions exist. The majority of residential areas or villages are located mainly in WSC 3 and 4 (Table 5.1.5.) with only 0.77% and 0.09% of total residential areas located in WSC 2 and 1A respectively.

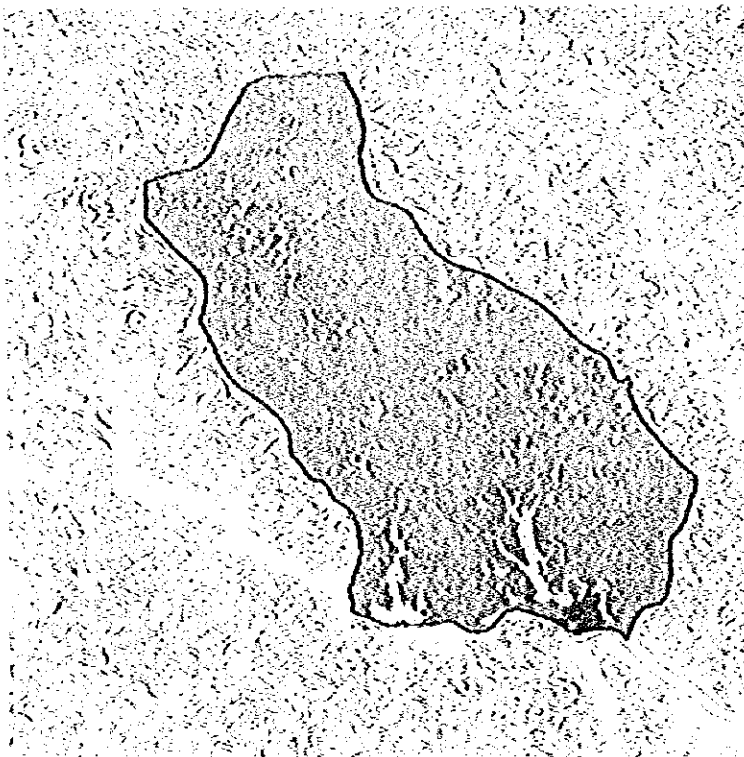
Specific Problems Encountered in Kok Basin Study Area








In common with the majority of the northern watershed areas, forest fire is a significant problem faced by watershed managers. Uncontrolled fires are still common, even though management practices to combat uncontrolled fires such as firebreaks have been constructed and good co-operation has been initiated from local land managers.

Reforestation on very steep slopes is problematic because of the relatively large and discontinuous areas concerned. The costs for planting and maintenance are high and damage from uncontrolled burning is very difficult to control.



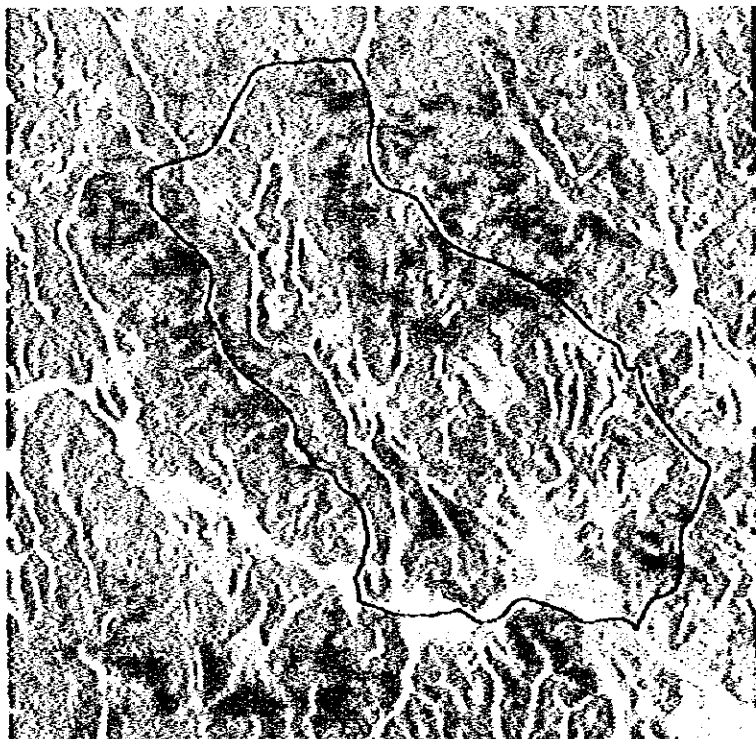
<p>ENVIRONMENTAL STUDY THE KOK-ING-NAN WATER DIVERSION PROJECT</p>	<p>Figure 5.1.2. Location of Study Basins in the Project Area</p>
<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	











-  Village
-  Orchard
-  Garden Crops
-  Water Body
-  Paddy Field
-  Upland Fields (Swidden)
-  Mixed Forest

Derived from aerophoto

Figure



-  0 - 1
-  1 - 3
-  3 - 9
-  9 - 13
-  13 - 17
-  17 - 21
-  21 - 25
-  >25 degree

Slope was automatically calculated by DEM of 1:50,000

Figure

ENVIRONMENTAL STUDY
THE KOK-ING-NAN WATER DIVERSION PROJECT

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Figure 5.1.3. Landuse Map with 20m Contour Lines Kok Basin

Figure 5.1.4. Slope Distribution Map Kok Basin

Table 5.1.5. Distribution and Area of Watershed Classes and Land-Use Patterns in the Selected Case Study Area in Kok Basin (Derived from 1996 Aerial Photography)

Water-shed Class	WSC Rai	WSC Areal Distribution	Land-Use Distribution in Each Watershed Class in Rai and as % of Total Watershed Class Area															
			Forest (Fo)	Encroached Areas (En)	Garden (Tr)	Orchard (Or)	Upland (Up)	Rice (Ri)	Urban (Ur)	Water (Wa)	Body							
	Rai	%	Rai	%	Rai	%	Rai	%	Rai	%	Rai	%	Rai	%	Rai	%		
1A	7186.46	47.9	6686.46	93.06	56.37	0.78	-	1.37	0.02	386.94	5.38	48.62	0.67	6.70	0.09	-		
1B	2210.05	14.7	2082.13	94.21	13.81	0.62	-	1.12	0.05	98.18	4.42	14.81	0.67	-	-	-		
2	3834.64	25.6	3358.41	87.58	76.01	1.98	31.94	0.83	6.17	0.16	254.14	6.63	75.61	1.97	29.66	0.77		
3	1432.52	9.7	1023.73	70.48	16.19	1.11	24.25	1.67	52.66	3.63	79.26	5.45	200.83	13.83	55.60	3.83		
4	319.63	2.1	76.90	24.06	14.00	4.38	2.30	0.78	17.62	5.51	66.43	20.78	78.00	24.40	61.87	19.36		
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total	15,003.30	100	13,227.63	88.16	176.38	1.17	38.69	0.39	78.94	0.01	884.95	5.90	417.87	2.78	153.83	1.02	5.01	0.03

Notes:

- Three villages appear in the aerial photograph: Ban Ruam Mit, Ban Pahai Pong Kham and Ban Cha To Toc.
- % - Percentage of each total watershed class area.

Land-ownership or land title in upland areas is also another major problem. Often poor people with no legal land tenure transfer land provided by the government to others to generate income. Once again they find themselves without land and encroach into new areas of forest in order to create new areas for agriculture. This is somewhat of an enforcement loophole and RFD recently established a new program of highland community forest to tackle this problem. Land ownership offers potential for greater sustainable land management - if illegal occupants of land are given some form of land title then it is hoped they will manage the land in a manner that will ensure long-term sustainable land use, as ownership will pass to future generations. Legal mechanisms to prevent transfer of land for capital gain need to be further investigated.

GIS Analysis for Watershed Management

In general, whenever soils are cultivated on slopes and exposed to erosive rains, the protection offered by close cultivation of crops needs to be supported by practices that will reduce velocities of run-off and thus reduce the amount of soil that will be transported with it. The most important of these practices are contour tillage, strip cropping on contours and terraced systems. Using the GIS database as previously described, the impact of adoption of such cultivation practices on soil loss was calculated. These results are shown in Figure 4.1.5. and show that soil loss in the areas where slash and burn agriculture is practised is largely mitigated by the adoption of such cultivation techniques, although large areas of potential soil loss still exist on the middle and upper slopes in the basin because of their steep nature.

Watershed Management Programmes

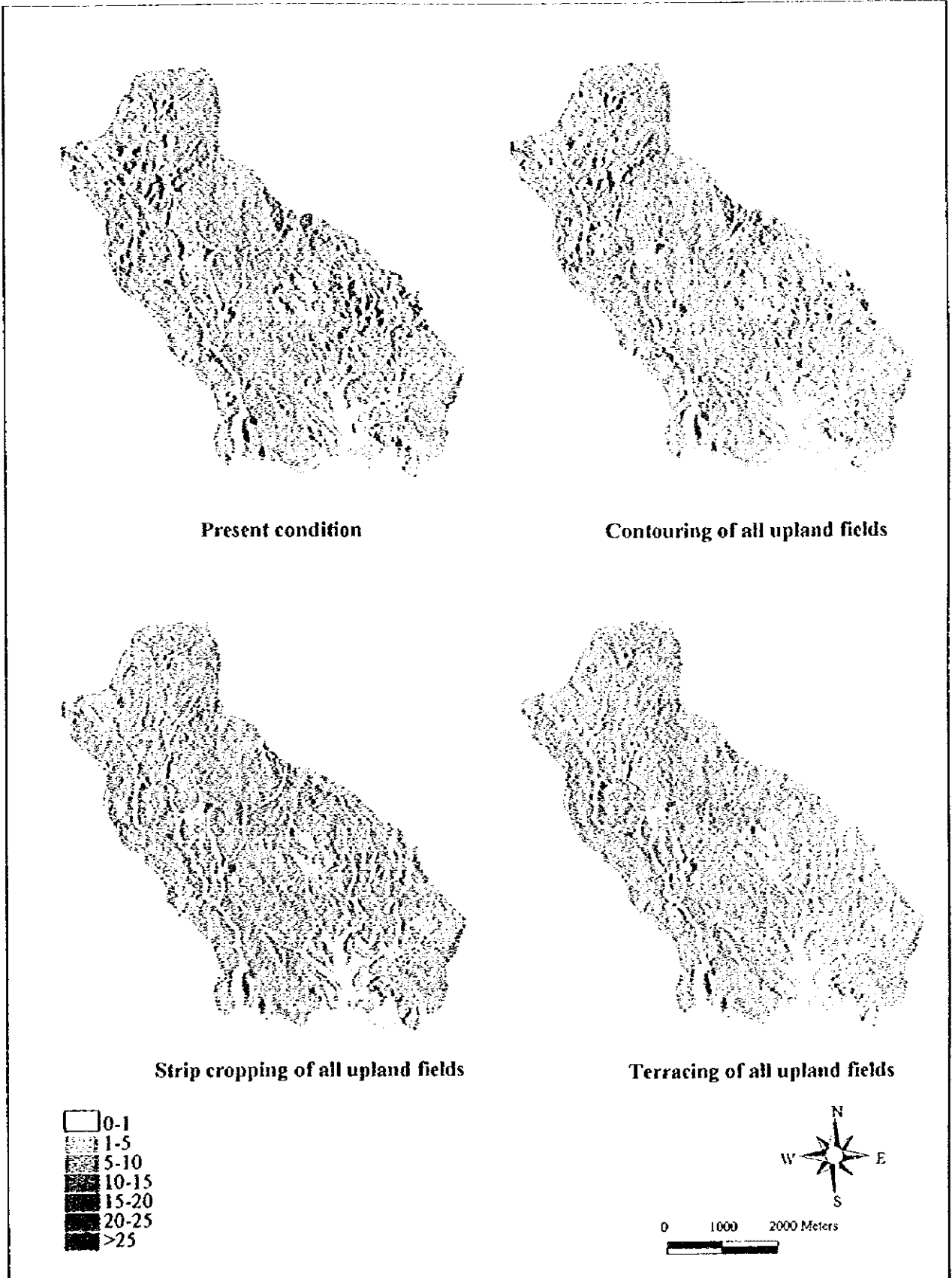
The Mae Nam Kok Watershed Management Centre, a department of the Watershed Management Division of RFD, manages all of the Kok sub-basin study areas. The ongoing activities consist of head-watershed rehabilitation, forest improvement, soil and water conservation, highland forest community development, and special programmes on reforestation relating to initiatives promoted by His Majesty the King. Although the programmes are deemed adequate, some areas might warrant some reforestation initiatives, including areas where villagers reside in WSC 1A or WSC 2. This would be dependent on villagers relocating to lower land outside WSC 1 or 2 areas. Reforestation initiatives for consideration include:

- *Reforestation for Head-watershed Protection:*

In those denuded areas identified in WSC 1A (about 56 rai or only 0.78% of WSC 1A) and not occupied, land should be converted to protection forest by means of reforestation using *Pinus* spp., or indigenous fast-growing tree species, or by natural regeneration and succession. Any opportunity to maximise biodiversity during any reforestation or rehabilitation programme should be managed in co-operation with RFD and utilising the results from initiatives such as the DANCED funded biodiversity project.

- *Reforestation as Commercial Plantation:*

Areas which have been recently encroached (14 rai), should be returned to forest plantation according to Watershed Classification Regulations. This amount of land is insignificant in terms of the total forest area and with the remaining area of land in WSC 1B. Potential exists for more efficient and sustainable use of land at lower altitudes (WSC 2 and WSC 3) incorporating more intensive soil and water conservation methods. If the efficiency of use of these areas was increased, it might negate the need for continued encroachment into WSC 1B areas for the production of agricultural crops. Commercial forest plantation should be established, possibly by the landowners under supervision by Tambon Administrative Organisations and local RFD officers.



ENVIRONMENTAL STUDY
 THE KOK-ING-NAN WATER DIVERSION PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 5.1.5. Potential Soil Erosion Loss under different conditions Case study in Kok Basin

- *Permanent Fruit Trees or Agro-forestry*

The large area of remaining natural forest in the study area suggests that if local occupants responsible for watershed management were able to protect and conserve the remaining forestry resources, or even manage them in a more sustainable manner, there should be no requirement to replant new forestry reserves. Permanent trees planted for agricultural use, i.e. fruit tree or agro-forestry systems are preferable for areas classified as WSC 1B and WSC 2. Other conservation measures such as contour grass-strips are recommended if long-term benefits are needed for both the landowners and downstream inhabitants.

The suggested watershed management options for the Kok study basin are summarised in Figure 5.1.6.

(b) *Ing Case Study - Watershed Management*

Figures illustrating land-use, and slope distribution of the Ing Study Basin are given as Figures 5.1.7 and 5.1.8.

Existing Needs Assessment

The village assessed in this component of the study is described below:

- *Ban Rong Chae, Mu 4 Tambon Viang, Thoeng District, Chiang Rai*

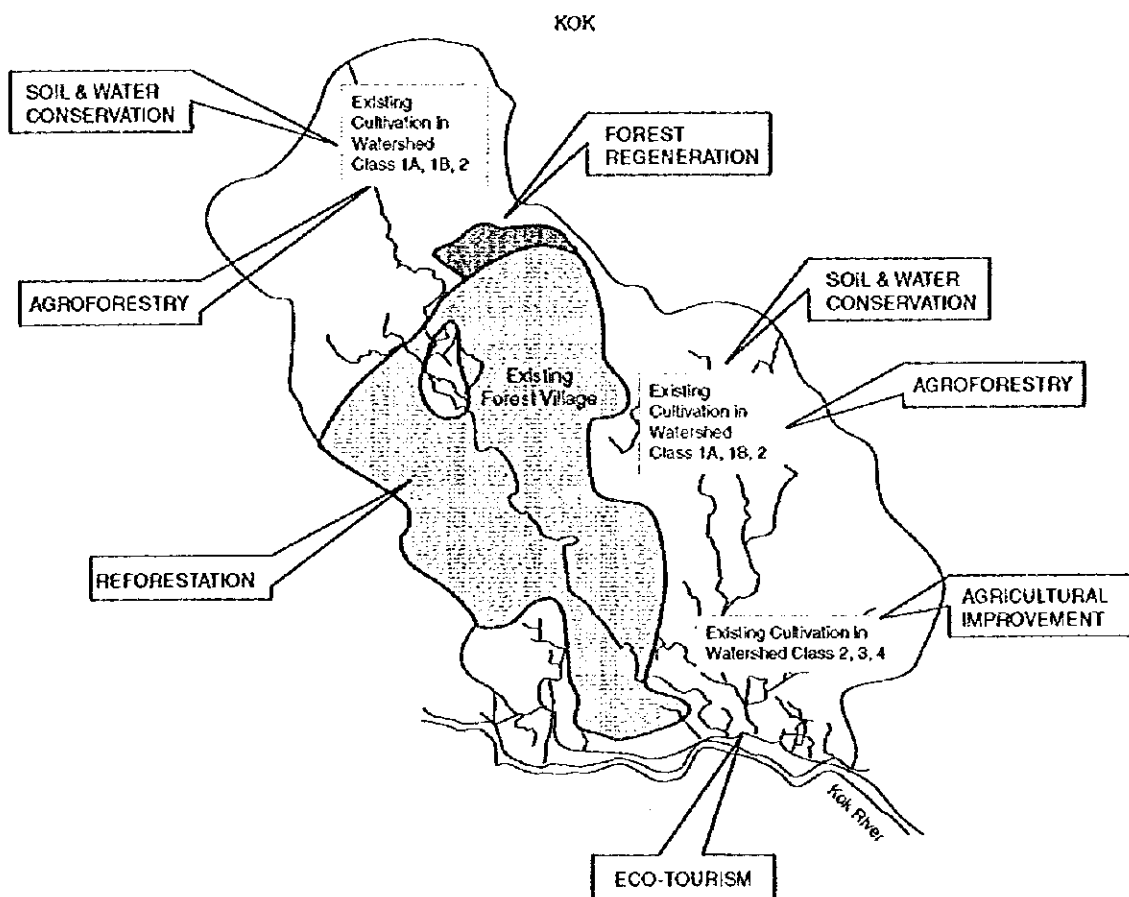
General Description:

The study village is located in the flat valley floor on the banks of the Ing River. There are many streams flowing through the village before draining into the Ing River. The village was founded in BE 2449 (1906).

Land use in the village comprises paddy rice fields (1600 rai), orchards (1400 rai), and a forest area of 5000 rai. The forest is protected as a community forest and is described in more detail in the resource conservation section below.

At present, the population of the village is 1294 persons divided between 283 households. A small proportion of the land used for rice paddy has *Nor Sor 3* land title documents, the remaining land having only the *Por Bor Tor 5* land tax receipt. The size of the land holdings ranges from 7 to 70 rai per household, with the average of about 10 rai. Rice is the main crop grown during only 1 season per year, achieving yields of up to 450 kg/rai. The village is self-sufficient in rice and generates a surplus that is sold. The surplus accounts for approximately 30% of the total produced.

On orchard land, maize and mung beans are grown. About 20% of the upland area has been planted with longan fruit trees, though the trees are only 3-4 years old and are not yet yielding fruit. On the higher slopes there is no cultivation, though some erosion problems were reported to occur in maize growing areas. During the dry season which occurs between February and April there is little to occupy the villagers in terms of agricultural work. During this period the villagers go out to seek paid employment (50% of all households), such as construction work in Bangkok.

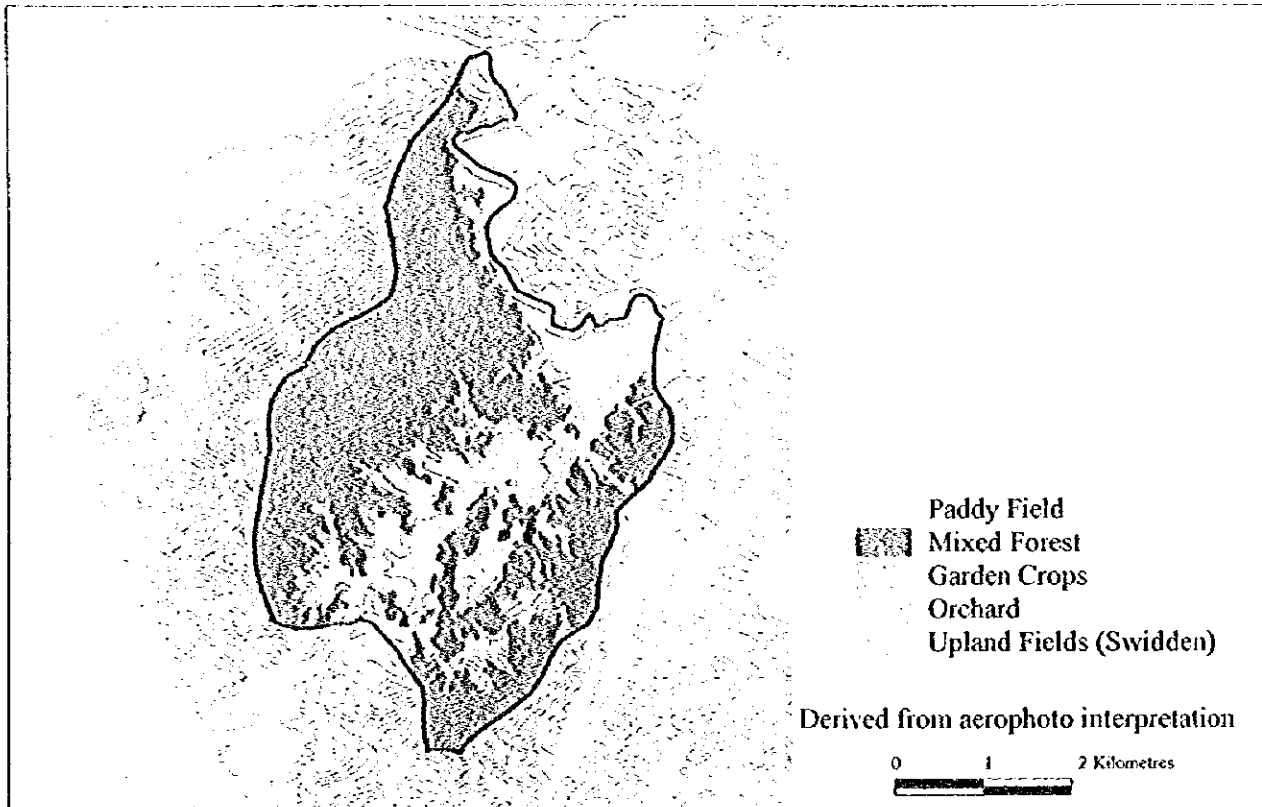


Not To Scale

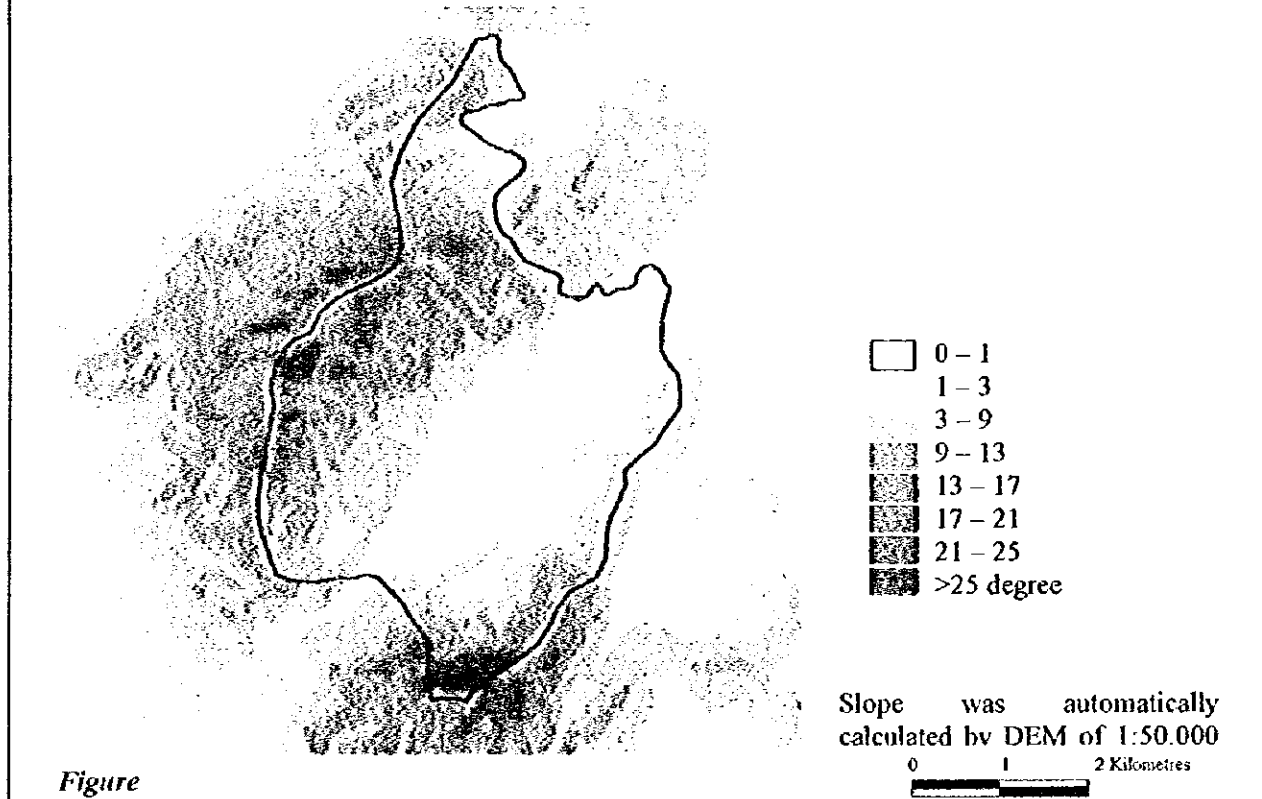
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THE KOK-ING-NAN WATER DIVERSION PROJECT

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Figure 5.1.6. Kok Basin : Watershed Management Programme



Figure



Figure

ENVIRONMENTAL STUDY THE KOK-ING-NAN WATER DIVERSION PROJECT	Figure 5.1.7. Landuse Map with 20m Contour Lines Ing (Lao) Basin
JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.1.8. Slope Distribution Map Ing (Lao) Basin

The villagers identified the following issues as the main problems facing the village:

- flooding of rice fields during August and September, causing damage to the rice crop; and
- shortage of water for rice cultivation during May and June.

Resource Conservation Measures

The village has an area of 5000 rai that is managed and protected as a community forest. The management of this community forest area is a collaborative effort together with 4 other villages (Mu 7, Mu 4, Mu 13, and Mu 16). The conservation work began in 1998 at the instigation of the district officer. However, the initiatives of a former village headman who was concerned by deforestation and potential implications on the source of the village water supply instigated the initial management actions in 1983.

The village has a set of rules on logging and collection of forest products. Violations are dealt with by warnings and fines, or by reporting violations to government officials where appropriate. The village attempts to prevent forest fires with a volunteer patrol organised by the village committee. In addition, the village has received training in forest management from the local forestry department and has started planting additional trees such as teak and fruit trees in gardens and public areas. The villagers feel that it would be difficult to increase their conservation efforts because they are limited by available land. They do, however, recognise potential for improved and enhanced management in forest areas.

The village now has a deep well, dug by the Department of Mineral Resources in 1997, to supply household tap water. The village committee would like to improve the village water supply for rice cultivation by installing weirs at various points on the streams in the village.

Existing Bio-physical Conditions

The distribution of land in different watershed classes and the relative land use for the Ing Study Basin is summarised in Table 4.1.6. Of a total area of about 9088 rai, about 32% or 3114 rai is classified as WSC 1A implying a third of the study area is situated in a head watershed area. However, about 99.5% of this steeply sloping area is still covered with forest with only 0.5% utilised for upland crops. A further 25% of the study basin is divided equally between WSC 2 and WSC 3. Under the watershed classification guidelines WSC 2 should be utilised as commercial forest. However, in the study basin, natural forest still covers about 90% of this area, the remainder being used for upland cropping. The upland cropping is distributed on the lower slopes that are less steep with the steeper slopes remaining forested.

In general the head-watershed is in good condition with approximately 50% of the whole study area remaining under forest cover and a low risk that soil erosion will reach critical levels. This is probably related to the fact that RFD has preserved WSC 1A and 2 areas as Doi Ha and Doi Som Conservation Zones. It is reasonable that about 65% of WSC 4 and 59% of WSC 3 have been used for cropping in this study area. However, soil and water conservation for erosion control and maintenance of soil fertility should receive more attention from the landowners.

Table S.1.6. Distribution and Area of Watershed Classes and Land-Use Patterns in the Selected Case Study Area in Ing Basin (Derived from 1996 Aerial Photography)

Water-shed Class	Land-Use Distribution in Each Watershed Class in Rai and as % of Total Watershed Class Area																
	WSC	Rai	%	Forest (Fo)	Encroached Areas (En)	Garden (Tr)	Orchard (Or)	Upland (Up)	Rice (Ri)	Urban (Ur)	Water Body (Wa)	Rai	%	Rai	%		
1A	3113.56	32.26	99.49	-	-	-	-	15.68	0.51	-	-	-	-	-	-	-	
1B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	1065.43	11.72	86.58	-	-	-	-	142.96	13.42	-	-	-	-	-	-	-	
3	1106.41	12.18	32.56	-	-	52.04	4.70	654.40	59.15	39.64	3.59	-	-	-	-	-	
4	3802.14	43.84	6.42	-	-	266.81	7.01	28.23	0.74	709.61	18.66	3.83	0.10	69.96	1.84	-	
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	9087.54	100	4624.85	50.89	-	318.85	3.51	28.23	0.31	3292.57	36.23	749.26	8.24	3.83	0.04	69.96	0.77

Notes:

- Under RFD Forest Zoning, 3903.56 Rai is in Doi Ha and Doi Bo Som Conservation Zone, 5183.98 is in the Economic Zone.
- The Conservation Zone in mainly WSC1A and WSC2 and the Economic Zone is mainly WSC3 and WSC4.
- Annual Rainfall is between 1400-1600mm.
- % - Percentage of each total watershed class area.

Specific Problems Encountered in Ing Basin Study Area

Illegal encroachment has been recognised by government agencies as a problem in this study basin. In addition, forest fire has been a common problem. Although fire protection units have been established, they are not sufficient to effectively cover the area required. Campaigns for fire prevention have been demonstrated, though whenever fire does occur it generally proves difficult to suppress. Generally, forest fires in watershed areas covered by dry dipterocarp and mixed deciduous forests are serious because of the readily combustible nature of the trees.

Inadequate soil conservation measures exist in this study basin despite efforts to educate villagers in the application of simple soil and water conservation techniques. The simplest of conservation measures using vetiver grass strips along contours to minimise erosion and run-off have been introduced to many villages, though the effectiveness of such measures has yet to be evaluated.

GIS Analysis for Watershed Management

In general, whenever soils are cultivated on slopes and exposed to erosive rains, the protection offered by close cultivation of crops needs to be supported by practices that will reduce velocities of run-off and thus reduce the amount of soil that will be transported with it. The most important of these practices are contour tillage, strip cropping on contours and terraced systems. Using the GIS database as previously described, the impact of adoption of such cultivation practices on soil loss was calculated. These results are shown in Figure 5.1.9. and show that the impact of adoption of such cultivation techniques is relatively minor, due mainly to the fact that the risk of catastrophic soil erosion loss is relatively minor in the first place.

Watershed Management Programmes

Watershed areas in the Ing basin are also managed under the Mac Nam Kok Watershed Management Centre of RFD. The majority of management activities available for the Ing Basin are more or less the same as those that may be applied to the Kok basin. As with the Kok study basin, consideration should be given to returning the WSC 1A areas presently under upland cropping to forest land and should involve Tambon Administrative Organisations. Only 16 rai or about 0.50% of WSC 1A in the study area is currently under upland cropping and does not represent a serious threat in terms of soil and water conservation or potential detrimental effects on downstream users. However, if there is a willingness and awareness of villagers and the TAO in this area, then such a restoration initiative is to be recommended.

Another 143 rai or about 13.42% of WSC 2 is presently under upland cropping, and consideration should be given to converting to permanent fruit tree cultivation or for the application of appropriate soil and water conservation measures. Either of these potential initiatives should have the full involvement of the TAO. A reforestation program should be also promoted by the local WMD of RFD with cash or other incentives. The species selected for commercial reforestation in this area must take into account the proximity to suitable markets and transport.

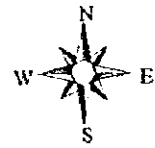
The suggested watershed management options for the Ing study basin are summarised in Figure 5.1.10.



Present condition



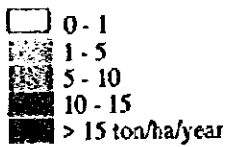
Contouring of all upland fields



Strip cropping of all upland fields

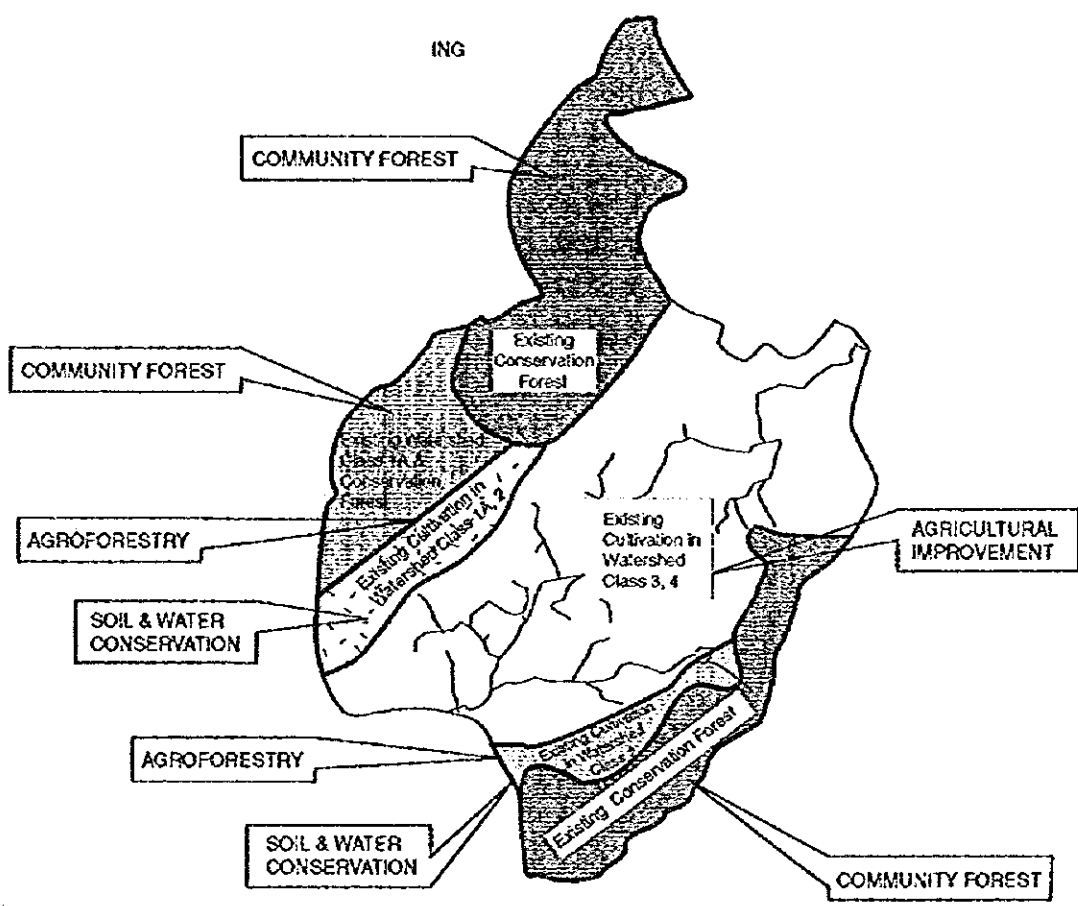


Terracing of all upland fields



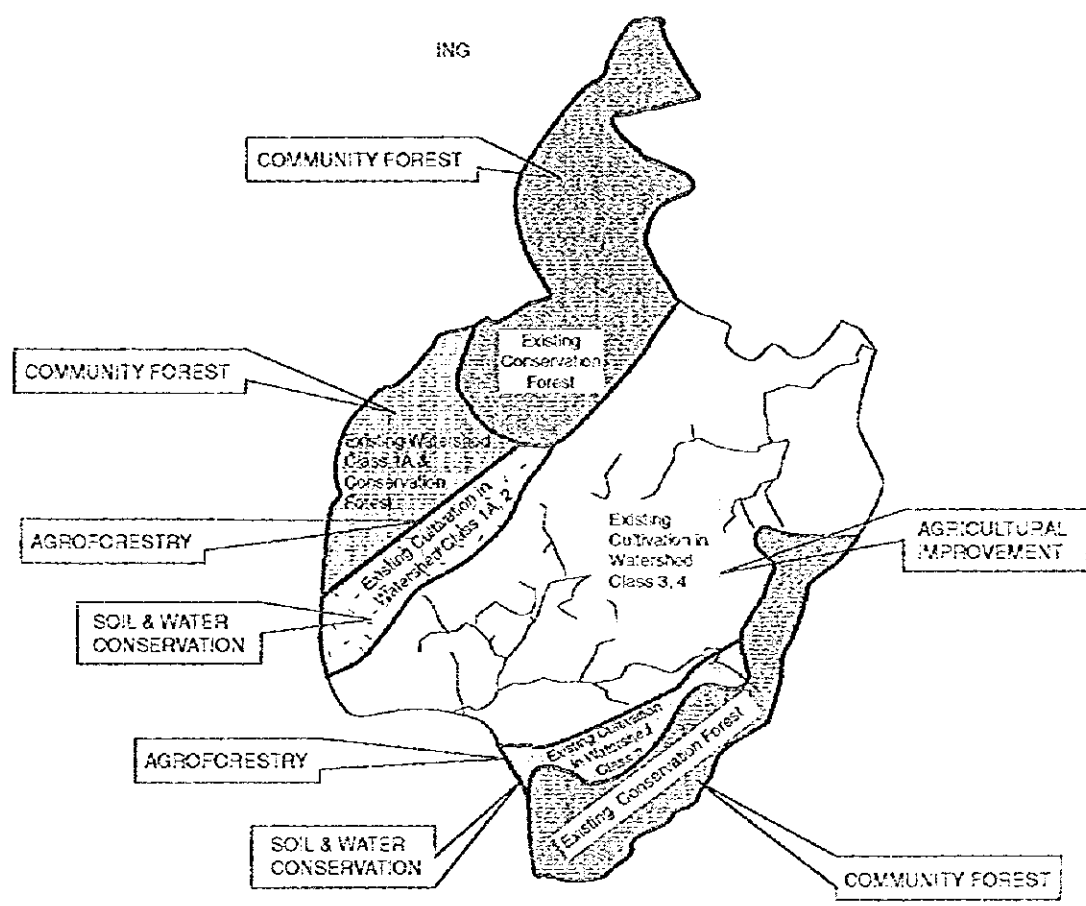
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Figure 5.1.9. Potential Soil Erosion Loss under different conditions Case study in Ing(Lao) Basin



Not To Scale

<p>ENVIRONMENTAL STUDY THE KOK-ING-NAN WATER DIVERSION PROJECT</p>	<p>Figure 5.1.10. Ing Basin : Watershed Management Programme</p>
<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	



Not To Scale

<p>ENVIRONMENTAL STUDY THE KOK-ING-NAN WATER DIVERSION PROJECT</p>	<p>Figure 5.1.10. Ing Basin : Watershed Management Programme</p>
<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	

(c) Nan Case Study - Watershed Management

Figures illustrating land-use, and slope distribution in the Nan Study Basin are given as Figures 5.1.11 and 5.1.12.

Existing Needs Assessment

The village assessed in this component of the study is described below:

- *Ban Tham Viang Gae, Mu 1 Tambon Na rai luang, Amphoe Song Khwae, Nan.*

General Description

The village is located on the valley slopes of the Yao River. The main tributary that flows through the village is Mae Hoy. The local area is completely deforested. The population, dominated by people from the Hmong hill-tribe ethnic group, comprises 1867 persons divided between 225 households.

The village was settled approximately 30 years ago at which time the surrounding area was still forested, mainly with dry dipterocarp species. The early settlers to the village practised slash and burn or swidden agriculture, each family clearing about 10 rai of land each year to plant upland rice. The yield in a good year is about 30 tang/rai. The annual yield of rice is only adequate to feed villagers for about six months of the year.

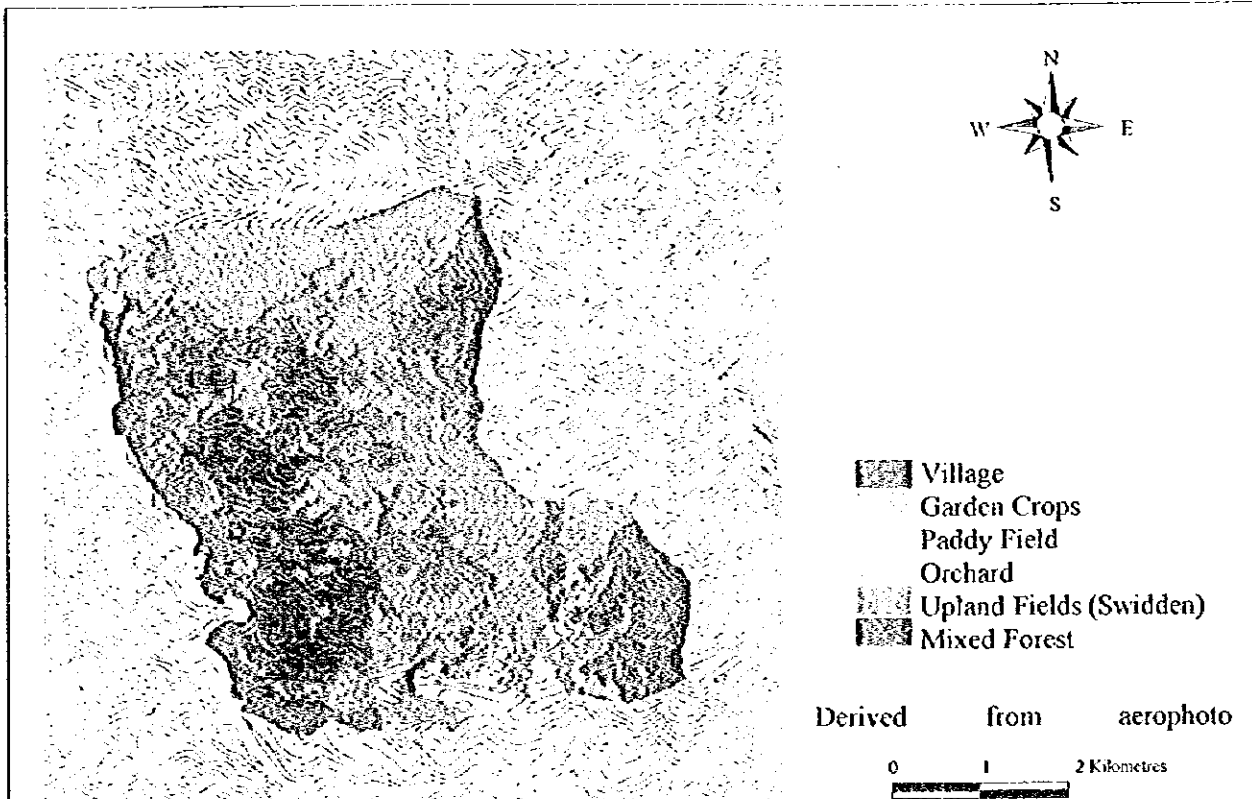
In the early 1970's maize was grown as a cash crop leading to increased land clearance. Maize cultivation has now largely been abandoned because of poor market prices. Villagers are now starting to plant lychee trees, in anticipation of an improvement in the available water supply. Some households also keep livestock, for sale in times of financial need rather than a regular source of income. The cattle are allowed to graze in open fields of imperata grass in selected areas in the village and the total cattle population in the village was estimated at 500.

Young people from the villages are forced to move away from the village to look for work in nearby urban centres such as Chiang Rai or Chiang Mai, or some travel as far as Bangkok. Those villagers who move away are forced to send money to the village to supplement its insufficient income. Approximately 40 households have such absent workers in their families.

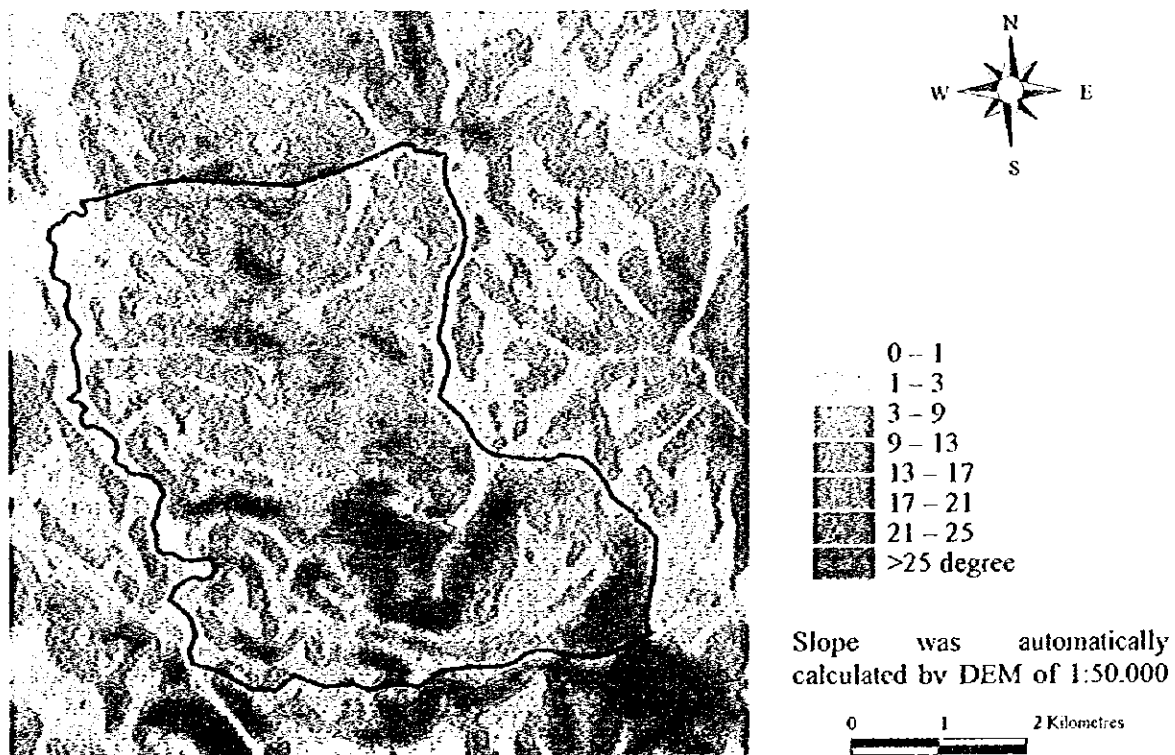
The water supply for the village comes from a natural stream about 2 km from the village and is piped to the village. The water supply was installed under a government funded project and is being expanded by a government agency to meet increases in water demand, both from household consumption and for watering fruit trees.

Resource Conservation Measures

The area surrounding the village water source is protected by the villagers who prohibit the cutting of trees and use of land on the stream banks for farming. There have been initiatives to encourage tree planting, as a means of watershed restoration and 2 years ago there was a tree-planting project, which planted pine trees. There was some doubt about this reforestation initiative as there was no land set aside for replanting and the majority of the land was already in use.



Figure



Figure

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THE KOK-ING-NAN WATER DIVERSION PROJECT

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Figure 5.1.11. Landuse Map with 20m Contour Lines Nan (Yao) Basin

Figure 5.1.12. Slope Distribution Map Nan (Yao) Basin

The only soil conservation method practised at present is a limited crop rotation using rice and beans over a three year period, which is an insufficient rotation period to be effective. The use of Vetiver grass (faek) as a soil stabiliser was introduced to the farmers, but there was little interest in implementation of any real programme to reduce soil erosion. The use of Ruzi grass was also introduced but the grass competed with the rice crop and was abandoned. Similar fears concerning competition between Vetiver grass and rice probably also hampered its adoption as a soil conservation measure. The village is now a part of the Upper Nan Watershed Management Project and has received a seed fund of 50,000 baht that has been lent to farmers for the purchase of lychee tree seedlings.

Existing Bio-physical Characteristics

The distribution of land in different watershed classes and the relative land use for the Nan Study Basin is summarised in Table 5.1.7. The case study area of upper Nan is located in Nam Yao-Suad catchment that is one of the six sub catchments under the DANCED Upper Nan Watershed Management Programme. Natural forest areas have been encroached rapidly during the past 3 decades by both legal and illegal timber cutting. Shifting cultivation has been practised for over thirty years and for the last 10 years cultivation has been continuous with no fallow periods. Coupled with the frequency of forest fires, the cultivation practices have led to a critical degradation of the watershed including catastrophic soil loss during heavy rain. Such cultivation has serious implications for soil and water conservation and on downstream users.

Approximately 52% of forest cover remains in this study basin with more than 38% of land use devoted to upland cultivation including upland rice. Almost 7% of the area is used for orchard trees, while approximately 1.5% of the lower-lying flatter land has been developed for paddy rice cultivation. Less than 1% of the basin is used for vegetable cultivation or for residential areas.

More than 40% of land classified as WSC 2 has been degraded and is now utilised for upland cropping. The area of WSC 2 that should be managed as commercial forest is presently comprised of approximately 54% mixed deciduous forest. About 262 rai has been encroached and 147 rai or about 2 percent of WSC 2 is occupied by various groups of people. According to DANCED, the inhabitants consist of Lue, Khamu and Local Thai. Two main villages may be identified from aerial photographs. The first, Ban Pang Ruk, is located in an area of WSC 3 while the second, Ban Tham Maeo Wrang Kae, is in an area classified as WSC 2 and located in the Nam Yao Forest Reserve.

In WSC 3 where upland crops are permitted to be grown as long as intensive soil and water conservation measures are adopted, about 47% remains under natural forest. Approximately 20% or more than 374 rai has been encroached with the remainder used for upland cropping (28.67%), rice cultivation (2.93%) and 2.40 rai as a residential area.

Specific Problems Encountered in Nan Basin Study Area

The traditional practice of slash and burn agriculture continues to be used with its severe consequences for soil and water conservation. The villagers reported problems of acute soil erosion with sheet erosion of soil following heavy rain and resulting in a loss of soil fertility.

Forest fires are another major hazard because of the abundance in the local area of imperata grass, which burns readily in the dry season. The villagers have received training on management techniques for fire prevention, though no formal measures have been adopted.

Table 5.1.7. Distribution and Area of Watershed Classes and Land-Use Patterns in the Selected Case Study Area in Nan Basin (Derived from 1996 Aerial Photography)

Water- shed Class	Land-Use Distribution in Each Watershed Class in Rai and as % of Total Watershed Class Area																	
	WSC Rai	WSC Areal Distribution %	Forest (Fo) Rai	%	Encroached Areas (En) Rai	%	Garden (Tr) Rai	%	Orchard (Or) Rai	%	Upland (Up) Rai	%	Rice (Ri) Rai	%	Urban (Ur) Rai	%	Water Body (Wa) Rai	%
1A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	7346.36	79.57	3941.05	53.65	261.84	3.56	5.84	0.08	-	-	2990.56	40.71	-	-	147.06	2.00	-	-
3	1886.49	20.43	877.53	46.52	374.72	19.86	35.67	1.89	-	-	540.85	28.67	55.32	2.93	2.40	0.13	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	9232.85	100	4818.58	52.19	636.56	6.89	41.51	0.45	-	-	3531.41	38.25	55.32	0.60	149.46	1.62	-	-

Notes:

- Approximately 3441.10 Rai is in the Nam Yao Forest Reserve with 95% in WSC2. About 5791.75 Rai is outside the Forest Reserve Area with partly WSC2 but mainly WSC3.
 - The Conservation Zone in mainly WSC1A and WSC2 and the Economic Zone is mainly WSC3 and WSC4.
 - Annual Rainfall is between 1400-1600mm.
- % - Percentage of each total watershed class area.

The main problem encountered by the villagers is the lack of self-sufficiency in rice. The approach adopted by the villagers is to diversify away from rice production into other areas such as the cultivation of fruit trees.

GIS Analysis for Watershed Management

In general, whenever soils are cultivated on slopes and exposed to erosive rains, the protection offered by close cultivation of crops needs to be supported by practices that will reduce velocities of run-off and thus reduce the amount of soil that will be transported with it. The most important of these practices are contour tillage, strip cropping on contours and terraced systems. Using the GIS database as previously described, the impact of adoption of such cultivation practices on soil loss was calculated. These results are shown in Figure 5.1.13. and show that the impact of adoption of strip cropping and terracing may largely reduce the soil loss from upland fields. Contour cropping is also effective, although the results indicated by the GIS are much less significant than for strip cropping or terracing.

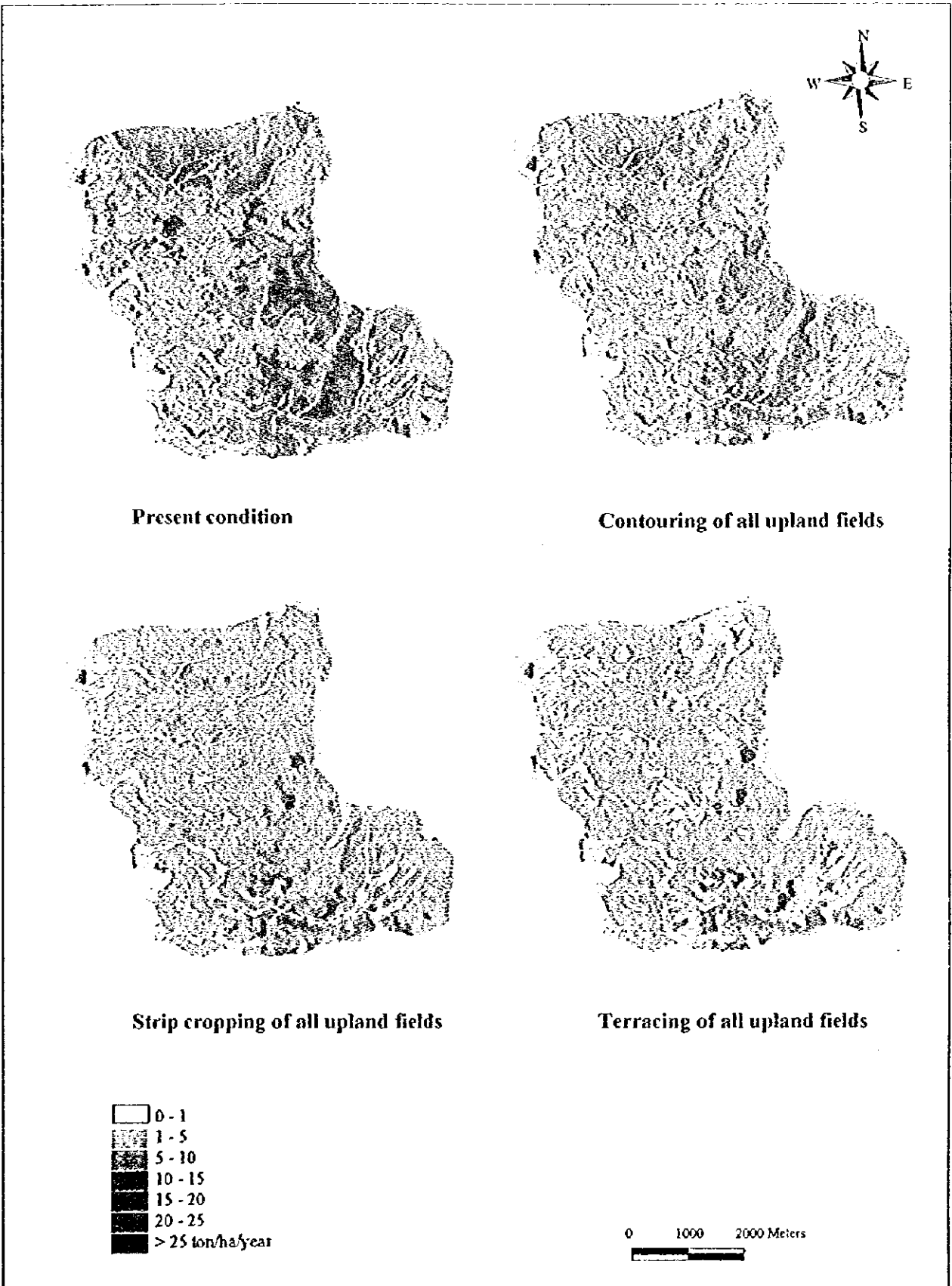
Watershed Management Programmes

By law, the study area belongs to the Watershed Management Division (WMD) of the Royal Forest Department (RFD). In addition to the WMD office of RFD in this study area, other government agencies, which are charged with environmental matters, are active. These include a number of provincial agencies (e.g. forestry, agriculture, fisheries, and public welfare) as well as the administrative units under the Ministry of Interior such as district (Amphoe) and sub-district (Tambon) organisations. The Amphoe and Tambon organisations have gained an increasingly strong influence since the new Constitution of Thailand was promulgated in 1997. This new Constitution has provided the local bodies with responsibility for environmental management (with emphasis on forestry, land and water resources) as well as some financial means.

Recently, the Upper Nan Watershed Management Project, has implemented watershed management initiatives in the area. Almost 150 new management activities have been initiated to attempt to halt and reverse the deterioration of the watershed. There are four new revised activities recently proposed by DANCED and RFD, being:

- strengthened project management procedures aimed at ensuring the success of the participatory approach to watershed management;
- development of GIS-generated participatory tools (maps) for project land-use planning and monitoring;
- assessment of the potential for ecotourism in the project area; and
- public dissemination of lessons learned from the project.

It has also been suggested by DANCED that additional funds should be targeted towards training activities for the newly empowered Tambon Administrative Organisation (TAO) in the management of natural resources, and RFD staff who will act as advisors to the TAO.



ENVIRONMENTAL STUDY
THE KOK-ING-NAN WATER DIVERSION PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 5.1.13. Potential Soil Erosion Loss under different conditions Case study in Nan (Yao) Basin

The majority of the Nan basin experiences heavy rainfall especially in the monsoon season and soil erosion has been identified as being the most severe of all of the four main tributaries of the north. Due to the severity of the problem, all upland and mountainous areas should be maintained under forest cover regardless of Watershed Classification. The status of this watershed is also of significant concern because it drains into Sirikit Reservoir, one of the main supply reservoirs for the Chao Phraya delta and the Bangkok Metropolitan area. Although sedimentation rates in the reservoir are not currently a cause for concern, further deterioration in the watershed may eventually lead to a shortened life of the reservoir. The increased flows down the Nan River that would result from implementation of the Kok-Ing-Nan project are also likely to lead to increased sediment transport to the reservoir, thus making watershed restoration even more urgent.

In addition to the requirement for intensive soil and water conservation programs in cultivated areas, about 7293 rai which is classified as WSC 2 should be gradually converted to forest plantation. Alternatively, agro-forestry combining teak or other suitable species offers a suitable management option for soil and water conservation in combination with contoured grass-strip conservation methods.

The existing DANCED program covers reforestation activities with an emphasis on fire protection. With respect to fire-damage alleviation, experiences gained from the highland areas of northern Thailand suggests that fire breaks of 2-4 metres in width are required, with burning restricted to early in the dry season to reduce the risk of the spread of fire to forest areas. Top-down burning is also suggested as a safer alternative since the fire will creep down slopes at relatively low speed making it easier to control.

Farmers should be encouraged to burn co-operatively, helping each other with the establishment of firebreaks and fire fighting. Co-ordination of fire control at a village or even higher administrative level, possibly with the help of local government authorities, has been shown to be beneficial in fire control and management.

The suggested watershed management options for the Nan study basin are summarised in Figure 5.1.14.

(8) Recommendations for Watershed Management Planning

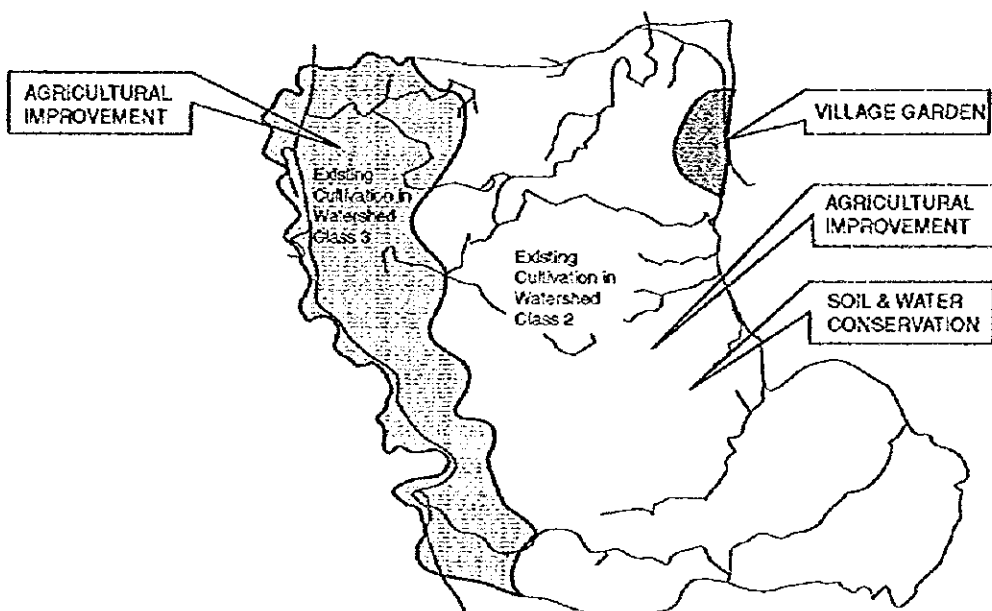
(a) Co-operative Reforestation Programme

As previously discussed the Tambon Administrative Organisations (TAOs) are now empowered to plan for the management of natural resources. All ongoing or proposed projects must acknowledge this fact. RFD Watershed Management Division, other government agencies, NGOs and project Community Co-ordinators are now required act as advisors to the TAO and support their management initiatives.

All stakeholders, particularly those acting as advisors to the TAOs, must be aware of the principles of sustainable watershed management and sustainable utilisation of land according to its suitability and carrying capacity. The TAOs will become empowered in their new role over the next 30 years and in order to achieve sustainable management of watershed resources, the following actions are recommended for consideration for implementation.



NAN



Not To Scale

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Figure 5.1.14. Nan Basin : Watershed Management Programme

The plan includes for measures for conservation of soil and water resources, agricultural extension, forest rehabilitation and encroachment prevention and other management options required for sustainable watershed management. The approach has a particular emphasis on participatory watershed management and advocates a "bottom-up" approach wherever possible. Such an approach is recommended on the basis that it offers the only really viable practical solution and on the basis that "top-down" approaches have largely failed in the past.

The plan also includes administrative and management measures to attempt to manage watershed residents in an effort to achieve sustainable habitation of resident populations without the requirement for resettlement. A Watershed Conservation and Information Centre is also recommended to assist in implementation and administration of the plan. Implementation of study and planning activities should be budgeted and financed separately by the relevant agencies. The centre should not duplicate efforts by the relevant agencies but should act as the focus for implementation in the Donor Basins and offer support directly to the TAOs. Dissemination of information to the public and general public awareness will be essential for any plan to succeed. Finally, project monitoring and evaluation of administrative financial and technical measures will also be required for successful implementation.

The Watershed Management Plan for the donor basins is divided into several components that are described in more detail in the subsequent sections:

- *Study and Planning Programme*

Participatory Watershed Planning is required for all of the donor basin areas and needs to be implemented by the TAOs with support from RFD staff. Land should be carefully evaluated and land-use constraints and carrying capacities assessed. This is particularly important in the most sensitive upper watershed areas or "head watersheds". The future study programs should address the following requirements for land-use planning in order to achieve environmentally and socio-economically sustainable watershed management practices. The required studies should be undertaken as co-operative and collaborative projects involving TAOs, government organisations and NGOs.

In the context of head watershed management a land suitability classification system needs to be developed for reforestation and agricultural purposes. This system will need to develop and assess information including:

- climatic factors;
- soil type and fertility;
- potential for small-scale irrigation development;
- opportunities to develop non-agriculturally based income generating activities;
- sustainable timber harvesting;
- collection of non-timber products;
- ecotourism; and
- suitable soil and water conservation measures to reduce soil erosion and maintain plant nutrient levels in the soil.

In order to reduce pressure on the remaining natural forest resources, and to promote reforestation programmes, issues relating to practical forestry management practices in remote inaccessible areas will need to be examined. In addition, appropriate tree species, which are suitable for forestry use and have available markets, will need to be identified. There is a great opportunity to maximise biodiversity during reforestation programmes and consideration should be given to biodiversity initiatives such as the current project funded by DANCED.

- *Administration and Management Programme*

In order to implement reforestation programmes and natural forest protection activities administrative functions and management of the programme needs to be considered.

Three levels of inter-sectoral co-ordination should be established at national, regional/main-river basin and local small watershed level. A National River-Basin Development Committee (NRBDC) should be established, as a policy, planning and co-ordination body. The Watershed Assembly, Watershed Network Committee (WNC) and Community Watershed Committee (CWC) should also be provided as operational bodies in the regional/main basin and small watershed levels.

In the context of the Kok-Ing-Nan Project Watershed Network Committees (WNC) and Community Watershed Committees (CWC) must play key roles in co-ordination of areas under TAO responsibility. The CWC should be organised and represented by members of the villages involved. WMD of RFD should take the overall responsibility in watershed resources management and should assist the programme on reforestation for conservation and for community utilisation. The TAO, with support from NGO and RFD officials should supervise villagers in planning and implementing watershed rehabilitation by measures such as reforestation, construction of check dams and small reservoir development in areas classified as WSC1B and 2.

- *Public Awareness and Information Dissemination Programme*

In order to ensure success of the watershed management initiatives it will be necessary to raise public awareness and educate the public as to the importance of sustainable watershed management through dissemination of information. In order to achieve this a number of initiatives will be required which are described below.

Increased communication among groups and individuals living and working in the project area will be required to bring attention to the requirement to rehabilitate the watershed, and the mechanisms by which this may be best achieved. Tools that might prove useful are described below.

The use of 3-dimensional models, maps, newsletters, village bulletin boards, workshops and working groups should be encouraged. These should address issues affecting upstream and downstream users and examine innovative techniques used by local groups, as well as providing a vehicle for easy and informal access to information.

People's forums bringing together watershed groups and government agencies should be set up to discuss current reforestation and forest protection projects. These forums should explore successful reforestation projects and examine reasons for success or failure.

Special events should be organised in downstream areas of the main provinces of each main basin, e.g. Chiang Rai for Kok basin, Phayao for Ing basin and Nan for Nan basin. These events should highlight rehabilitation and reforestation initiatives in the upper basins and the importance of such initiatives for downstream users and residents.

- *Evaluation and Monitoring Programme*

Generally, the success or failure of any reforestation initiative in Thailand has been monitored and evaluated by government agencies or committees, except for those projects

supported by international fund agencies. The process has not always been successful and has often resulted in wasted resources. An approach of participatory monitoring and participatory evaluation is therefore recommended for the Kok-Ing-Nan watershed rehabilitation projects. Local participatory groups should implement evaluation and monitoring systems.

In participatory monitoring and evaluation, 3 levels of monitoring are suggested. The first level would be to look at project inputs, including provision of seeds, seedlings, fertiliser, water, compost, and donation of money, labour and other resources from local people organised by the TAOs. In addition, any training programmes or other related activities should also be monitored. Output level monitoring would indicate the consequences of input elements such as areas reforested for conservation or areas forested for use as community forests. In addition, any rehabilitated areas would need continued monitoring after project implementation to ensure potential future degradation is avoided.

In addition to the output level elements, people's awareness and changes in land management practices should be monitored. This monitoring should be combined with measures of rates of change of physical aspects of the environment such as soil erosion, productivity of land, farmer's income, water yield and severity of forest fire.

The group responsible for monitoring and evaluation in the initial stages should include representatives from TAO, government organisations and NGOs. In the long term, this monitoring and evaluation activity should be transferred to local organisation such as TAOs with governmental officers as technical advisors.

(b) Forest Protection and Encroachment Prevention Programme

The published literature and the case studies support the requirement for forestry conservation as a means of maintenance of watershed functions, in particular, soil and water resources. Many villagers are well aware of the need for forest protection and are implementing various activities to protect forest areas around their own water sources for the purpose of maintaining water supplies.

Further forest protection is difficult because of the need to maintain agricultural land in order to derive adequate income. This limits the amount of land available for forest use. However, there is scope for improved management of areas that have already enjoyed some degree of protection and for increased tree planting in farm holdings to increase tree cover. Efforts should be made to increase awareness of the need to maintain the existing forest area and to improve its management by planting more trees. Improved monitoring of forest use by the local people is also required.

- *Encroachment Prevention*

It is impossible to guarantee that existing forest areas are not encroached further. However, the case studies indicate that it is not an unachievable goal. Already, some villages are protecting forest areas and enforcing rules against encroachment. This should be encouraged and promoted wherever possible.

- *Development of Sustainable Agriculture Systems for Encroachment Management*

The aim of farming system development (FSD) is to rapidly identify useful local practices, as well as introduce new technology, for the benefit of small farmers. Agricultural extension workers assist families to help identify farm management

practices that fit local ecological and socio-economic conditions. Income generation and food production are obviously important, but sustainability is critical. The approach is long term and participatory in nature.

The productive potential of the project area is limited by physical and biological factors. The extent of resource degradation, as well as its causes and effects, should be assessed to determine constraints and identify required improvements. Appropriate conservation and management practices should also be identified to maintain and improve the productivity of land and other natural resources.