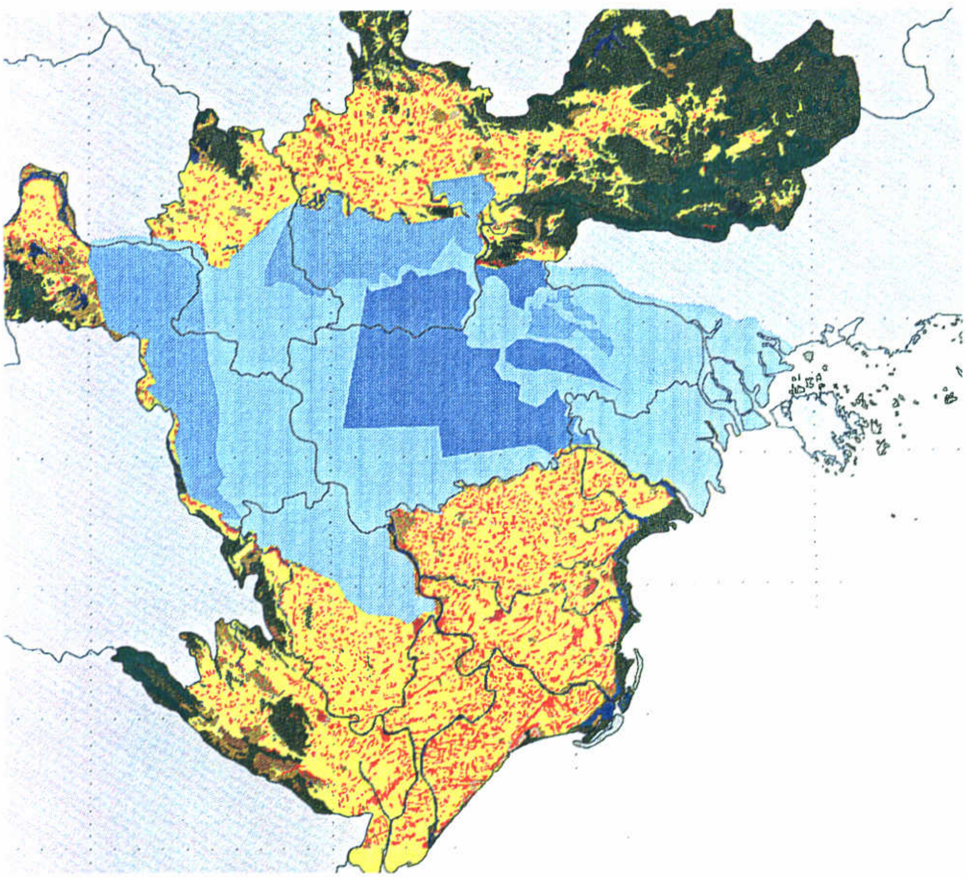
Government of The Netherlands
Ministry of Foreign Affairs

Government of the Socialist Republic of Vietnam
Hydrometeorological Services

VIETNAM COASTAL ZONE VULNERABILITY ASSESSMENT and First Steps Towards Integrated Coastal Zone Management

REPORT No.7



FINAL REPORT
April 1996

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SYNOPSIS

From November 1994 to April 1996 a project has been conducted which assessed the vulnerability of the coastal zone of Vietnam to the impacts of accelerated sea level due to global warming. The project was conducted according to the Common Methodology recommended by the Intergovernmental Panel on Climate Change.

The project involved a European Team comprising Polish and Dutch coastal zone management specialists which worked closely together with Vietnamese counterparts in a joint project office in Hanoi. During the study extensive data on physical, socio-economic and institutional characteristics of the coastal zone of Vietnam were collected. Digitization of the entire coastal zone formed the basis for GIS analyses which determined areas of different land-use types inundated by various flood scenarios. Further analyses provided loss and risk figures for land use types, population and capital value.

The findings showed the high sensitivity of Vietnam to a rise in mean sea level. Vietnam's vulnerability was ranked as CRITICAL and protection measures were seen to be immense. Most sensitive areas are the Mekong Delta and the region of Ho Chi Minh City and Vung Tau. Recommendations for increased momentum towards Integrated Coastal Zone Management are made with associated actions to strengthen local capabilities for coastal management.

Vietnam ranks with the small island states as being among the most vulnerable nations in the world for the impacts of accelerated sea level rise.

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COMPLETE LIST OF VIETNAM VA PROJECT REPORTS

PROGRESS REPORTS

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List of Abbreviations

ASEAN	Association of South East Asian Nations
ASLR	Accelerated Sea Level Rise
CHM	Centre for Marine Hydrometeorology - South
CIS	Coastal Information System
CCP	Climate Change Programme (of Vietnam)
CCTRAIN	Country Team for Climate Change Training Project (of UNITAR)
CMH	Center for Marine Hydrometeorology - South, of HMS, HCMC, Vietnam
CSRG	Center for Remote Sensing & Geomatics, Institute of Geology, National Center for Natural Science & Technology, Vietnam
CZMC	Coastal Zone Management Centre of RIKZ
CZMS	Coastal Zone Management Subgroup, Response Strategies Working Group 3, IPCC
DEM	Digital Elevation Modelling
DGIS	Directorate General for International Co-operation
DH	Delft Hydraulics
DMU	Disaster Management Unit of UNDP
DoSTE	Department of Science, Technology and the Environment
DSS	Decision Support System
EIA	Environmental Impact Assessment
FRH	Frederic R Harris B.V., The Hague, The Netherlands
FNIS	Framework National Implementation Strategy
GDP	Gross Domestic Product
GEF	Global Environment Fund
GIS	Geographical Information System
GMS	Geo-Management System
HAT	Highest Astronomical Tide
HCZ	Hydraulic Condition Zone
HMS	Hydrometeorological Service, Hanoi, Vietnam
IBW-PAN	Institute of Hydro-Engineering, Gdańsk, Poland
ICOR	Incremental Capital to Output Ratio
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
LTRA	Long Term Resident Advisor
MHC	Marine Hydrometeorological Centre, Hanoi, Vietnam
MS	Mekong Secretariat, Bangkok
MSL	Mean Sea Level
MTVA	Medium Term Visit Advisor
MWR	Ministry of Water Resources, Vietnam

NEA	National Environment Agency
NIAPP	National Institute for Agricultural Planning and Production, Ministry of Agriculture, Vietnam
ppt	Parts per thousand
RAMSAR	UNESCO protected site "wetland of international importance"
RIKZ	National Institute for Coastal and Marine Management, Ministry of Transport, Public Works and Water Management, the Netherlands
RRMDP	Red River Delta Masterplan Development Project
RSWG	Response Strategies Working Group
SC	Steering Committee
SCS	State Committee for Sciences
SPC	State Planning Committee
SFEZ	Southern Focal Economic Zone
STRA	Short Term Resident Advisor
STVA	Short Term Visit Advisors
TFAP	Tropical Forest Action Plan
ToR	Terms of Reference
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
VA	Vulnerability Assessment
VMS	Vietnamese Mekong Secretariat
WCC'93	World Coast Conference 1993, The Hague, The Netherlands
WFP	World Food Programme
WMO	World Meteorological Organization

PART I - INTRODUCTION

I INTRODUCTION

I.1 Background

The International Response to Climate Change and Accelerated Sea Level Rise

The sea level rise phenomenon is not new and a natural rate of sea level rise of about 10 to 20 cm per 100 years is presently being experienced. Due to accumulated man-made "greenhouse" gases in the atmosphere and the depletion of the ozone layer, climate change effects are expected to take place that will cause global warming and an accelerated rate of sea level rise over the coming century. By the latest predictions, the accelerated rate of sea level will be between 30 cm and 100 cm per 100 years. These facts have led to a mobilisation of the International Community to respond to the impacts of accelerated sea level rise and other climate change related phenomena.

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly formed the Intergovernmental Panel on Climate Change (IPCC) which in turn established three working groups. Working Group III, the Response Strategies Working Group set up four Subgroups to evaluate response strategies to limit or adapt to climate change. Among the recommendations of the Subgroup for Coastal Zone Management was the call to implement comprehensive coastal zone management plans by the year 2000, to identify coastal areas at risk, and to provide technical assistance to developing nations in assessing vulnerability to accelerated sea level rise (ASLR).

As a first organizational step towards these goals, in March 1991, UNEP together with and a number of countries formed the "Interim Advisory Group on Assessing Vulnerability to Sea Level Rise" within the framework of the IPCC Response Strategies Working Group in order to derive a consistent methodology of Vulnerability Assessment (VA). This methodology was applied and further developed in a series of short duration national case studies, involving a representative sample of various categories of coastal environments. During a meeting in Geneva in August 1991, guidelines were adopted (the so-called "Seven Steps") for the execution of national VA case studies and published in a "*Common Methodology*" (ref 1).

VA case study activities soon followed, executed and coordinated through the IPCC Coastal Zone Management Subgroup, chaired by the Netherlands, with representatives of Argentina, Australia, Bangladesh, France, Gambia, Japan, Kiribati, the Netherlands, Saudi Arabia, United Kingdom, United States of America, Venezuela, and UNEP's Regional Seas Programme.

At the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil in 1992, the UN Framework Convention on Climate Change (UNFCCC) was adopted by over 150 countries. Vietnam is a signatory to that convention and is preparing to meet its commitments. Specifically Agenda 21 of UNCED, in Chapter 17 "Oceans and Coasts", identifies Integrated Coastal Zone Management as a key activity for sustainable development of coastal areas and calls for states to adopt measures .....

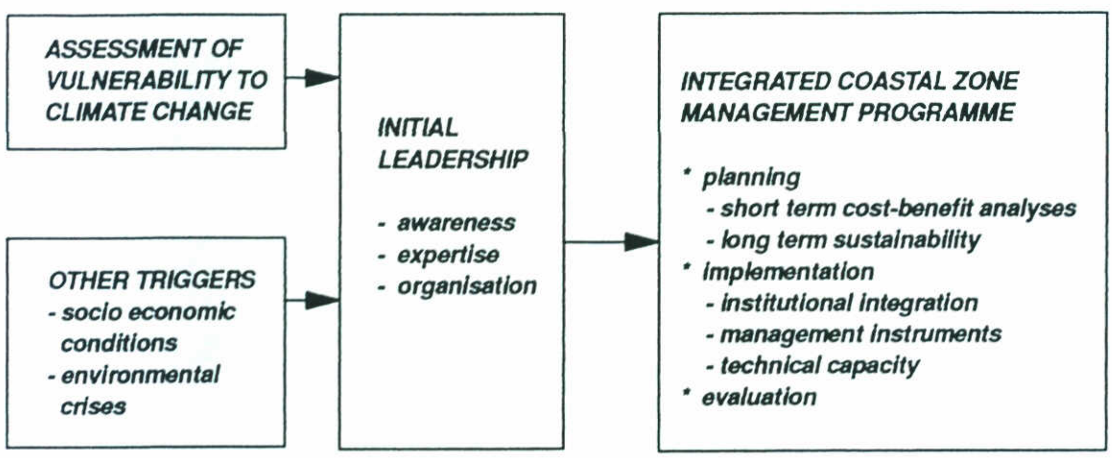
" to cope with and adapt to potential climate change and sea level rise, including the development of globally acceptable methodologies for coastal vulnerability assessment,

modelling and response strategies, particular for areas such as small islands and low lying coastal areas"

A global inventory made in preparation of the UNCED Conference in Rio de Janeiro in 1992 showed that Vietnam is indeed one of the most vulnerable nations as regards the threat imposed by climate change, including ASLR. It was clearly recognised that the vulnerability needs to be quantified and response strategies need to be developed.

The role of a vulnerability assessment as a recognised "first step" towards ICZM is described in the World Coast Conference Report in 1993 (ref 2), see Box I-1. It is considered as an excellent "trigger" to stimulate awareness and activities for ICZM by introducing long-term planning and preparedness as an important step towards sustainable development of coastal zones.

Box I-1
Vulnerability Assessment as a possible "trigger" to ICZM
(ref. World Coast Conference Report, WCC'93, The Netherlands, 1993)



The response of Vietnam to Climate Change and Sea Level Rise

As a participant of the UNFCCC, in order to comply, Vietnam is required to establish a Country Programme outlining its commitment and methodology to respond effectively to the limit and manage the impacts of man-induced climate change.

Assisted by the UN Agency UNITAR (United Nations Institute for Training and Research) with a training project (CCTRAIN), the Government of Vietnam has set up a "Country Team" with the following aims:

- Organise national workshops and training seminars
- Develop a Framework National Implementation Strategy (FNIS)
- Publicise and promote consensus on the FNIS
- Study the potential and resources for implementation and identify UNFCCC related projects and assistance requirements.

The Country Team comprises representatives from key Ministries and operates via a Coordinator, Executives, a Core Team and 4 Working Groups. The Hydrometeorological service, HMS is a focal point in Vietnam for Climate Change issues and a leading member of the Country Team providing the Core Team Secretariat and with the Director General of HMS as Coordinator and Chairman.

In addition to the many other activities initiated by the Country Team and recognising the potential risks and the need to respond to threatened sea level rise impacts to the Vietnam coastal zone and its sustainable development, a specific request for assistance with *"... a study on Vulnerability Assessment along the guidelines as set up by the Coastal Zone Management Subgroup of IPCC"* was made by the Director General of HMS in his letter to the Netherlands Embassy in Bangkok on 2 March 1992.

Subsequent meetings and discussions both in the Netherlands and Vietnam culminated in a Pilot Mission to Vietnam by coastal specialists from Poland and the Netherlands in October 1993 (ref 3). As a result of this Pilot Mission an outline for an 18-month study in Vietnam was identified with the primary objective to provide Vietnamese counterparts with assistance in executing a VA to assess the impacts of accelerated rate of sea level rise on the coastal zone of Vietnam and in so doing to strengthen the capabilities of Vietnamese organisations in preparation for ICZM activities.

A Project Document outlining the details of the proposed project and the required timing and funding was presented to DGIS in mid 1994 and the project was initiated in November 1994.

The Vietnam VA Project - Terms of Reference

The Vietnam VA Project is formally known as "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management" (DGIS Project Activity Number WW039104).

The project terms of reference were described in the Project Document (ref 4) as follows:

With the primary aim to strengthen the capabilities for the implementation of ICZM activities in Vietnam, the project "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management" must fulfil the following Terms of Reference:

Specialist assistance must be given to the Vietnamese Government by conducting together with Vietnamese counterparts a Vulnerability Assessment to accelerated sea level rise along the lines of the IPCC Common Methodology for such studies. In so doing, the focus must be to support, guide and strengthen Vietnamese capabilities for the complex technical, institutional and organisational matters involved in effectively managing the Vietnamese coastal zone, particularly in view of the pending threats from accelerated sea level rise and climate change. Outputs from the project are therefore required as follows:

- *A Vulnerability Assessment document*
- *Workshops and seminars in Vietnam*
- *A strengthening of capability (staff and equipment), communication and inter-agency cooperation of Vietnamese counterpart organisations*

The project must not aim to design and implement a full programme for implementation of Integrated Coastal Zone Management (ICZM) in Vietnam. The programme of work and the listed outputs should be seen as providing important first steps towards this longer term objective.

Apart from project reports (Inception, Progress and Final), findings (impacts and responses) should be demonstrated using computer based storage, retrieval and graphical display/simulation techniques for further use and planning and as an aid to decision making. As a basis the WCC'93 approaches and guidelines should be used.

During the project, close cooperation and liaison with other relevant programmes underway in Vietnam must be maintained (eg UNITAR, Red River Master Plan Development, Mekong Secretariat, Climate Change Programme etc.).

Objectives

The objectives of the Vietnam VA Project were:

(i) To strengthen and upgrade the technical capacity of Vietnamese counterparts for the efficient management of the Vietnamese coastal zone in both the short and long term;

(ii) To encourage and strengthen the links and interactions between Vietnamese organisations involved in coastal management as a priority for effective ICZM in the short term and as a first step toward the longer term goal of implementation of ICZM in Vietnam;

(iii) To arrive at a full Vulnerability Assessment for the Vietnamese coastal zone within the 18 month study period, consistent with the format and requirements of the IPCC;

(iv) To demonstrate, by working on specific local Pilot Studies, the application of techniques, tools and decision making systems for solutions to actual existing serious coastal problems;

(v) To conduct effective communication and synergy of effort with other on-going relevant projects and programmes such as UNITAR, RRMDP, CCTRAIN, UNDP, WFP etc.

(vi) To work openly, interactively and closely in a trilateral team to cover all the stated project objectives and thereby build and bond effective working relationships between the local participants in Vietnam.

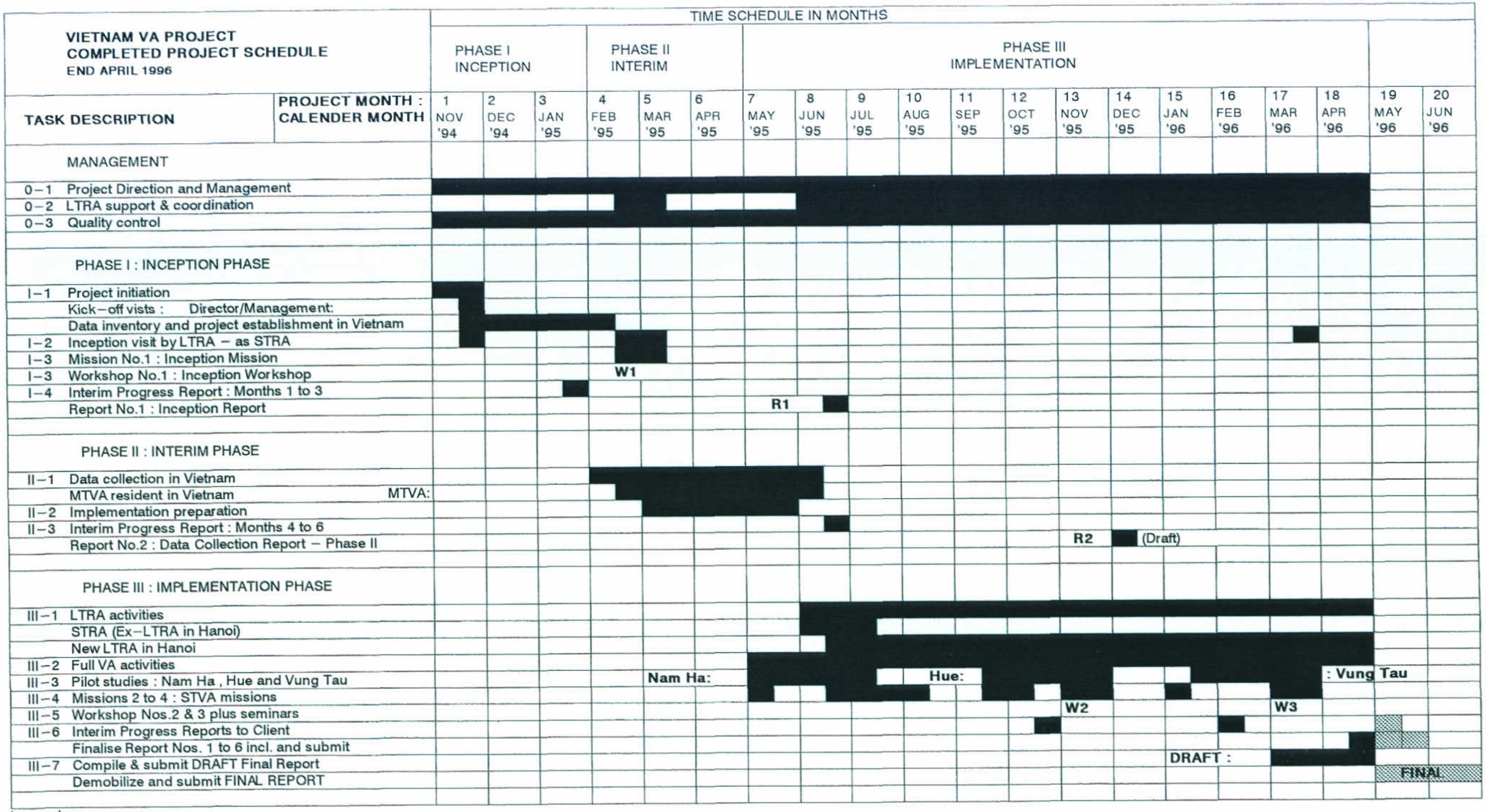
Completed Schedule

The project was executed as planned over an 18 month study period from November 1994 to April 1996 inclusive, in 3 Phases as described in the completed schedule of Figure I.1-1:

PHASE I : Inception Phase
PHASE II : Interim Phase
PHASE III : Implementation Phase

In addition to the traditional VA activities outlined in the IPCC *Common Methodology* (ref 1), the Vietnam VA Project covered the foundation and first steps towards ICZM implementation in Vietnam by incorporation of 3 *Pilot Studies* : Sea dyke erosion in Nam Ha Province, Flooding and lagoon management, Thua Thien Hue Province and Coastal Management and Planning, Baria Vung-Tau Province. *Workshops* (3), small seminars (numerous) and other technology transfer activities were undertaken.

The combination of the long term VA, short term Pilot Studies and other technology transfer activities provided a project that has resulted in a strengthening of technical and management capabilities of Vietnamese counterparts to deal with the coastal zone management demands imposed by increased development and climate change related impacts on the Vietnamese coastal zone. Interagency cooperation has been encouraged, stimulated and assisted and together with Vietnamese counterparts a strategy and request for follow up studies has been



Legend :
Work completed to end of April 1996
Comments on draft reports

Vietnam VA Study

Completed Project Schedule

Fig No I.1 - 1

formulated and accepted. These are important first steps towards implementation of ICZM in Vietnam.

I.2 PROJECT INCEPTION

In, *Report No.1*, the Inception Report (ref 5), a description is given of the project activities and decisions during the initial stages of the project and the planned activities and methodologies for the VA analyses and Pilot Studies.

The Project Team

Appointed and supported by the Netherlands Government, the project team comprised three parties Poland, the Netherlands and the Socialist Republic of Vietnam. In Figure I.2-1, the overall arrangement of the Vietnam VA Project participation is shown.

- Vietnamese Agencies

The Marine Hydrometeorological Centre (MHC), situated in the SE suburbs of Hanoi (Dong Da District), was the main focal point for the project. The MHC is responsible for the management of data from the network of marine hydro-meteorological recording stations along the entire coast and on offshore islands as well as deepsea oceanographical data collection. MHC is staffed by about 45 people in Hanoi and is one of over 10 units throughout Vietnam within the far larger Hydrometeorological Service (HMS). Specialists at MHC are mainly concerned with marine and coastal hydraulic disciplines such as sea level changes, tides, waves and oceanography.

In the south of Vietnam, MHC coordinated activities with the Center of Marine Hydrometeorology - South, CMH, in Ho Chi Minh City. CMH is also a centre within the Hydrometeorological Service of Vietnam (HMS).

- European Agencies

Contact point for the contract with The Netherlands Government (Directoraat Generaal Internationale Samenwerking, DGIS) as Client was The Institute of Hydroengineering of the Polish Academy of Sciences, IBW-PAN, (Gdansk) of Poland. IBW-PAN provided the Project Director, Medium Term Visit Advisor (MTVA), assistant to the Project Manager and specialist advisors for the missions activities in Hanoi.

The Project and Financial Management was conducted jointly by the VA Vietnam Joint Venture between Frederic R Harris B.V. (The Hague) and Delft Hydraulics (Delft), The Netherlands. The Project and Financial Manager was provided by Frederic R Harris B.V.. The Long Term Advisor, resident in Hanoi for 12 months from May 1995, was provided by Delft Hydraulics from within the VA Vietnam Joint Venture. The Joint Venture also provided Dutch coastal zone specialists for the short term missions.

The Coastal Zone Management Centre (CZMC) of National Institute for Coastal and Marine Management (RIKZ), within the Ministry of Transport, Public Works and Water Management of the Netherlands, participated as Quality Controller and Dutch Government representative.

The Steering Committee

The Vietnamese Steering Committee which guided the project and provided coordination and support, particularly for data acquisition and priority setting, was chaired by Prof.Dr Nguyen Duc Ngu, the Director General of HMS and comprised the following:

Dr Nguyen Duc Ngu (Chairman), Director General of HMS, Hanoi
Mr Nguyen The Tuong, Director, Marine Hydrometeorological Centre, HMS, Hanoi
Dr Nguyen Ngoc Huan, Deputy Director, Marine Hydrometeorological Centre, HMS, Hanoi
Dr Vo Van Trac, Vice Minister, Ministry of Fisheries, Hanoi
Dr Dang Hung Vo, Dep. Director General, General Department of Land Administration, Hanoi
Dr To Linh, Office of Government, Hanoi
Dr Phan Van Hoac, Director, Centre for Marine Hydrometeorology - South, Ho Chi Minh City

Operational arrangements and logistics

The operational arrangements included the following :

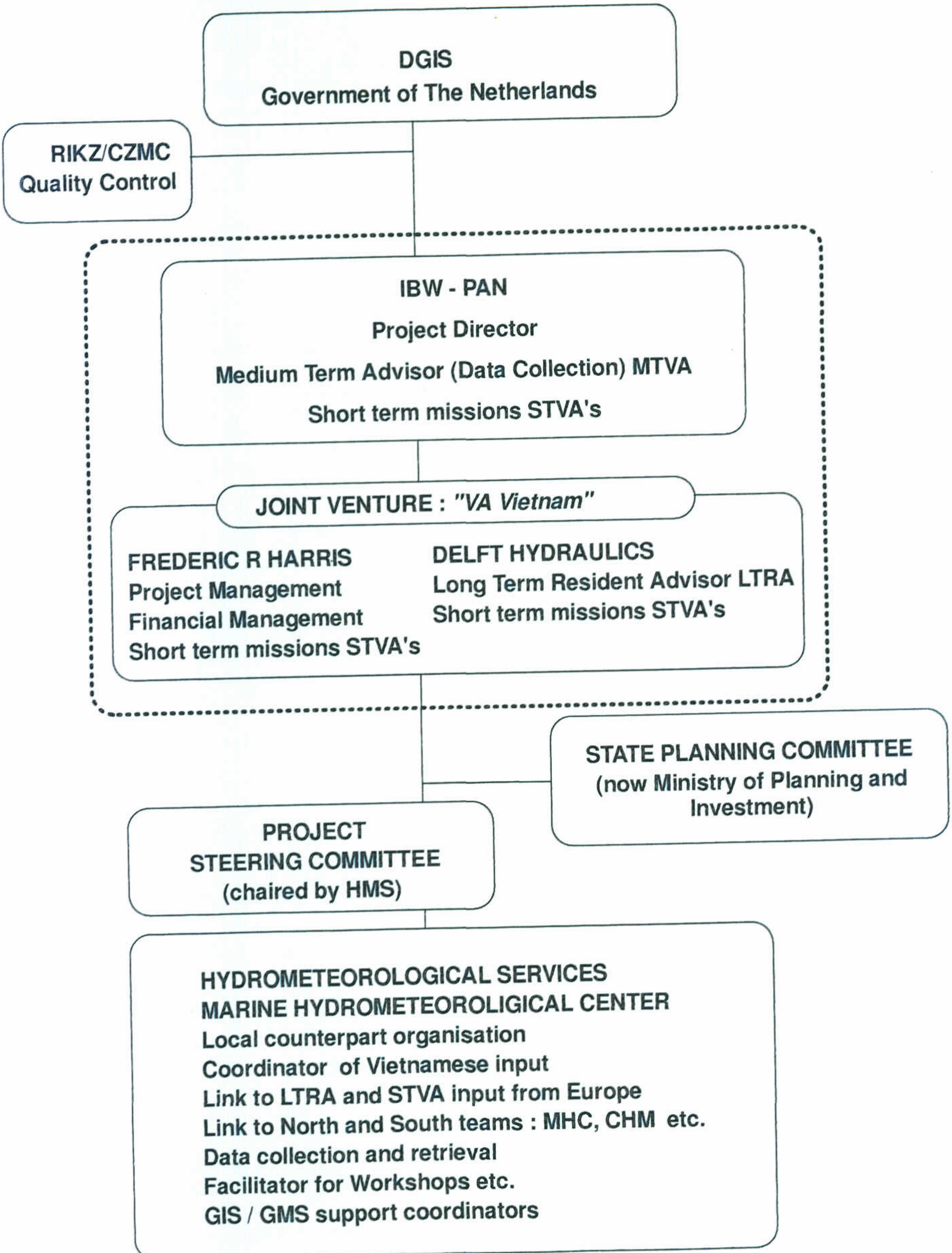
Establishment of Project Office in Hanoi, Vietnam

A Project Office was established in Hanoi, very close to the offices of MHC (29a Nam Thanh Cong, Dong Da District, Hanoi). The office was equipped (by the Project) with communication and printing equipment and other office facilities. In addition, software purchases were undertaken (including office software, drawing packages, GIS software PC-SPANS EXPLORER, data display software GMS-DECIDE, digitizing, scanning and printing software etc). A transportation agreement was also made which ensured full access to a project car.

Access to data and information

Data and services, such as maps, aerial photos, reports and recordings (raw data such as tides and water levels etc.) were obtained via MHC in direct negotiation with the data source. Almost all data needed to be obtained by way of contracts for supply on a case by case basis between the Vietnamese agencies. This proved to be good way of involving a wide spectrum of Vietnamese specialists from various ministries and organisations in the project.

ORGANISATION CHART : PROJECT TEAM



Vietnam VA Study	
Project Organisation	Fig No I.1 - 2

I.3 Data Collection

In *Report No.2,* (ref 6), a description of the data collection activities is provided as well as a first scan and review of available data. Following this, in March 1995, a specialist advisor (MTVA) was stationed in Hanoi for 4 months to supervise a full programme of data collection. The data collection programme covered all aspects of the physical, socio-economic and institutional data requirements for the VA analysis as well as identifying data sources for the pilot studies. To formalise and facilitate release and delivery of data, about 18 data contracts were awarded and conducted with a wide variety of Vietnamese organisations, most of whom were Government institutes and agencies, described in Table I-1.

All reports submitted by Vietnamese specialists were reviewed and edited by the project team following which interviews were held with each author to discuss and finalise the submission. All these reports are available on request as separately bound appendices to *Report No.2* (ref 6).

From the reports, important data for the VA was extracted and summarised. In all cases, no long term time series data were retrieved although in many cases, during meetings and discussions, original data and recordings were reviewed (eg water levels with MHC).

Digital data collection of the land use and topography of the coastal impact zone was captured during two digitization contracts. North Vietnam was covered by the Centre for Remote Sensing and Geomatics of the Institute of Geology and South Vietnam was covered by the National Institute for Agriculture and Planning of the Ministry of Agriculture and Rural Development. These contracts each employed over 10 scientists & technicians to digitize data from 400 map sheets in 6 months. The huge database so formed was then made available for analysis.

The combined interpreted data and digitized data form part of the basis for the Coastal Information System used in the analysis and visualisation of the VA.

Difficulties encountered during data collection were mainly related to the establishment of datum levels both horizontally and vertically. Historically Vietnamese maps have been compiled in Chinese, French, US and Vietnamese cartographic systems each with different projection and accuracy levels. Many of the present maps suffer from the poor conversions between these systems. Vertical datums, which were different in the south to the north of Vietnam were only recently "joined" or reconciled. Standard reference levels can now be referred to Hon Dau Datum HD nationally. HD will be used throughout this report. HD is about 0.14m above MSL.

Table I-1 : Summary of data collection contracts

No.	Contract title, organisation (and contact person)
PHYSICAL AND ENVIRONMENTAL DATA CONTRACTS	
A1	Coastline types of Vietnam Vietnam National Centre for Natural Sciences and Technology, Institute of Geological Sciences (Prof.Dr. Nguyen Dich Dzy and Dr. Vu Cao Minh), Hanoi
A2	Inventory of Coastal protection and River Dykes in Vietnam's coastal zone Ministry of Water Resources (Dr. Ton That Vinh), Hanoi
A3	Landuse and Topography of the Vietnamese coastal zone - See Section 2.4 : "Digitization Contracts"
A4	Subsidence of Vietnam's coastal areas Vietnam National Centre for Natural Sciences and Technology, Institute of Geological Sciences (Prof.Dr. Nguyen Dich Dzy and Dr. Vu Cao Minh), Hanoi
A5	Tidal characteristics around Vietnam MHC of HMS, Hanoi (Dr. Nguyen Tai Hoi, Nguyen Manh, Tran Phuong Dong etc.)
A6	River characteristics in Vietnam MHC of HMS, Hanoi and Institute of Hydrology of HMS, Hanoi. (Hoang Minh Tuyen, Pham Kim Oanh)
A7	Storm characteristics on the Vietnam coast MHC of HMS, Hanoi (Dr Nguyen Doan Toan, Tran Hong Lam, Nguyen Thi Hai etc.)
A8	Wave characteristics on the Vietnam coast MHC of HMS, Hanoi (Dr Nguyen Doan Toan, Tran Hong Lam, Nguyen Thi Hai etc.)
A9	Flood prone areas Ministry of Water Resources, Hanoi (Dr Nguyen Trong Sinh, Le Duc Nam, LH Thuan, TT Luat, LHung Nam)
A10 a	Littoral materials and littoral processes along the Vietnam coast Sub-Institute of Physics, Ho Chi Minh City (Dr Hoang Xuan Nhuan)
A10 b	Erosion and accretion on the sea coast of Vietnam Vietnam National Centre for Natural Sciences and Technology, Institute of Geological Sciences, Hanoi (Prof.Dr. Nguyen Dich Dzy and Dr. Vu Cao Minh)i
A11	Groundwater characteristics in the Vietnam coastal zone Ministry of Water Resources, Hanoi (Dr Nguyen Trong Sinh, Le Duc Nam, Le Huu Thuan, Le Hung Nam)
A12	Datum levels in Vietnam, MHC, Hanoi (Nguyen Tai Hoi)
A13	Design water levels in the Vietnam coastal zone, MHC, Hanoi (Nguyen Tai Hoi)
A14	Coastal flora habitats and ecological types Mangrove ecosystem research center, Vietnam National University, Hanoi (Prof.Dr.Sc. Phan Nguyen Hong)
A15	Fauna of Vietnam's coastal zone Dept.of Vertebrate Zoology, Faculty of Biology, University of Hanoi (Prof.Dr. Vu Trung Tang)
SOCIO-ECONOMIC AND INSTITUTIONAL CONTRACTS	
SE1	Existing socio-economic factors and development of Vietnam with emphasis on the coastal zone Institute for Strategic Development Planning, State Planning Committee, Hanoi (Dr. Anh)
SE2	Socio-economic development scenario for 2025 for Vietnam with emphasis on the coastal zone Institute for Strategic Development Planning, State Planning Committee, Hanoi (Dr. Anh)
SE3	Legal and institutional affairs relating to the development and management of the coastal zone of Vietnam Institute for Strategic Development Planning, State Planning Committee, Hanoi (Dr. Anh)

I.4 Methodology

In, *Report No.3*, (ref 7) particular reference is made to the following three aspects :

GIS analysis

The digitized land use data was loaded into a GIS software packet SPANS EXPLORER on PC together with the topographical data. The topographical data was used in a procedure to determine the areas flooded for four water level events: 1/year, 1/10 year, 1/100 year and 1/1000 year water levels for the case with no sea level rise and for the case with sea level rise. Therefore, in total 8 flood scenarios were investigated. In GIS, the 8 flooded areas were confronted with land use maps and a cross tabulation provided the areas of different land use types in each flooded area.

FFR analysis

A *Flooding and Flood Risk* (FFR) program received as input, the cross-tabulation results from the GIS analysis. The FFR model then performed risk and loss calculations on these data to provide figures for land use types *at loss* and land use types *at risk*. Population density factors per land use class and capital value per sq.km. per land use class were used as multipliers to arrive at the loss and risk statistics, split into 13 land use classes. Per land use class per province the following information was provided by the FFR analysis model:

- area at loss
- area at risk
- people to be moved
- people at risk
- capital value lost
- capital value at risk

With the use of numerical "development factors" per land use class and per province, a projection was made for the revised values of the above 8 results per province using population density and capital value per sq. km. pertaining to the 30 year scenario of 2025.

GMS analysis

The GMS (Geomanagement System) was used as the basis to store and view data of many types for the various coastal units. For each of the coastal provinces, there is a graphical file in the GMS software (GMS-DECIDE) which can be activated to view a wide variety of data types and figures, photographs etc. Gradually an extensive database of many types of information (documents, maps, scanned photographs, GIS output etc.) has been built up for each coastal province and can be easily displayed using GMS. The FFR programme was also activated from within the GMS-DECIDE software.

I.5 Pilot Studies

Three Pilot Studies were conducted and each of these is briefly reviewed here :

Pilot Study No.1 Sea dyke erosion in Nam Ha Province

Report No.4, relating to Pilot Study No.1 (ref 8), describes a review of the sea dyke safety along the Red River coastal provinces of Thai Binh and Nam Ha conducted in July 1995, which focused on the serious erosion of weak sea defences in the Nam Ha Province, District of Hai Hau. Site visits were undertaken together with personnel from the Department of Dyke Management and Flood Control and in liaison with local authorities at Provincial, District and Commune level. Physical data and previous studies were reviewed and discussed with Vietnamese specialists from various ministries and Institutes. Socio economic and environmental data were also reviewed including land use, population and economic factors. A classical *managed retreat* strategy has been adopted for decades at Nam Ha whereby successive dyke lines are abandoned together with many hectares of productive land. The situation has reached the stage where the village of Ha Trieu is under threat and evacuation plans are underway. This situation will be particularly vulnerable in the event of accelerated sea level rise and the Pilot Study examined, analysed and interpreted selected available physical, socio economic and institutional data.

Pilot Study No.2 Flooding and lagoon management, Thua Thien Hue Province

Report No.5, (ref 9), describes a short study of the problem of flooding and management in the coastal lagoon system at Hue in the central coast province of Thua Thien Hue conducted in November 1995. Site visits were undertaken together with personnel from the local Hue University, Hanoi University and the Sub-Institute of Physics (Ho Chi Minh City). Extensive discussions and meetings were held with the local authorities, particularly at the People's Committee of Thua Thien Hue Province in the City of Hue. Serious flooding problems can be alleviated by hydraulic means but not without adversely affecting important local economies and users of the lagoon waters since not only water levels will be affected but also salinity impacts and morphological changes can take place with huge consequences. The study reviewed the physical, environmental, economic and institutional properties and constraints of the region and set out a framework for addressing the complex issues in more detail.

Pilot Study No.3 Vung Tau planning

Report No.6, (ref 10), describes the brief review of the planning issues presently facing the area of Vung Tau in the south of Vietnam. The area is situated close to Ho Chi Minh City and has the possibility to take advantage of natural deepwater port facilities and a burgeoning nearby offshore industry as well as good recreational beaches and tourism. However, one of the few remaining mangrove forests in Vietnam is endangered by the developments. The mangrove forest is not only an environmental resource but it also plays an important protective role to the local river trading ports and waterways leading to the Port of Saigon. Site visits were undertaken with local specialists and local authorities were consulted and informed. An important inventorising and visualisation of the key issues was achieved which provides focus for careful consideration of planning and development options and a framework for further study.

PART II - VULNERABILITY ASSESSMENT

PART II - VULNERABILITY ASSESSMENT

Introduction

The full vulnerability assessment (VA) was conducted in the implementation phase of the project.

The role of the VA is to examine the ability of Vietnam to cope with the consequences of global climate change, including accelerated sea level rise. This includes identifying the populations and resources at risk, investigating the costs and feasibility of possible responses to adverse impacts and examining the institutional capabilities of implementing those responses. This assists Vietnam with providing a longer term perspective to the planning and development of its coastal zone.

The Common Methodology (ref 1) has been applied in this study with the following 7-Step procedure :

Step 1 : Specification of study area and boundary conditions

Step 2 : Inventory of study area characteristics

Physical characteristics
Natural habitats and species
Socio-economic characteristics

Step 3 : Future development factors - identification of future scenarios (2025)

Step 4 : Physical effects and natural system responses

Step 5 : Response strategies

Step 6 : Vulnerability profile - assessment of vulnerability and interpretation of results

Step 7 : Relevant actions and priorities

Activities and findings of each step, applied to the coastal zone of Vietnam, are described in the following sections of Part II of this report.

II.1 Step 1 : Specification of study area and boundary conditions

The "extent" of the study area

For maximum impact, usefulness and coverage, the study area extent included the entire coast of Vietnam. Upper and lower limits to the study area were selected based on the following considerations of the hydraulic impact zone, considering a 1 in 1000 year event and sea level rise of 1m over the next century.

The "upper" elevation of the study area

The "upper elevation" or landward boundary of the study area should be chosen in such a way that, as a minimum, those areas are encompassed which will be physically affected by ASLR through changes in the probability of flooding, by erosion and sedimentation patterns, or by salinity intrusion; noting that land subsidence can also play a role in extending the study area to be considered.

A first approach is to fix the upper (inland) boundary of the study area based on a sum of an extreme water (sea) water level, subsidence and sea level rise. Initial discussions were held with MHC and the Institute of Geology, and estimates of these values were made early in the study (Phase I) to guide the data collection process. Considering a 100-year return period water level above MSL of 2.6 m (highest in N Vietnam), an expected subsidence over the next 100 years of about 0.4 m and an ASLR over 100 years of 1.0 m, results in an elevation of +4.0 m HD. This will be the total elevation below which inundation occurs once in 1000 years on an open unprotected sea coast.

Backwater effects and salinity intrusion can increase the upper elevation of the study area. To cater for these effects required an additional elevation. Initially the total chosen elevation was +6.0m MSL but this was later increased to +10m MSL for the following reasons :

- As the data collection progressed and information on catchment types, deltas and river flooding was assimilated, it was clear that river flood levels were elevated well beyond extreme sea levels within several kilometers of the coast;

- As the water level slope in rivers "flattens" due to sea level rise, the river bed will adjust to the new hydraulic regime and sediments will be deposited in the downstream reaches near the mouth. This on-going process can adjust the bed so much that, within a matter of decades, the sea level rise is manifested as an equivalent river water level rise many kilometers upstream of the mouth, far beyond the originally marked study area below the +6m MSL elevation;

- there is a lack of detailed information about topography on available maps. On some source-maps, only the 0 and +10m contours were shown and this only gave a poor definition of the topography and slopes below that elevation level.

It was therefore decided to adopt the upper study area elevation contour of +10m HD.

The "lower" elevation of the study area

The "lower" elevation of the study area was chosen as the coastline that could best be interpreted from topographical maps. The 1/1 year return period water level was selected as the "lower" elevation limit. Hereby, intertidal areas were excluded from the analysis. The 1 in 1 year water level along the Vietnamese coastline varies from +1.8m above MSL in the far north to +0.8m above MSL in the far south. Figure II.1-1 illustrates the extent of land included in the study area for this VA study.

Islands excluded

Some description of the offshore islands of Vietnam is given in the report but the islands were not included in the VA analysis of impacts and responses. This does not mean that they are not considered important or vulnerable but for practical reasons (shortage of data and information and the sheer number of separate islands - over 1,000 - total coastline length of more than 2000 km) they could not be included in the quantitative approach followed.

Subdivision of the study area

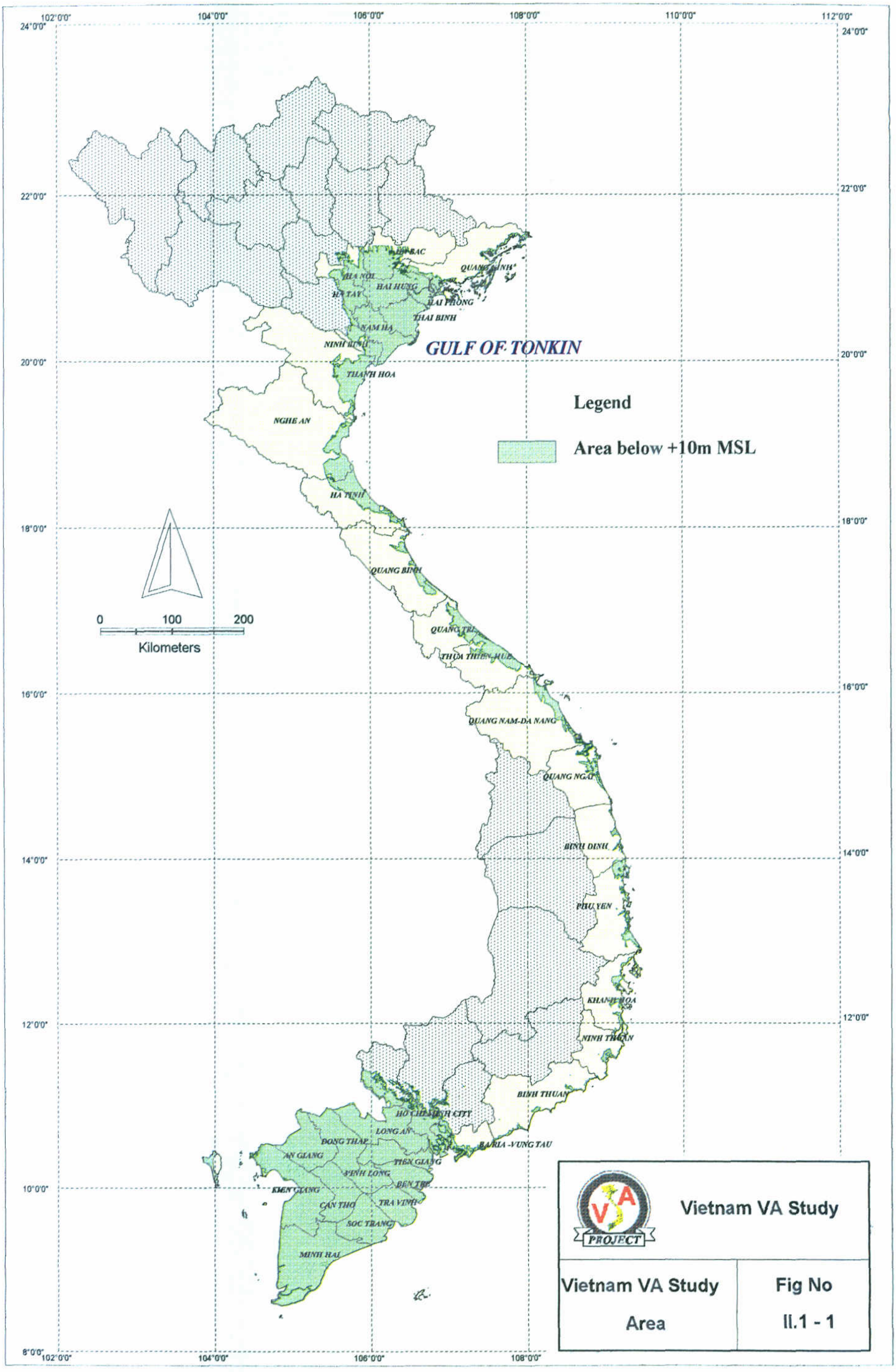
A subdivision of the study area has been necessary and convenient for the purposes of data collection and administration and for facilitating the analysis. All provinces which contain land in the study area are considered as *coastal zone provinces* in this report. The Provinces concerned are highlighted in Figure II.1-2, grouped into the regions of the Red River Delta, Central Coast North (includes Quang Ninh), Central Coast South and the Mekong Delta. Of the total of 54 Provinces of Vietnam, 35 are coastal zone provinces. Of these, 26 are *coastal provinces*, containing a sea coastline.

Climate change impacts considered

The only climate change effect that was considered in the study was the accelerated sea level rise. A sea level rise scenario of 100 cm over the next century was used to provide a worst case situation, according to recent predictive modelling (ref 2). Considering less than this, for example a lower rate of rise of 30 cm over the next century was not warranted given the accuracy of the topographical information (within 0.5m accuracy in many areas). Predictions about other effects of global warming such as increased storm intensity and changes in rainfall patterns were not quantified adequately in available reports to enable them to be included in the analysis.

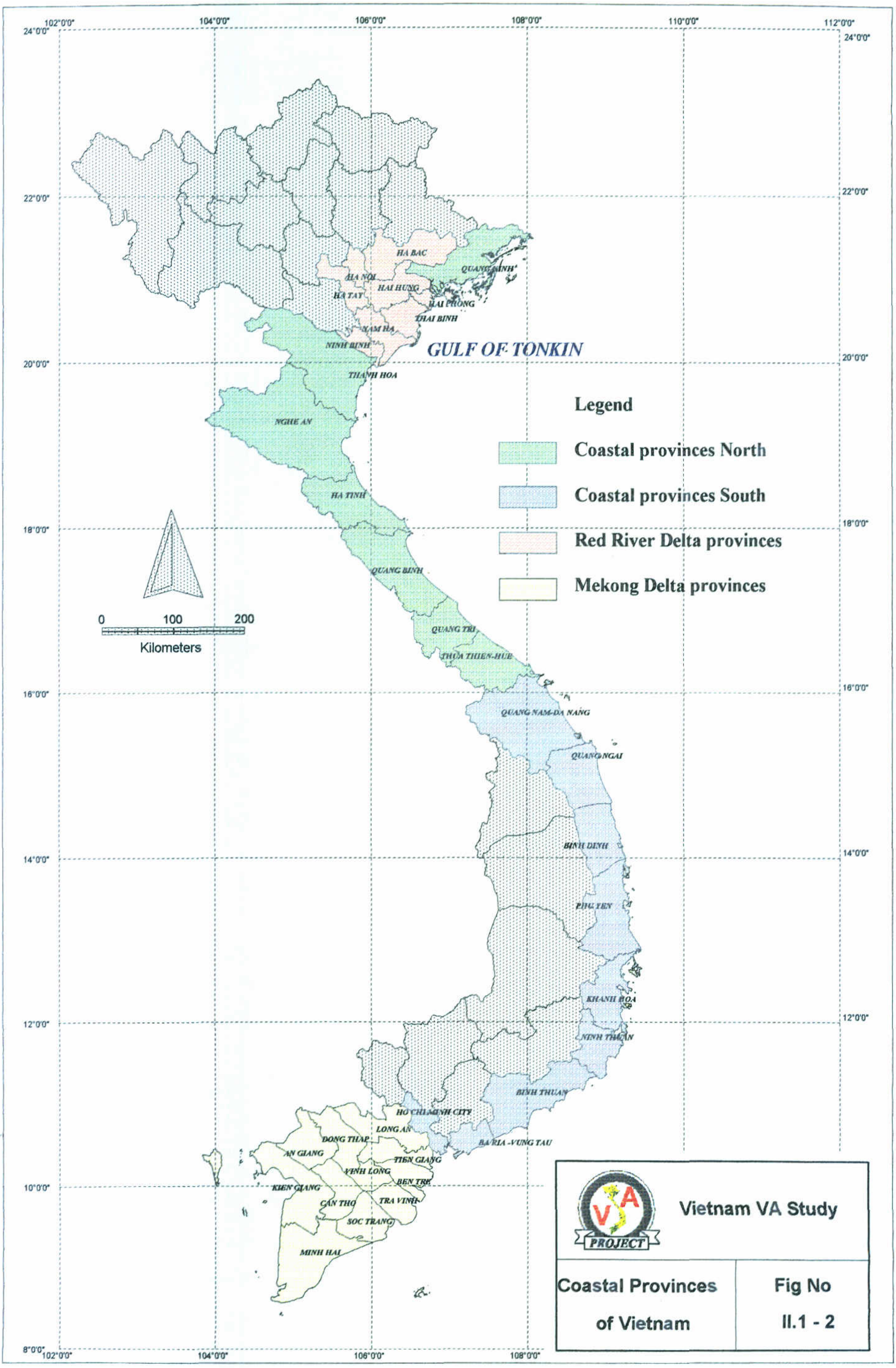
TABLE II.1-1 : BOUNDARY CONDITIONS :
SEA LEVEL RISE & CLIMATE CHANGE
As used in the Vietnam VA Study

Boundary condition	Units	ASLR0	ASLR1
Accelerated sea level rise over the next 100 years	m	0.0	1.0
Other effects related to climate change		None	None



Vietnam VA Study

Vietnam VA Study Area	Fig No II.1 - 1



Coastal Provinces of Vietnam

Fig No II.1 - 2

II.2 STEP 2 : INVENTORY OF STUDY AREA CHARACTERISTICS

II.2.1 Inventory of Study Area Characteristics : Physical Characteristics

For each of the coastal zone provinces of Vietnam a full set of physical characteristics has been deduced from the various data sources investigated in accordance with the requirements of Step 2 of the Common Methodology. In Table II.2-1 physical characteristics are summarised in terms of Coastal, River and Marine Characteristics. A summary breakdown per province is contained in the Appendix A of this report. In the case of flood prone areas, salinity intrusion, drainage and subsidence some additional descriptions have been added in this report. In *Report No.2* (ref 6) of the VA Study the physical characteristics are described in more detail, with references and with submitted Vietnamese source-data reports as appendices.

Coastal Characteristics

Selected important coastal characteristics are briefly discussed in the next chapter, and summarised in Figure II.2-1 and Table II.2-1.

Coastline length

A characteristic coastline length of 3822 km (excluding islands) has been deduced from the mainland coastline of Vietnam from Mong Cai in the north to Ha Tien in the south. (Note : In various references, this length varies from 2500 to 4500 depending upon the way it is measured). The method used in this report incorporates small bays but neglects any river or estuarine coast and small indentations in the coastline of less than 1 km).

Coastline morphology

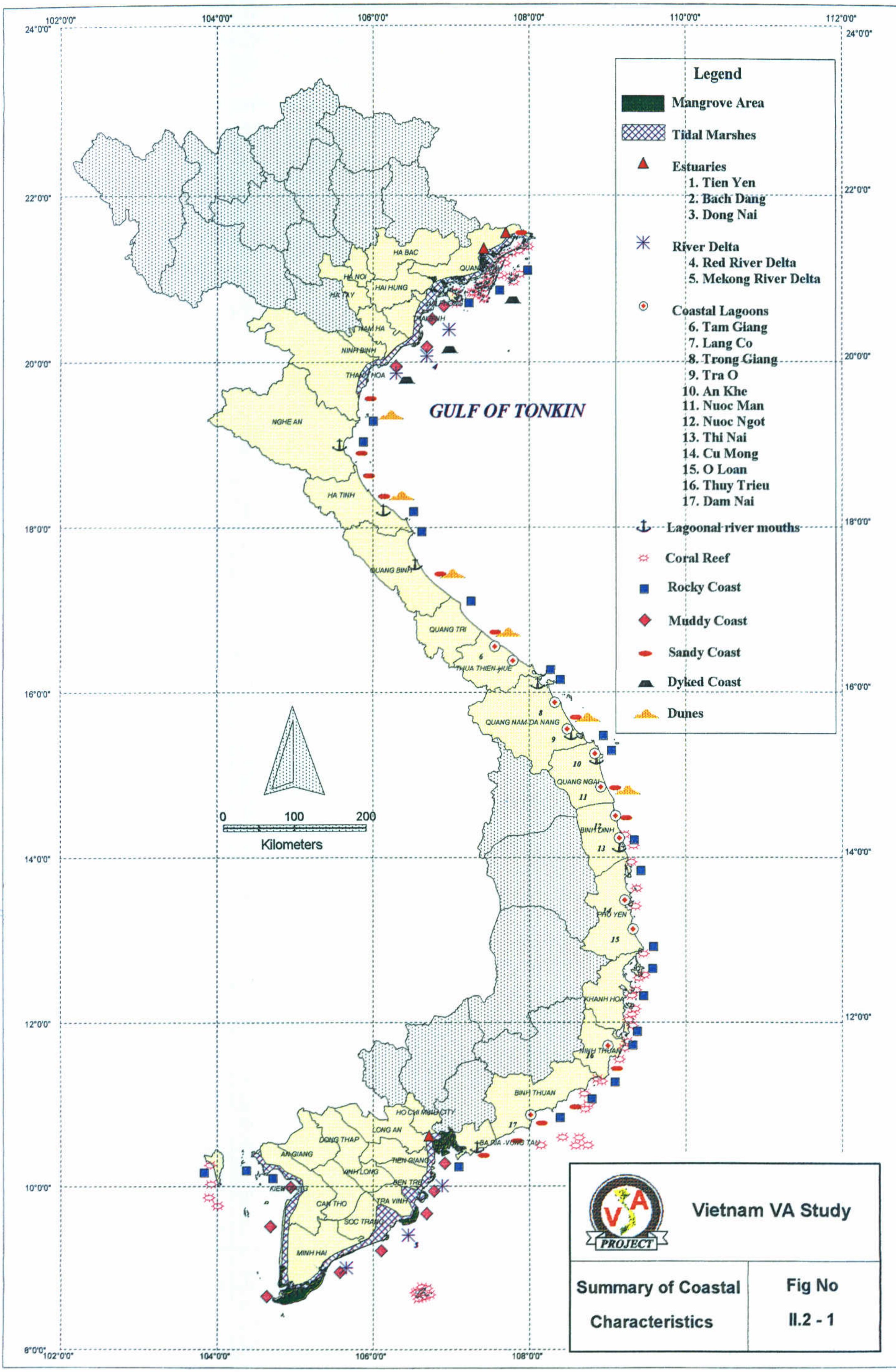
Almost 25% of the coastline of Vietnam is classified as hard and rocky coast. These areas are concentrated in the far north (Quang Binh) and southern central coast (Binh Dinh to Binh Thuan). About 21% of the coast is fronted by natural sand dunes, mainly in the north central coast (Quang Binh to Thua Thien Hue). Just over 50% of the coast consists of generally low coast with sandy or muddy beaches representing the delta coastlines of the Red River Delta in the north and the Mekong Delta in the south.

Coastal zone elevations

The elevation of the land in the coastal provinces is summarised in Figure II.1-1which shows the area of land below +10m HD and Table II.2-1 which provides the breakdown as areas below the elevations of +10m, +5m, +2.5m and 0m HD respectively in each coastal region. Striking to note is that the Mekong Delta provinces are all below the +10m HD elevation, with almost 80% of the Mekong Delta land below the elevation of +2.5m HD. In the case of the Red River Delta, only about 30% lies below the same elevation.

Coastal protection

About 30% of the coast of Vietnam is protected by artificial structures. These are mainly low



Vietnam VA Study

Summary of Coastal Characteristics

Fig No II.2 - 1

TABLE II.2-1 NATURAL SYSTEM DATA: PHYSICAL CHARACTERISTICS	UNITS	WHOLE NATION	COASTAL REGIONS: Red River Delta	N.Central Coast	S.Central Coast	Mekong Delta
COASTAL CHARACTERISTICS						
Total overall coastline length (incl. small bays)	km	3822	242	1076	1629	875
High rock cliff, no beach	km	580	0	148	414	18
High rock cliff with beach	km	139	15	48	76	0
Low rocky coast with beach	km	149	0	59	90	0
Low sand/mud coast and beach	km	1694	176	519	292	707
Low coast with sand/mudflats, river mouths etc.	km	316	51	68	47	150
Sand dunes with beach	km	944	0	234	710	0
Total coastline length (check..):	km	3822	242	1076	1629	875
Total area of province	km2	155181	17329	56981	46719	34152
% of province below +10m HD	km2	201	73	17	12	100
Area below +10m HD	km2	61819	12603	9414	5640	34162
Area below +5m HD	km2	50157	9775	5355	1386	33641
Area below +2.5m HD	km2	37471	6263	2595	585	28028
Area below 0m HD	km2	115.9	99	5	0.9	11
Sea dyke with no revetment	km	877.5	111	215	75.5	476
Sea dyke with stone or concrete revetment	km	283	84	145	52	2
Sea dyke plus seawall	km	11	0	9	2	0
Ports, quays etc.	km	24.5	4	6	14.5	0
Total protected coastline	km	1196	199	375	144	478
Total protected coastline	%	31	82	35	9	55
Sea dyke crest height (ave.) above MSL	m	50.6	16.7	19.1	1 to 3	14.8
Sea dyke crest width (ave)	m	52.2	13	14.7	1 to 4.5	24.5
Mangroves in front of shoreline type	km	712	35	124	33	520
Coast with groynes	km	8	3	0	4	1
Coastline length of islands within 100 km only	km	1937	303	1191	203	240
Natural (geological) subsidence	mm/yr	0 to 3	1 to 2	0 to 1	0 to 3	0
Man induced subsidence	mm/yr	little data	local max. 40	no data	no data	0
RIVER CHARACTERISTICS						
Name of major river entering the sea		Red River	Red River	Ma (Thanh Hoa)	ThuBon (Dnang)	Bassac
Name of major river entering the sea		Mekong River	Thai Binh	Ca (Ha Tin)	Dong Nai (HCM)	Mekong
Number of major rivers entering the sea	#	28	2	10	14	2
Total average annual discharge to sea (all rivers)	m3	757.8	123	69.1	79.7	486
Average discharge rate to sea (all rivers)	m3/s	28148	3900	2178	2460	19610
Peak discharge rate to sea	m3/s	241190	35000	43366	90524	72300
Total annual sediment load discharged to sea (all rivers)	mill.t	405.4	215	11.8	8.6	170
Measuring station			Hanoi	HoangTan (TH)	Hoi An (Dnang)	Can Tho
Distance from coast (along the river)	km		180	7	10	88
1 per 10 years maximum water level	m		12.5	2.7	2.2	1.9
1 per 50 years maximum water level	m		13.8	3.1	2.8	1.95
1 per 100 years maximum water level	m		14.2	3.4	3.0	2
Number of major lagoons	#	12	0	2	10	0
Total length of river and estuary dykes	km	9306	3568	2611	583	2544
Salinity (0=no problem to 5 = severe)	index	ave 4	ave.3	ave.4	ave.3	ave.4
Drainage (0=no problem to 5 = severe)	index	ave 4	ave.5	ave.2	ave.2	ave.4
Sluice gates in operation in dyke systems	#	829	208	207	396	18
Annual flooding (0=no problem to 5 = severe)	index	ave 4	ave.4	ave.3	ave.2	ave.5
MARINE HYDRAULICS & METEOROLOGY						
High high water of spring tide (HHWS) (north to south)	m	0.4 to 1.8	1.7 to 1.6	1.8 to 0.4	0.5 to 1.4	0.8 to 1.4
Low low water of spring tide (LLWS) (north to south)	m	-0.4 to -2.2	-1.7 to -1.5	-1.9 to -0.4	-0.6 to -2.2	-0.3 to -2.1
Tidal range (HHWS-LLWS) (north to south)	m	1.0 to 3.8	3.4 to 3.1	3.7 to 0.8	1.1 to 3.8	3.5 to 1.1
approx. extreme storm surge range at the coast	m	0.5 to 1.5	1.0 to 1.5	1.0 to 1.5	0.5 to 1.5	0.5 to 0.8
1 per 10 years maximum water level at the coast	m	1.1 to 2.3	2.1 to 2.2	2.3 to 1.3	1.6 to 1.1	1.6 to 1.1
1 per 50 years maximum water level at the coast	m	1.15 to 2.5	2.2 to 2.5	2.5 to 1.5	1.6 to 1.2	1.6 to 1.1
1 per 100 years maximum water level at the coast	m	1.2 to 2.6	2.6 to 2.3	2.6 to 1.6	1.7 to 1.3	1.7 to 1.2
1 per 10 yrs max. significant deepwater wave hgt.	m	6.5 to 12	8 to 10	6.5 to 12	9 to 13	8 to 9
Ave. number of typhoons crossing coast per year	#	5 to 6	2	2 to 3	1 to 2	<<1/year
Average annual rainfall	mm/yr	1000 to 3000	2000	2000-3000	1000-2400	1400-2000
Wettest month		Sept.-October	Sept.	Oct.	Oct.	Oct.
Average rainfall in wettest month	mm/m	300 to 1000	500-700	600-1000	300-900	300-600
Driest month		January-March	January	March	Jan - Mar	January
Average rainfall in driest month	mm/m	100 to 250	150-200	150-250	100 - 250	100-200
Winter months (January)	deg.C	17 to 26	17	18	22-26	25 to 26
Summer months (July)	deg.C	26 to 30	28	30	28-30	26 to 28

dykes, 75% of which contain no armour protection. Sea dykes are along the sea coastline while estuary dykes protect lagoon and estuarine shores up to about 12 km from the river mouth. Sea and estuary dykes extend along about 2,700km of sea and estuary shorelines, generally designed to withstand storm surges, high tides and some wave action. In the north, where sea and estuary dykes have been built for centuries, they are generally stronger and better established than those of the central and southern coast which were built after 1975.

Islands

Within 100 km of the coast of Vietnam are over 1000 islands with a total coastline length of over 2000 km (more than 50% of the coastline length of the national mainland). The vast majority of the islands are offshore of the coastal provinces of Quang Ninh and Haiphong in the far north of Vietnam.

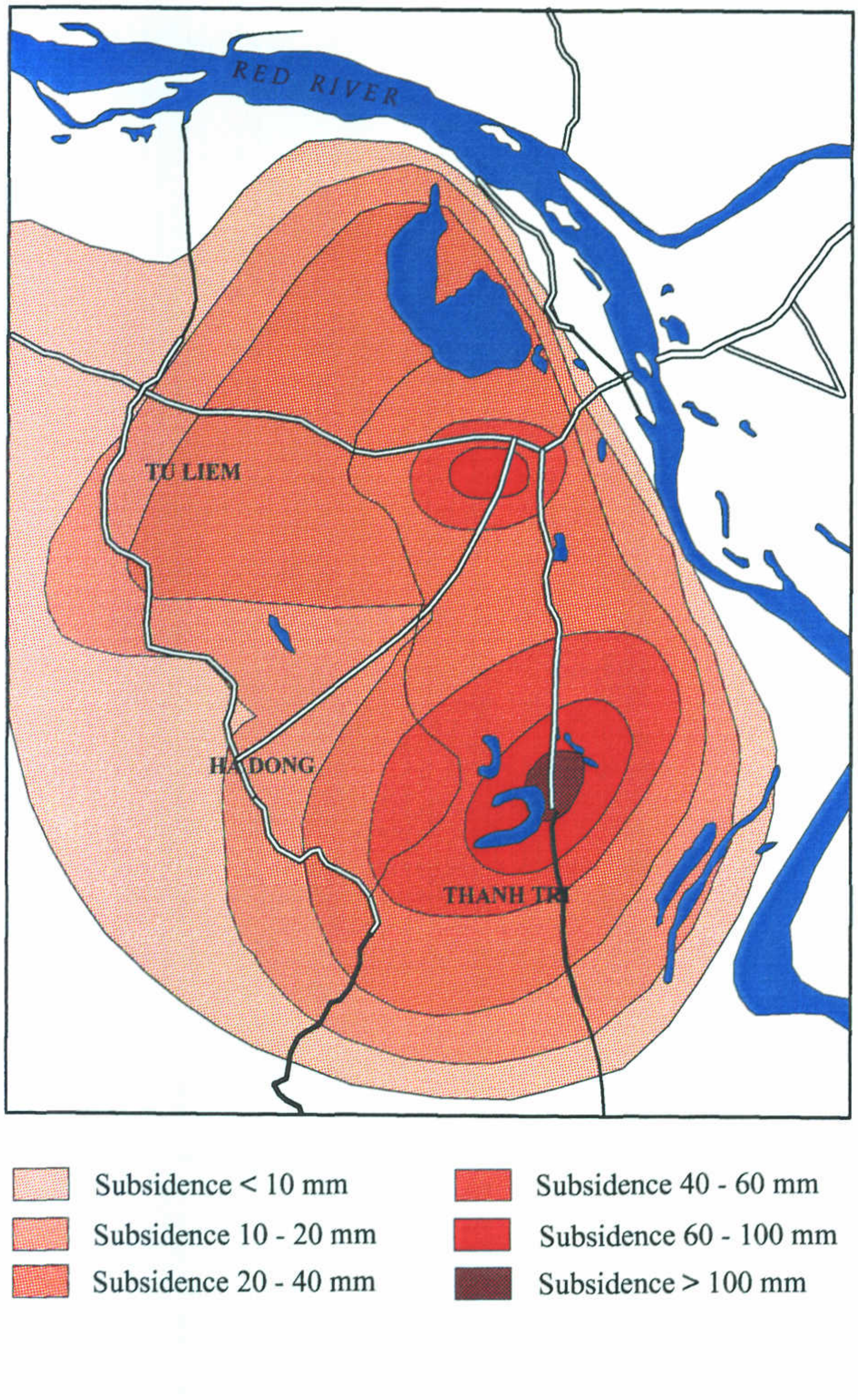
Geological subsidence

Generally, the geological subsidence in Vietnam is limited to less than 3mm/year in the deltas and less than 1 mm/year along the central coast.

Groundwater extraction and man-induced subsidence

At present, the water demands of the households, agriculture and industry in Vietnam's coastal zone are met by surface water exploitation, with the exception of the larger coastal cities, as described Box II-1. Of concern is the potential subsidence for cities such as Hanoi and Ho Chi Min City and others due to groundwater extraction which is relatively new to Vietnam and for which reliable measurements and controls are scarce. However, as population and industrial demands for water increase, if the exploitation rate remains unchecked, a subsidence of several centimeters per year is possible in these areas. Such subsidence rates are already apparent near Hanoi as shown in Figure II.2-2. Man induced subsidence has not been included in the analysis due to a lack of sufficient data at other sites. The data from Hanoi indicate that man induced subsidence, especially in the delta areas may be a very significant fact in future and, if not controlled, it may lead to a severe safety problem in some coastal cities. Subsidence needs special attention and monitoring.

Subsidence of Hanoi region
Period 1988 - 1992



Vietnam VA Study

Hanoi subsidence 1988 to 1992	Fig No II.2 - 2

BOX II -1: NATURAL SYSTEM DATA - PHYSICAL CHARACTERISTICS
Groundwater extraction and man-induced subsidence in Vietnam (ref 6)

(1) Red River Delta

In the vicinity of Hanoi, the groundwater is a valuable clean water source which is now exploited for drinking and domestic water supply. At present the total capacity of all treatment plants on the southern side of the Red River in Hanoi is about 400,000 m^3/day. The maximum subsidence of 176 mm since about 1988-1992 (about 4 cm/year) is found in the south of Hanoi near Phap Van, while on the average a subsidence rate of about 1 cm/year can be estimated for the greater Hanoi region. By 2010 the amount of groundwater exploited may increase to double the present amount, while in 2020 a groundwater exploitation of about 1 million m^3/day is anticipated. Subsidence computations predict a total maximum subsidence of 750 mm near Phap Van under an exploitation rate of 1 million m^3/day. The other cities and towns in the Red River Delta do not have as favourable conditions as Hanoi for freshwater extraction. The groundwater there is usually saline or not abundant, for example, near Haiphong, Hai Duong, Tha Binh, Nam Dinh, Nam Ha, and Ninh Binh. At present, all these cities use surface water (from rivers, lakes) to meet the demands. Only in Haiphong some groundwater is exploited on a small scale for production and living conditions. As a result, the increased subsidence of these urban areas due to groundwater exploitation remains negligible. In Hanoi the situation remains serious.

(2) Central Coastal Areas

The cities of Vinh, Hue, Da Nang and Nha Trang all use surface water for meeting their water demands. Only in Danang some groundwater is exploited on a small scale for production and living conditions, while in Nha Trang, wells are being used for pumping groundwater coming from rivers. Therefore, increased subsidence of these urban areas is negligible.

(3) Ho Chi Minh City and Mekong Delta

Ho Chi Minh City and Vung Tau mainly use surface water for production and living conditions. Some wells are also being used for a small groundwater exploitation of about 30,000 to 50,000 m^3/day, which is about 10 % of the city's demand. However, a groundwater exploitation of 1 million m^3/day is anticipated for the year 2000. The exploitation works will mainly concentrate in the North and Northwest (Hoc Mon, Cu Chi). Under these conditions, some vulnerable areas in the North of the city (Le Minh Xuan, Binh Chanh areas) may suffer from a maximum subsidence of 300 to 600 mm in due time. Groundwater reserves in the Mekong Delta are very large. However, its potential use is limited by three factors: salinity, permeability of the aquifers and salinity intrusion during aquifer recharge. The safe yield of the basin has been assessed at roughly 1 million m^3/day, which corresponds with an abstraction rate of about 1 % of the total groundwater reserve over a period of 30 years. At this rate, negative effects of salinity intrusion and infiltration of saline groundwater to production areas are expected to be limited. At present, the water demands in the Mekong Delta are mainly met by the use of surface water with some groundwater exploitation on a small scale as near the city of Can Tho. The subsidence is as yet unremarkable and negligible but needs careful attention due to its sensitivity to sea level changes.

River Characteristics

The following sections summarise some of the key characteristics of the rivers of Vietnam, together with Figure II.2-3.

River systems

There are 9 major river systems entering the sea from the coast of Vietnam. In each of the two main deltas are 2 large rivers with gradually sloping, broad catchments. A further 5 are shorter, steeper rivers draining the upland mountain ranges behind the northern and souther central coast. The largest river in Vietnam, by far, is the Mekong River which has over 6 times the average discharge of its closest contender, the Bassac River, also on the Mekong Delta. Both deltas experience strong sediment discharges via their main rivers which also deliver huge amounts of sediment to the delta per year.

River water levels

These are reported in detail in Report No.2 (ref 6). The water levels in the various rivers at distances from the coast are summarised in Table II.2-1 based on available water level recordings reported and analysed in ref 6. Of note is the very flat slope of the water surface in the Dong Nai, Bassac and Mekong rivers compared to the rivers in the central and north coasts. Also important is the fact that, in many rivers on the central coast, the water levels just inside the river, several kilometers upstream of the mouth, exhibit a sharp rise in extreme floods despite their proximity to the sea. For example in the Ca river, at 2 km from the mouth, the 100 year water level is estimated at 1.5m above the water level at sea during the event, mainly caused by the restriction of the river flood near the mouth as it propagates to sea. (This has lead to misunderstanding of extreme *water* levels as being extreme *sea* levels or *surge* levels and therefore an overestimation of extreme sea level and storm surge levels in the past.)

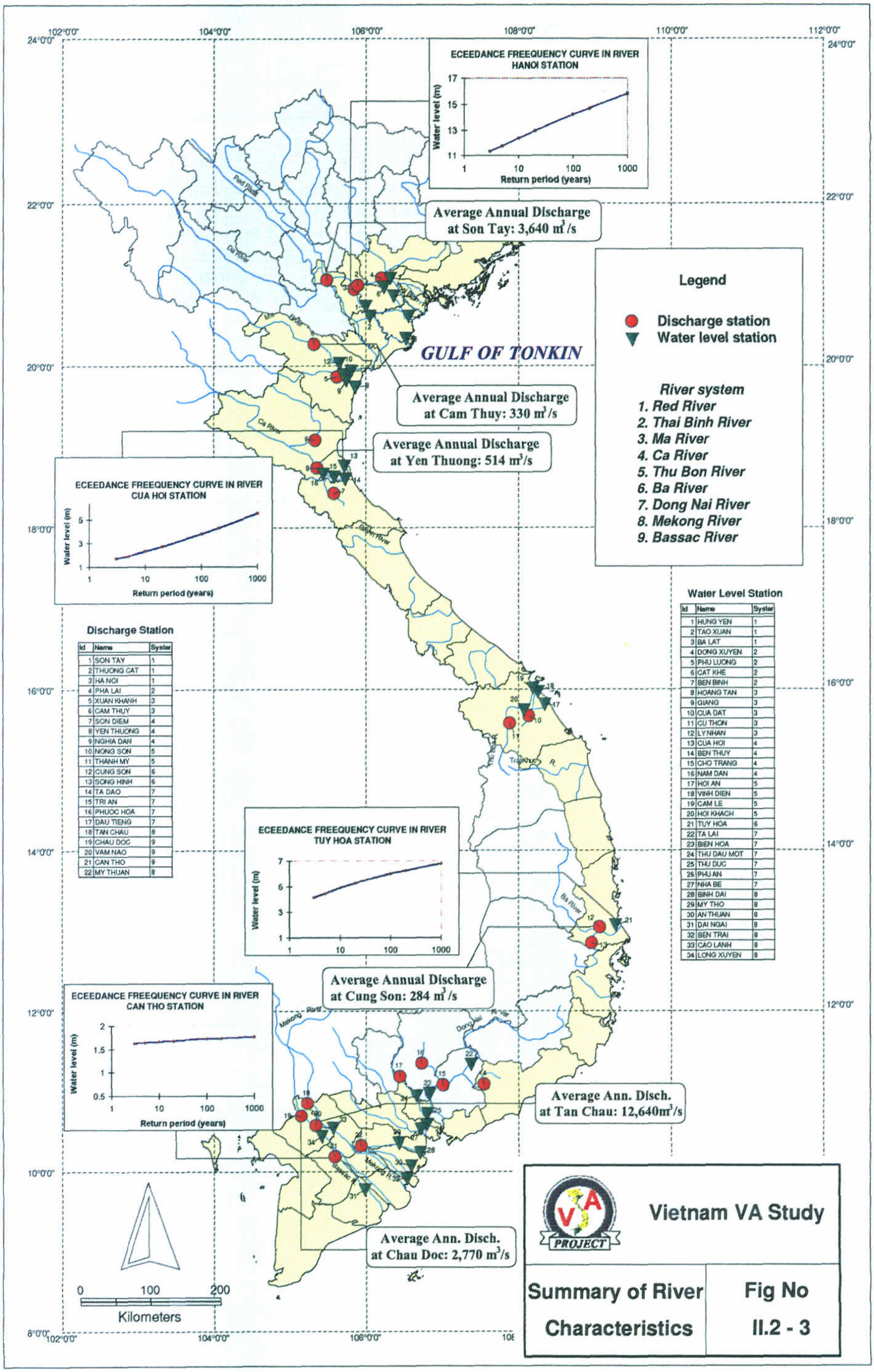
Lagoons and estuaries

The 12 coastal lagoons of Vietnam are concentrated in the central coast regions. The largest is the 68 km long Tam Giang to Cau Hai system of lagoons, in the Province of Thua Thien Hue.

Flooding and flood prone areas

Flooding is one of the most negative influences in Vietnam's development at present. Unfortunately, flooding is most serious in areas which are among the most economically active such as the Red River Delta and the Mekong Delta. The most flood prone area in Vietnam is the Mekong Delta where annual floods cause havoc to all provinces but particularly to the inland delta provinces such as Dong Thap, An Giang and Long An. Other hot-spots for flooding include the Red River Delta provinces of Ha Tay and Hai Hung as well as the central coast provinces of Thanh Hoa, Quang Binh, Thua Thien Hue and Quang Binh.

The flood prone nature of the Mekong Delta is apparent when considering that almost the



Discharge Station

Id	Name	System
1	SON TAY	1
2	THUONG CAT	1
3	HA NOI	1
4	PHA LAI	2
5	XUAN KHANH	3
6	CAM THUY	3
7	SON DIEM	4
8	YEN THUONG	4
9	NGHIA DAN	4
10	NONG SON	5
11	THANH MY	5
12	CUNG SON	6
13	SONG HINH	6
14	TA DAO	7
15	TRI AN	7
16	PHUOC HOA	7
17	DAU TIENG	7
18	TAN CHAU	8
19	CHAU DOC	9
20	VAM NAO	9
21	CAN THO	9
22	MY THUAN	8

Water Level Station

Id	Name	System
1	HUNG YEN	1
2	TAO XUAN	1
3	BA LAT	1
4	DONG XUYEN	2
5	PHU LUONG	2
6	CAT KHE	2
7	BEN BINH	2
8	HOANG TAN	3
9	GIANG	3
10	CUA DAT	3
11	CU THON	3
12	LY NHAN	3
13	CUA HOI	4
14	BEN THUY	4
15	CHO TRANG	4
16	NAM DAN	4
17	HOI AN	5
18	VINH DIEN	5
19	CAM LE	5
20	HOI KHACH	5
21	TUY HOA	6
22	TA LAI	7
23	BIEN HOA	7
24	THU DAU MOT	7
25	THU DUC	7
26	PHU AN	7
27	NHA BE	7
28	BINH DAI	8
29	MY THO	8
30	AN THUAN	8
31	DAI NGAI	8
32	BEN TRAI	8
33	CAO LANH	8
34	LONG XUYEN	8

Vietnam VA Study

Summary of River Characteristics

Fig No II.2 - 3

entire delta lies below an elevation of +2.5m (as far inland as the Cambodian border) which is 1m below the once per 5 year flood level at the border with Cambodia of +3.5m HD. Weak low dykes in this delta are often unable to withstand floodwaters. A strategy adopted in these provinces is a first line of defence that holds against "lower" early season floods for protection of summer-autumn crops but which fails against the main annual floods in October-November. These weak defences are repaired and rebuilt each year by local people largely with their own resources and total almost 2,750 km in length.

Recent extreme floods occurred in the Red River in 1971 (a 100 year return period) and in the Mekong Delta in 1978 (approx. 1 in 75 years). Extreme floods were again encountered in the Mekong in 1994 and 1995 and in the Thua Thien Hue - Quang Ngai - Binh Dinh Provinces region of the central coast in 1995. In the months of October to November 1995 (during the study period of this project) over 100 people were drowned in these central provinces as a result of severe flooding caused by 3 consecutive typhoons (see the Newspaper article in Box II-2).

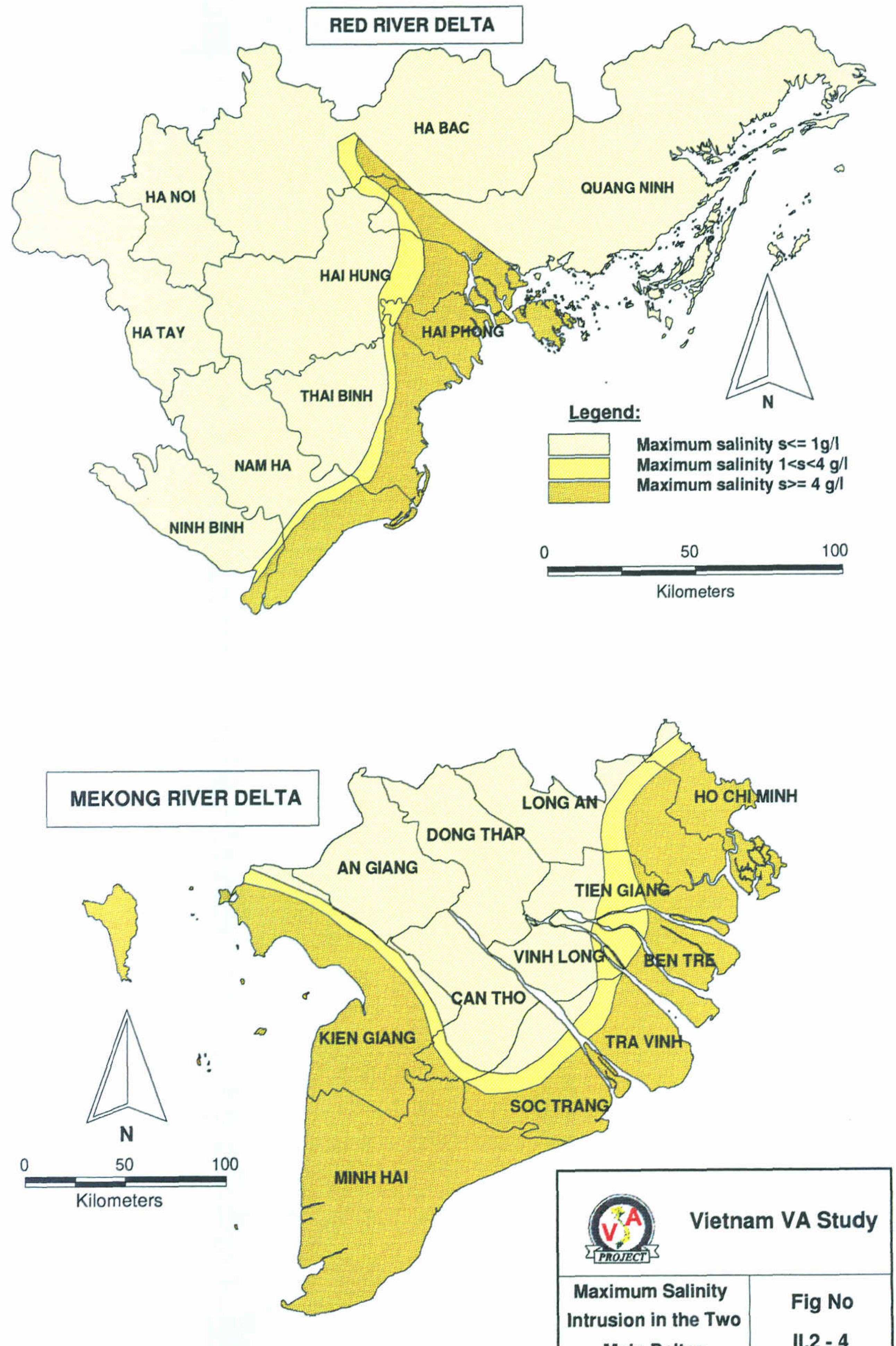
Salinity intrusion problems

In general, the inland extent of saline intrusion (1 g/l) in the river systems varies from 15 km (Ma and Ca Rivers), 35 to 50 km (Red River, Thai Binh, Thu Bon Rivers) and up to about 100 km in the far south (Bassac, Mekong, Dong Nai-Saigon Rivers). The maximum extent of saline water intrusion in the deltas is presented in Figure II.2-4 giving the isohalines of 1 and 4 g/l which are characteristic concentrations with respect to agriculture (crop damage occurs above 1 g/l and beyond 4 g/l rice crops are not sustainable). In the report of the Red River Development Master Plan (ref 11), it is noted that further study is needed to understand the effect of salinity intrusion on the development of the irrigation and drainage systems and the relative productivity of the irrigated area.

In the Mekong Delta Masterplan Report (ref 12), it is reported that a large area of the Mekong Delta experiences sea water intrusion through creeks and canals, because of its flatness and its low elevation. The salt water intrusion reaches its peak in April-May, affecting about 1.6 - 2 million ha or about 50 % of the Delta, and is lowest in October. During the rainy season fresh water from the Mekong and Bassac, as well as local rainfall, push the saline water back towards the sea, allowing for cropping for a period of about six months. The duration of salinity intrusion is presented in Figure II.2-5.

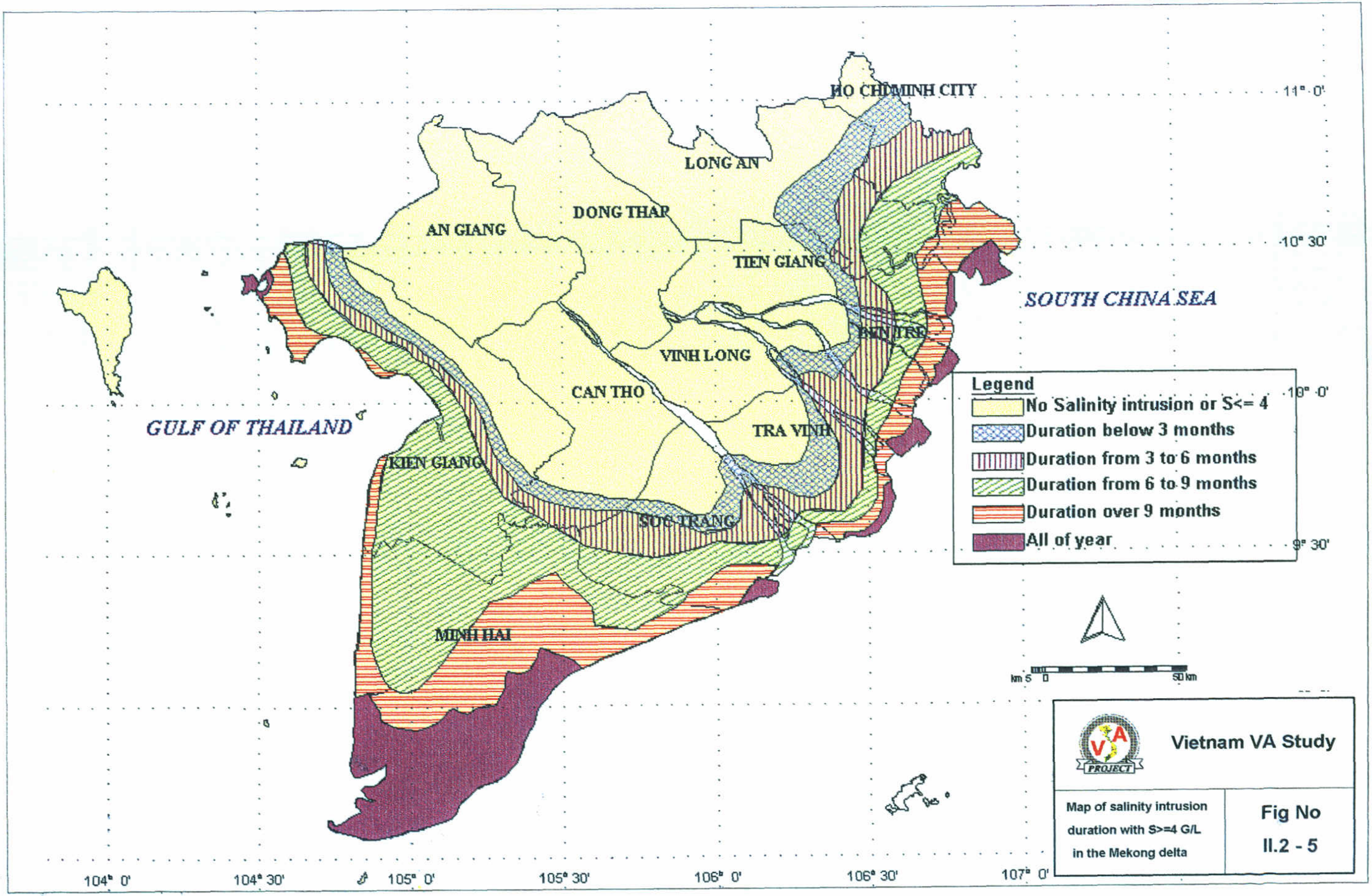
In the central coast, salinity intrusion is problematic at Hue where the lagoon is seasonally highly saline (dry season) and as a consequence high salinity levels enter irrigation channels and rivers with associated reduced crop yields (ref. 9).

The results of the qualitative analysis have been presented in Table II.2-1 by using a severity scale from 0 (no problem) to 5 (serious problem). The analysis shows that the salinity problems in the Red River Delta, Mekong Delta and the Dong Nai Basin are the most severe while the problems in Quang Ninh province and the southern Central Coastal areas are the least severe.



Vietnam VA Study

Maximum Salinity Intrusion in the Two Main Deltas	Fig No II.2 - 4



Vietnam VA Study

Map of salinity intrusion duration with S>=4 G/L in the Mekong delta

Fig No II.2 - 5

BOX II-2 : NATURAL SYSTEM DATA - PHYSICAL CHARACTERISTICS
Flood events in 1995-1996 - Newspaper report
ref."Vietnam News" October 12, 1995

Floods paralyse life in central province

HANOI — At least 22 people have died and 12 are missing due to flash floods in central Quang Binh province.

Some 50 communes of the province have been seriously damaged by the floods which have knocked down 10,050 houses, 29 school buildings and nine medical centres.

The floods have paralysed transport on Highway 14 in Quang Tri and National Highway 1 for almost two days, destroyed some sections of the Hanoi to HCM City railway, and caused a traffic jam of over 500 vehicles at the Gianh river, as well as serious damage to thousands of hectares of rice crops.

Torrential rains caused flooding and damage to buildings and farms in the central provinces of Quang Tri, Quang Binh, Thua Thien-Hue and Quang Nam-Danang.

In the ancient Vietnamese capital of Hue on the Huong River, many streets were one to two metres underwater.

Officials in southern Dong Thap and Kien Giang provinces estimate property damage there at VND112 billion, with more than 40,000 people without food in Dong Thap alone, the daily *Nhan Dan* reports.

Meteorologists expected rain to continue in Quang Tri for the next few days.

Landslides have also occurred at kilometre 126 on highway 37 in Yen Bai, a mountainous province north of Hanoi, and destroyed many houses. Earlier landslides had damaged houses and caused deaths in Yen Bai. — **VNS**

Drainage problems

Similar to salinity, drainage is very problematic in the delta coastal provinces where waterlogging of the areas behind dykes can result in flood damage. The challenge to allow drainage but prevent seawater (salinity) intrusion is a serious issue on the Red River Delta coast (Thai Binh/Nam Ha). Also in the central coast provinces, the very high rainfall intensity, steep catchments and high storm surge levels at sea (in typhoons once or twice a year) cause devastating drainage problems in low-lying areas such as around Hue City and lagoons.

Drainage facilities are generally of either *gravity* drainage (through drainage channels and via sluices to the main rivers) or *pumping* (pumping water from fields into the main rivers). Problems arise in both cases when river levels are high at times of high tides, and when there are typhoon induced storm surges.

Water logging is defined to occur when there is a surplus of water, over and above the depth of water above the depth required for the rice crop at different stages of its development. If this excess water is not drained, there is a reduction in crop production or, in the extreme case, a complete failure of the harvest.

Flooding is defined as the inundation of land by the ingress of water directly from a river, either by overtopping of the river banks (or dykes) or by failure of the dykes.

A review of the drainage facilities and problems in the Red River Delta is given in Box II-3, which illustrates the drainage problems facing other low lying parts of the Vietnamese coastal zone.

Similar to salinity, drainage problems have been qualitatively assessed in Table II.2-1, with an index of 0 (no problem) to 5 (serious problem).

River protection structures

River dykes extend inland from the estuary dykes. River dykes are also well established in the north, in the Red River Delta and the adjacent provinces compared to the lower and weaker defences of the southern provinces and the Mekong Delta.

The total length of river dykes is 4,615 km and the province with the longest length of river dykes is Thanh Hoa Province in the northern central coast, with 909 km of river dykes (dykes on both sides of the river : 1km of river = 2km of river dyke).

In the Mekong Delta the river defence systems are weak such as polder embankments, roads and small polder dykes. These are built by local people using local resources and they offer protection only for the summer-autumn crops (early floods), being inundated annually in the later floods (October-November) in the inland delta provinces.

BOX II-3 : Drainage problems in the Red River Delta (ref 11) (... as an example of problems facing low lying areas of Vietnam)

The drainage facilities in the Red River Delta now include more than 300 sluices and 6000 pumping units. The installed capacity for drainage alone is 270 MW. The total area drained is about 1,000,000 ha made up of 540,000 ha drained by gravity, and 460,000 ha drained by pumping. The provision of the drainage facilities has been an important factor in contributing to the increase in rice yields that have taken place over recent years and to reduction in transport difficulties in areas which used to be water logged for up to 6 months. However, the present drainage situation is still not sufficient due to:

- the lack of drainage facilities,
- the inadequate capacity of pumping stations,
- the age of the pumping stations and other structures. Most of these have been in operation from 20 to 30 years. Inadequate maintenance has resulted in a reduction in pumping capacity by about 20 %.
- the reduction in the capacity of drainage canals by siltation and by deposition of rubbish by the local people,
- damage to ancillary drainage structures,
- inadequate power supply,
- inappropriate cropping systems, and
- reduction in the surface area of natural ponds and lakes caused by reclamation (often illegal) for housing or other developments.

The agricultural land in the Red River Delta is protected by a system of dykes and polders, and structures on water courses. At present there are no accurate data on the extent and frequency of the occurrence of water logging. Based on the land elevations and data kept in the provinces, it is estimated that about 244,000 ha suffers from some degree of water logging annually.

Areas susceptible to waterlogging are as follows :

PROVINCE	AREA (ha)
Ha Noi	8,000
Ha Tay	25,000
Hai Hung	55,000
Hai Phong	3,000
Nam Ha	60,000
Ninh Binh	25,000
Thai Binh	30,000
Ha Bac	28,000
Vinh Phu	10,000

Many irrigation companies have not been able to adequately maintain canals, drains and pumping stations. This has resulted in unreliable and inadequate water supplies (or drainage) at times of greatest needs. Some low-lying areas could be more profitably used for an irrigated spring paddy crop, followed by 6 to 7 months of fish production. With some small holding ponds, year-long fish production appears feasible.

Marine and meteorological characteristics

The following sections, and Figure II.2-6, summarise the marine and meteorological characteristics.

Tidal levels

Tide ranges (astronomical tides neglecting meteorological effects) generally are largest in the north with highest tide levels of about 1.8m HD. The range reduces toward the central coast the highest tide level off Thua Thien Hue Province barely reaches 0.4m HD. Tide range increases again towards Vung Tau in the south with a highest tide level of 1.6m (approx.HAT) and decreases westward along the Mekong delta coast to +0.8 m HD.

Storm surges

In the north, the extreme storm surge reaches 1.0 to 1.5m in typhoons and on the central coast 1.0 m in extreme cases. In the south, particularly along the Mekong Delta, typhoons are very rare and extreme storm surges are related to monsoon winds and barely exceed 0.5m at the coast.

Design water levels

Design water levels at the coast are a combination of extreme storm surges and high tides. As such the 100 year storm water level varies from 2.5m HD in the far north to less than 1.3m HD in the southern central coast and rising again to 1.7m HD in the far south at Vung Tau, reducing again across the Mekong Delta coast. In Figure II.2-6 are plotted some typical sea level excedence curves for the various locations.

Wave climate

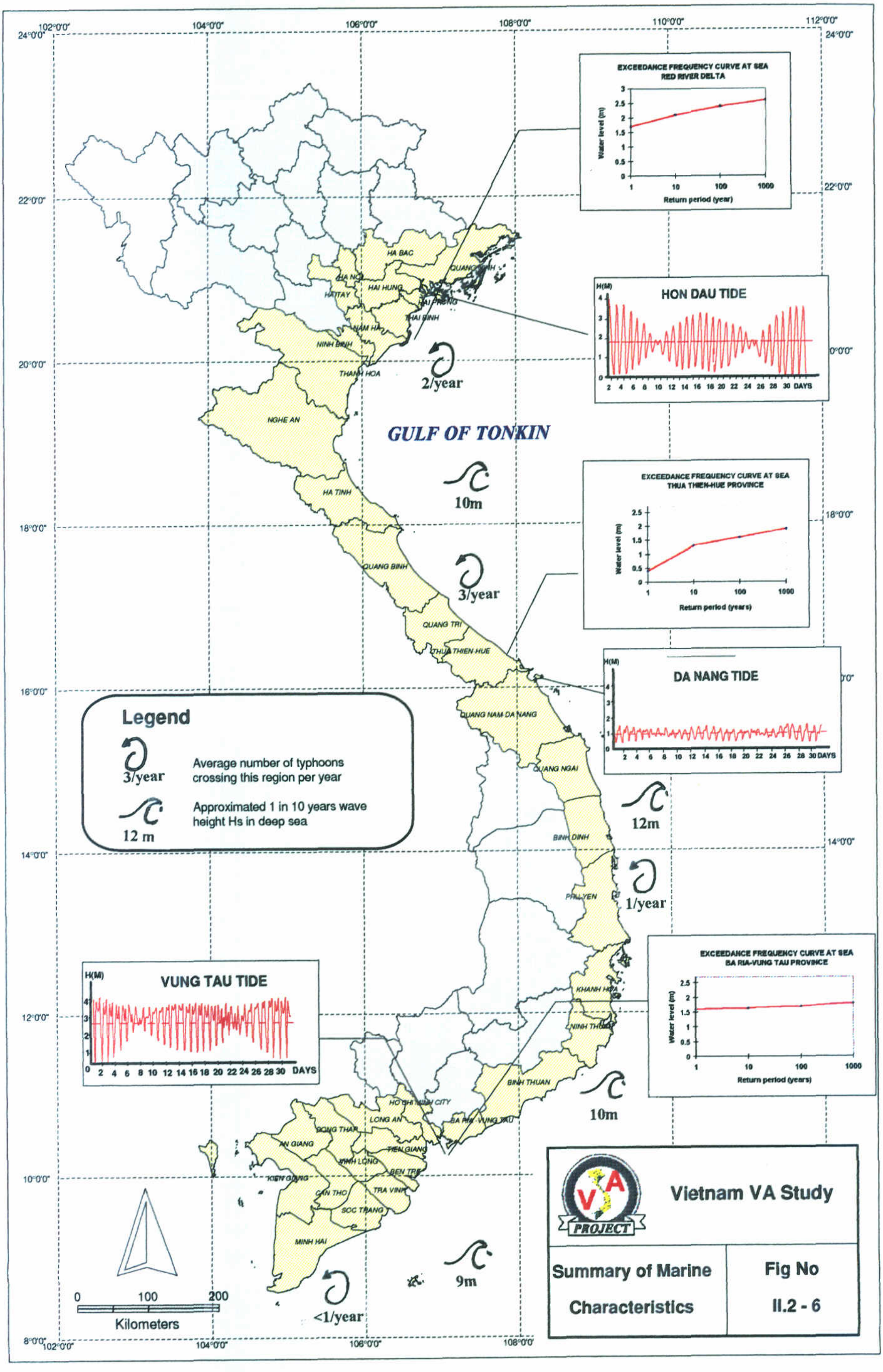
Deepwater significant wave heights are greatest off the central coast where the 1 in 10 years wave (Hs) is approximately 10 to 12m. In the far north and far south the design wave heights reduce considerably due to shelter of Hainan Island in the north and the changed climatic conditions (no typhoons) in the south.

Rainfall

Rainfall is highest in the central coastal areas near Thua Thien Hue with over 3000 mm/year, mostly falling in the short season from October to January. In the Red River and Mekong Deltas the figure reduces to around 2000 mm/year. The driest coasts are those of the southern central coast with less than 1000 mm/year.

Temperature

Temperature is consistently highest in the south with high humidity, frequently above 30 degrees C over most of the year. In the north, the temperature is more seasonal with winter temperatures of 10 to 15 degrees C not uncommon but with high summer temperatures above 30 degrees C.



Summary of Marine Characteristics

Fig No II.2 - 6

Monsoons

The whole climate of Vietnam is subject to the SE Asia monsoon seasons whereby the SW monsoon dominates with S-SW winds in summer months. The NE monsoon winds bring cold continental air streams from the Chinese mainland which brings down temperatures in the north in winter months.

Typhoons

An average of 6 typhoons cross the coast of Vietnam per year, mostly from a SE'ly direction heading NW. These typhoons travel long distances across the South China Sea and arrive at the Vietnamese coast laden with high rainfall and extreme wind speeds with associated high waves and storm surges. These are very damaging for the weak dykes in the north and the exposed coastal sand dunes and lagoon systems in the central coast. The northern provinces encounter the majority of typhoon events (4 per year pass north of Thua Thien Hue Province) while the Mekong delta area is relatively free from typhoon attack.

II.2.2 Inventory of Study Area Characteristics : Habitats and Species

Much of the following information has been derived from the GEF commissioned 1994 report: "Biodiversity Action Plan for Vietnam" (ref. 13) and the world Bank document of 1995: "Environmental Program and Policy Priorities for a Socialist Economy in Transition" (ref 14). Details are summarised as follows and in Figures II.2-1, II.2-7 to II.2-9 :

Ecosystem types

Coral reefs

Coral reefs (Figure II.2-1) are concentrated on the rocky coasts and islands of the far north (Quang Ninh and Haiphong Provinces) and the southern central coast and some offshore islands. Reefs in the north are generally smaller, narrower and shallower (<10 m deep) but in the south they are more extensive and higher in diversity of type and species (eg platform reefs Nha Trang to Cam Ranh and barrier reefs Phu Yen to Khanh Hoa). On the delta coasts (Red River and Mekong) and on the north central coast the coral is limited to reefs on the few offshore islands. In general the coral reefs are under serious threat due to human activities such as dynamite fishing, coral mining for the cement industry and pollution. Environmental threats are summarised in Figure II.2-7. Coral areas such as Cat Ba Island are part of the natural protected area system described in Figure II.2-8.

Estuaries

Estuaries of the major rivers, outside the delta areas (eg Ca River, Ma River etc.), experience varying salinity regimes depending on the season. The average annual salinity varies from 5 - 10 ppt near the coast and the suspension concentration in the rainy season ranges from 20 - 100 g/m^3. Mangroves dominated by Rhizophoracae develop well, while algae, seagrass, invertebrates, plankton and shrimp larvae in particular are also abundant.

Deltas

The Red River Delta and the Mekong Delta have dynamic coastlines with mud and fine silts which accrete (eg Thai Binh coast) or erode (eg Nam Ha coast) with a speed of tens of metres per year. Close to the coast the salinity of the river branches and groundwaters remains high, particularly in the dry seasons. The brackish water environment and the brownish red mud with high contents of iron and manganese and intensive oxidation favour the development of mangrove such as Rhizophora, Kandelia and Cyprus. The shrimp Metapenaeus ensis is an important resource for both the Red and Mekong River deltas.

Coastal Lagoons

Typical coastal lagoons occupy 5% of Vietnam's coastline and occur only in the central region from Quang Tri to Ninh Thuan province. These lagoons (280 - 21,600 ha in area), are enclosed by high sand barriers or dunes (2 to 25m high), and are connected to the sea through narrow lagoon inlets. The largest lagoon system is that of Tam Giang to Cau Hai near Hue. Salinity levels are greatest in lagoons between Phu Yen and Ninh Thuan, where the annual rainfall is low (700 mm) and the biotic communities are similar to those in the sea. Other lagoons show noticeable seasonal changes in the types of species with a clear dominance of brackish water species in the rainy season and saline species in the dry season. In general, the coastal lagoons are productive ecosystems due to their high nutrient levels which exceed those of the sea, even in the dry season. Fish, shrimps, crabs, molluscs and *Gracilaria* are exploited.

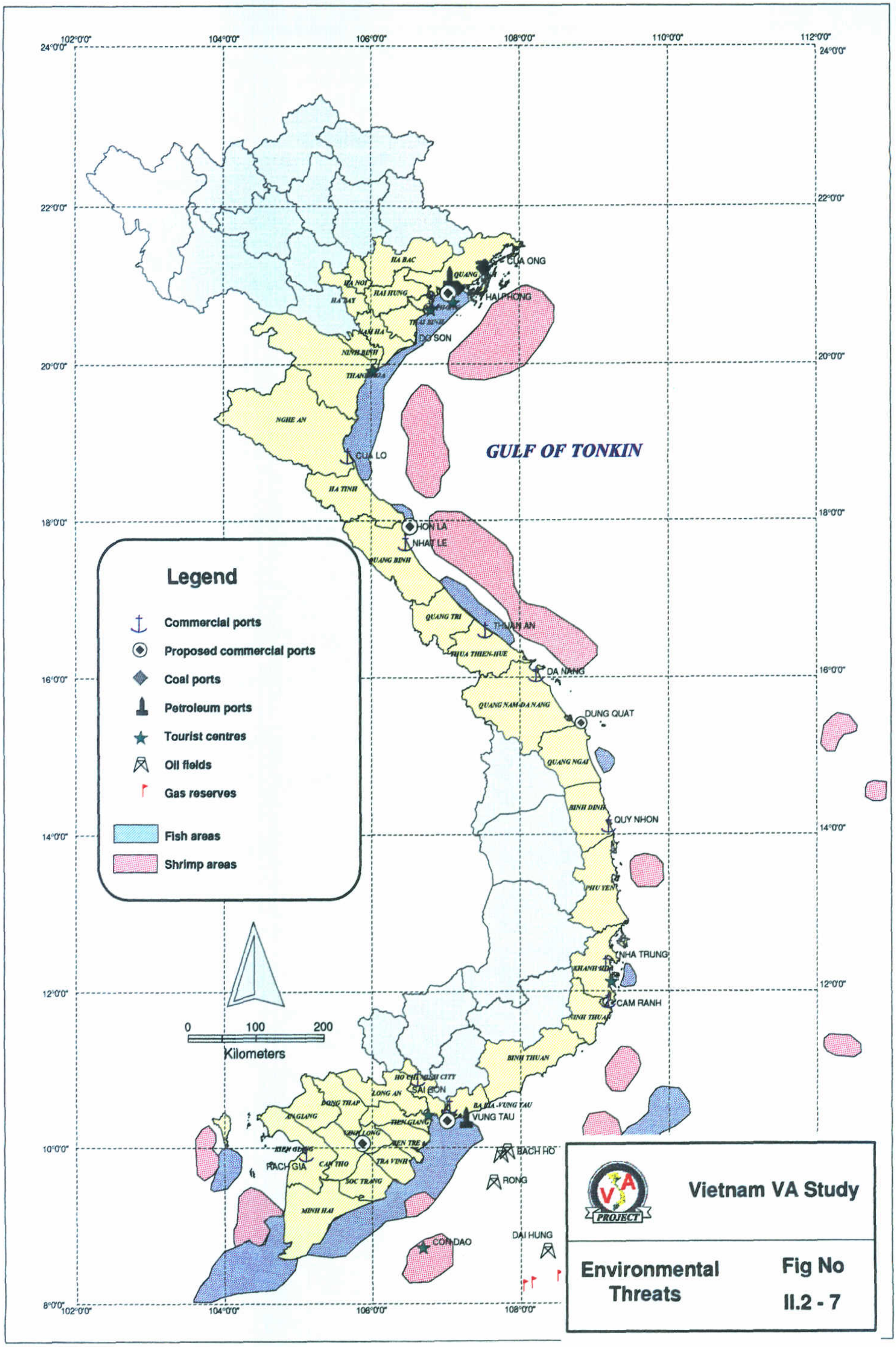
Lagoon inlets

Lagoon river mouths, mainly concentrated from Thanh Hoa to Binh Dinh, are characterised as restricted openings in frontal sand barriers. Their location width and therefore flushing efficiency is governed by the balancing dynamics of the lagoon discharge and the sea level and wave attack and varies according to the seasons. The vegetation cover near the lagoon mouth is thin and mainly consists of the water palm *Nippa fructicans* at high tidal flats and the seagrass *Phyllospadix* at low tidal flats. Aquatic resources are poor and vary with seasons. Fish, shrimps and crabs are the main products.

Tidal Marshes, mangroves, sea grass

Tidal marshes are mainly distributed along the northern coast from Mong Cai in Quang Ninh to Thanh Hoa Province (74,520 ha), and in the South from Vung Tau to Kien Giang (207,480 ha) - Figure II.2-1. In the central region, only a few tidal marshes occur (18,000 ha). The total area of tidal marshes is about 300,000 ha, 80 % of which possess mangroves (nearly 100 species) and seagrass. These figures are consistent with the national distribution of mangroves as computed from the VA landuse data as stored in GIS, (Figure II.2-1) which are presented in Table II.2-2.

The area of present wetland forests represents only 30% of the wetland area covered in 1940. Destruction of wetlands was devastating during Vietnam's war years due to defoliant spraying, particularly in the Mekong area but recovery efforts have been fairly successful. However, the recovery made by replanting in these areas has been rapidly overtaken by the expansion of aquaculture activities with the creation of ponds for shrimp farming. The fish pond creation is not only unwise environmentally but is also carried out in an uneconomic and careless way with the result that due to acidification of pond waters the fish ponds are



GULF OF TONKIN
Legend
Commercial ports
Proposed commercial ports
Coal ports
Petroleum ports
Tourist centres
Oil fields
Gas reserves
Fish areas
Shrimp areas
0 100 200
Kilometers
CUA ONG
HAI PHONG
DO SON
CUA LO
HON LA
NHAT LE
THUAN AN
DA NANG
DUNG QUAT
QUY NHON
NHA TRUNG
CAM RANH
SAI GON
VUNG TAU
RACH GIA
BACH HO
RONG
DAI HUNG
CON DAO
HA BAC
HA NOI
HAI HUNG
HA TAY
NAM HA
NINH BINH
THANH HOA
NGHE AN
HA TINH
QUANG BINH
QUANG TRI
THUA THIEN-HUE
QUANG NAM-DA NANG
QUANG NGAI
BINH DINH
PHU YEN
KHANH HOA
NINH THUAN
BINH THUAN
HO CHI MINH CITY
LONG AN
DONG THAP
AN GIANG
TIEN GIANG
VINH LONG
BEN TRE
TRA VINH
KIEN GIANG
CAN THO
SOC TRANG
MINH HAI
BA RIA-VUNG TAU
102°0'0"
104°0'0"
106°0'0"
108°0'0"
110°0'0"
112°0'0"
24°0'0"
22°0'0"
20°0'0"
18°0'0"
16°0'0"
14°0'0"
12°0'0"
10°0'0"
8°0'0"
Vietnam VA Study
PROJECT
Environmental Threats
Fig No
II.2 - 7

unproductive and often abandoned (eg Minh Hai area of the Mekong Delta).

Non- vegetated tidal marshes are mainly found in the Red River and Mekong Deltas, extending seawards from large mangrove stands. In general, the tidal marshes are economically vital as they provide the spawning and nursery grounds for numerous fish, prawns and mollusc species. Famous among such sites is the Xuan Thuy bird reserve area at the mouth of the Red River which is a RAMSAR site. Prominent wetland sites in Vietnam are shown in Figure II.2-9.

TABLE II.2-2 : NATURAL SYSTEM DATA : HABITATS AND SPECIES
Mangrove areas per coastal province of Vietnam (1994)

PROVINCE	AREA OF MANGROVES sq.km.
Quang Ninh	315
Haiphong	16
Hai Hung	5
Thai Binh	13
Nam Ha	5
Baria Vung Tau	146
Ho Chi Minh City	422
Ben Tre	113
Tra Vinh	232
Minh Hai	1067
Soc Trang	22
TOTAL AREA OF MANGROVES IN VIETNAM	2344
PERCENTAGE OF VA STUDY AREA	3.8 %

Coastal and Marine Biodiversity

Over 60 species of fish, 146 molluscs, 107 crustacea and many waterbirds and mammals inhabit the tidal marshes of Vietnam. Some details on the biodiversity of tidal marshes are summarised in Table II.2-3 by describing 3 important areas :

TABLE II.2-3: NATURAL SYSTEM DATA : HABITATS AND SPECIES
Biodiversity of 3 important tidal marsh areas (numbers of species)
(Ref. Biodiversity Action Plan(1994))

Location & Province	Mangrove	Molluscs	Crustacea	Birds
Cai Bau (Tien Yen to Ha Coi) Mangrove forest Quang Ninh	23 (400 km2)	24	30	36
Xuan Thuy - mudfalts Provincial reserve & RAMSAR site Nam Ha, Red River Delta (mouth)	8 (100 km2)	38	30	40
Ca Mau - mangrove forest Nature reserve Minh Hai, Mekong Delta	105 (1400 km2)	55	19	33

Marine algae and invertebrates

The total number of marine algae identified is 653 species including 301 species of rhodophytes, 151 chlorophytes, 124 phaeophytes and 77 cyanophytes. From the marine invertebrates, over 300 species of scleractinian coral (including 62 reef building corals) have been identified in addition to 2,500 species of molluscs, 1,500 crustacea, 700 polychaete, 350 echinoderm, 150 porifera and some other groups.

Marine fish

The total number of marine fish species recorded is 2,038, 70% of which are demersal species. Marine fishes of Vietnam are predominantly tropical with a small proportion of sub-tropical species mainly distributed in the Gulf of Tonkin. Recent studies of the coral reef fish fauna have revealed a total of 346 species.

Marine mammals, turtles, waterbirds etc.

Only four species of marine mammals are recorded. However, several other species of whales and dolphins can be expected. At present 5 species of marine turtles inhabit the mostly coral areas of the far north and the southern central coast. About 200 species of waterbirds and 10 species of serpents are recorded in the coastal zone of Vietnam.

Threats to biodiversity

In general, the biodiversity in Vietnam is rapidly decreasing. This topic is of such national concern that Vietnamese scientists have recently published the *Sach Do Viet Nam* (Vietnamese Red Book) summarising the status of threatened animals in the country. Table II.2-4 presents the status of the major groups in terms of endangered, vulnerable, threatened, rare or undetermined. In addition, the country totals and the coastal zone totals are also listed. Of the 150 species and subspecies of fish and invertebrates listed in the Red Book, 83 are marine including 37 fishes and 46 corals, molluscs, crustacea and enchinoderms.

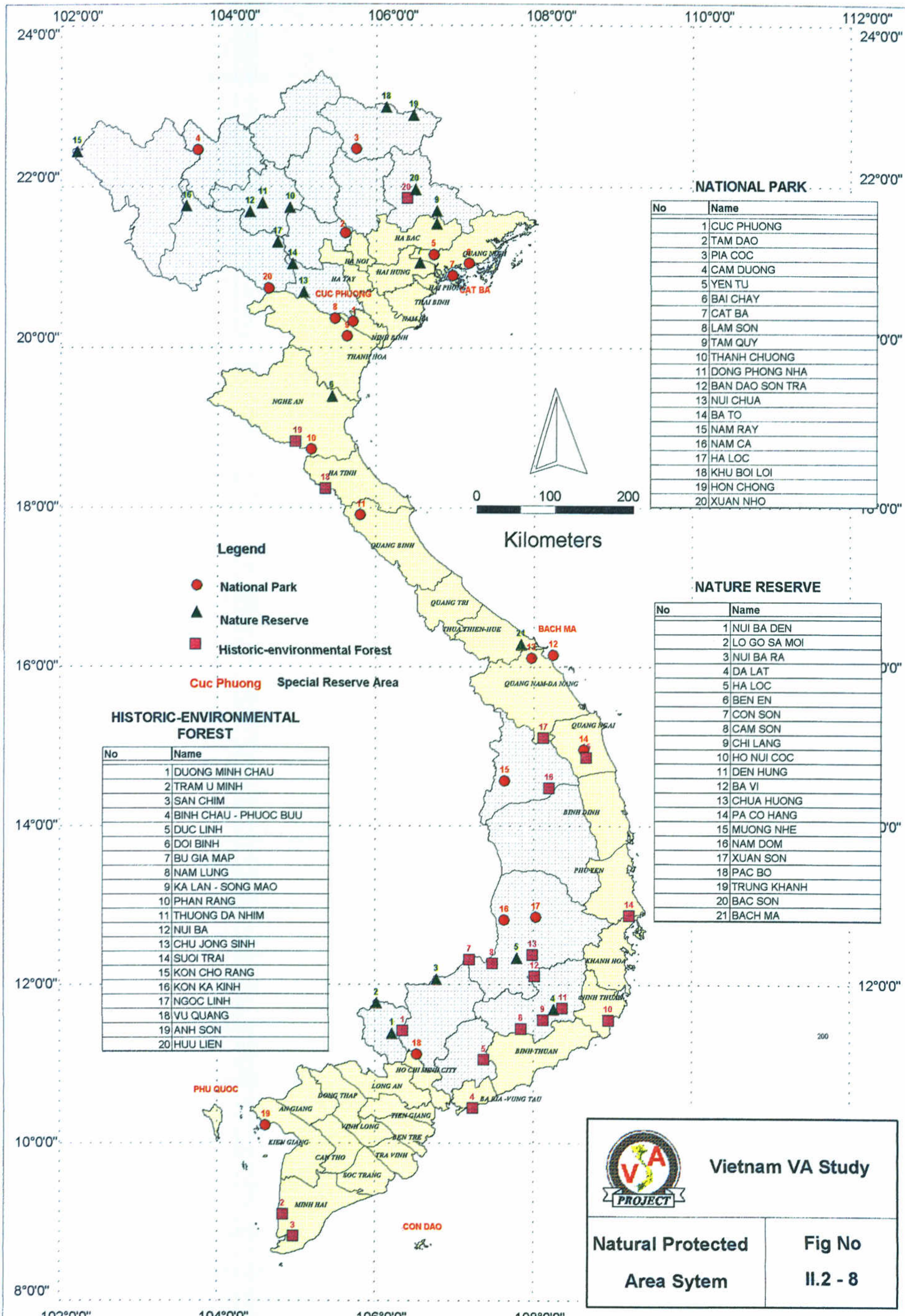
There are also some 40 species of rare and endangered fresh and brackish water fishes. A separate Red List has been prepared for 350 endangered and threatened plants.

TABLE II.2-4 : NATURAL SYSTEM DATA - HABITATS AND SPECIES
Red Book Categories of Vietnam
(Ref. Biodiversity Action Plan(1994))

	Inverts	Fishes	Reptiles	Birds	Mammals	Total
Endangered	10	6	8	14	30	68
Vulnerable	24	24	19	6	23	96
Threatened	9	13	16	32	1	71
Rare	29	29	11	31	24	124
Undetermined	3	3				6
Total species in danger	75	75	54	83	78	365
Total species in the country	7000	2500	260	800	275	10835
Total species in the coastal zone	5500	2038	10	200	4	7752

The total of species in danger is high for a single country and reflects the seriousness of the threats to wild habitats in Vietnam. In particular, fishery, industry, ports and tourism are the threats to the Marine and Coastal Biodiversity in Vietnam. Figure II.2-7 provides an overview of the threats facing the biodiversity of the Vietnamese coastal zone.

The extensive coastal waters and estuaries are abundant fishery resources with an annual exploitation potential of about 1.2 million tonnes, of which 60% to 70% is from capture fishery. Overfishing (large quantities, undersized fish, undersized mesh nets, dynamiting) is a main threat to the various fish species. Another threat is the destruction and degradation of coastal vegetation and coral reefs by human activities as marine-based tourism, port operations, oil and gas winning. These activities lead to coastline erosion and consequently to loss of habitat and loss of critical shelters for fishermen. Serious losses to mangrove areas as mentioned are a further threat.



NATIONAL PARK

No	Name
1	CUC PHUONG
2	TAM DAO
3	PIA COC
4	CAM DUONG
5	YEN TU
6	BAI CHAY
7	CAT BA
8	LAM SON
9	TAM QUY
10	THANH CHUONG
11	DONG PHONG NHA
12	BAN DAO SON TRA
13	NUI CHUA
14	BA TO
15	NAM RAY
16	NAM CA
17	HA LOC
18	KHU BOI LOI
19	HON CHONG
20	XUAN NHO

NATURE RESERVE

No	Name
1	NUI BA DEN
2	LO GO SA MOI
3	NUI BA RA
4	DA LAT
5	HA LOC
6	BEN EN
7	CON SON
8	CAM SON
9	CHI LANG
10	HO NUI COC
11	DEN HUNG
12	BA VI
13	CHUA HUONG
14	PA CO HANG
15	MUONG NHE
16	NAM DOM
17	XUAN SON
18	PAC BO
19	TRUNG KHANH
20	BAC SON
21	BACH MA

HISTORIC-ENVIRONMENTAL FOREST

No	Name
1	DUONG MINH CHAU
2	TRAM U MINH
3	SAN CHIM
4	BINH CHAU - PHUOC BUU
5	DUC LINH
6	DOI BINH
7	BU GIA MAP
8	NAM LUNG
9	KA LAN - SONG MAO
10	PHAN RANG
11	THUONG DA NHIM
12	NUI BA
13	CHU JONG SINH
14	SUOI TRAI
15	KON CHO RANG
16	KON KA KINH
17	NGOC LINH
18	VU QUANG
19	ANH SON
20	HUU LIEN

Natural Protected Area Sytem

Fig No II.2 - 8

Coastal and Marine Protected Areas

Overview of protected areas

The single most important factor affecting wildlife in Vietnam is habitat loss or change. Protected areas such as parks are designed to protect wildlife habitat, and are an indicator for future efforts to maintain the biodiversity and ecosystem functions. Figure II.2-8 gives an overview of the Protected Area System declared in 1986 and covering in total about 1 million hectares (10,000 km^2), although management of most areas has yet to be established. Some of the reserves are very valuable for biodiversity conservation, but unfortunately many are too small and contain only areas of interest for historic or recreation reasons. The Tropical Forest Action Plan (TFAP) concluded that the protected area system required considerable revision as it was inadequate in area, forest quality and standards of management to meet its objectives. That plan proposed 18 reserve extensions and four new reserves, including 5 special reserve areas situated in the Coastal Zone (comprising the land between MSL and +10 m) of Vietnam. These special reserve areas are listed in Table II.2-5 and separately indicated in red in Figure II.2-8.

TABLE II.2-5 : NATURAL SYSTEM DATA - HABITATS AND SPECIES
Proposed special reserve areas in the coastal zone
(Ref. Tropical Forest Action Plan (1994))

Name of reserve	Province	Original area (km2)	Proposed area (km2)
Cat Ba	Hai Phong	152	152
Cuc Phuong	Ninh Binh-Thanh Hoa	225	225
Bach Ma	Thua Thien Hue	225	870
Con Dao	Cuu Long (Mekong)	60	200
Phu Quoc	Kien Giang	50	144

Wetlands

According to RAMSAR Convention wetlands are defined as: *"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporarily, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres. "*

In addition the Convention provides that ..."*Wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres lying within the wetlands.*"

Vietnam has joined the RAMSAR Convention and has nominated one site, Xuan Thuy in the Red River delta as a RAMSAR site for protection under this convention.

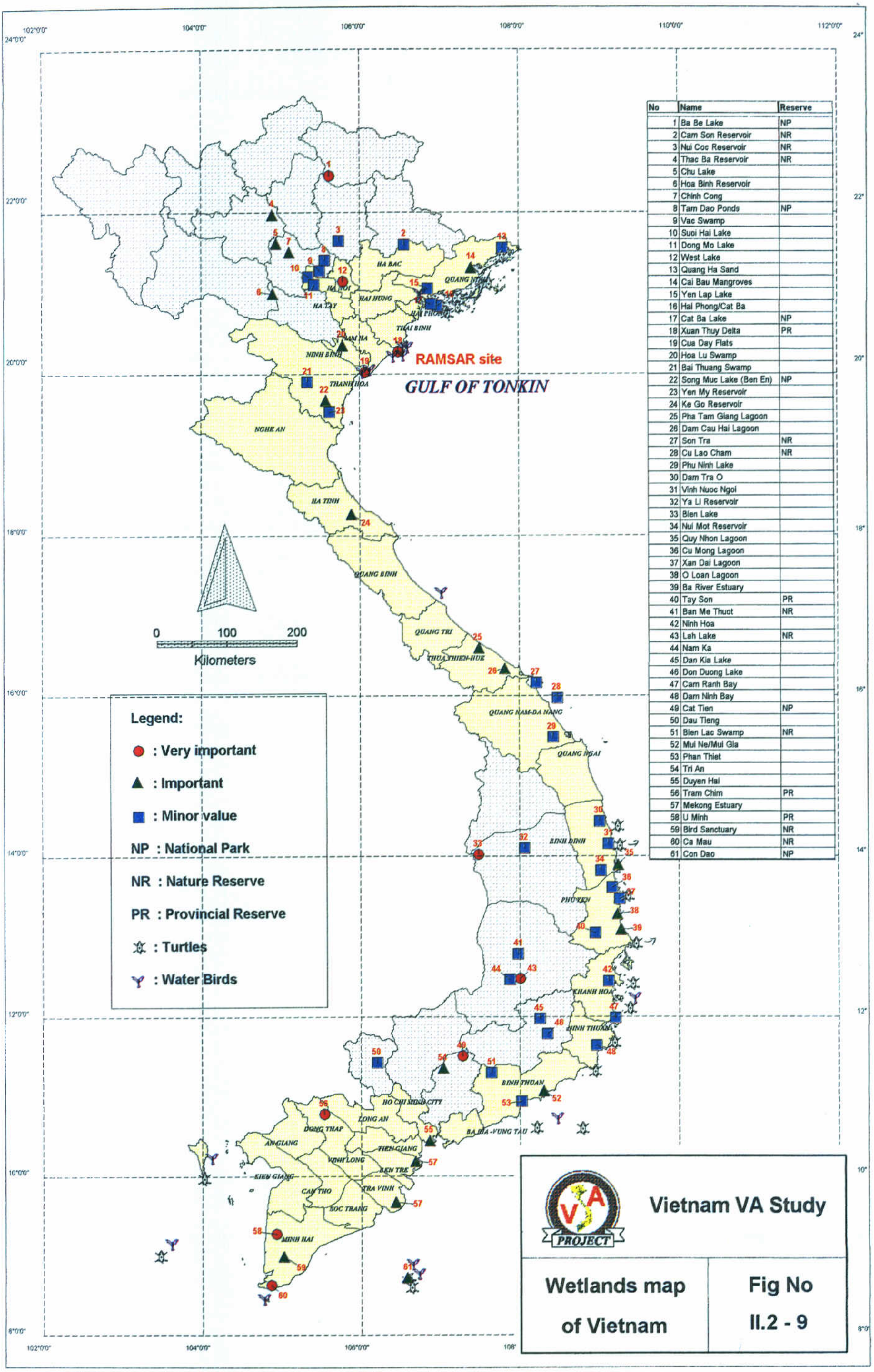
However the management of wetlands in general in Vietnam is not well defined in terms of roles, functions and responsibilities. The Ministry of Forestry manages several wetland sites that fall into forest estates including important mangrove areas and a few lakes and rivers that pass through nature reserves. However, the Ministry of Fisheries is responsible for production rates of fishing in lakes, rivers and marine areas.

By their dynamic and inter-related nature, wetlands are also particularly prone to pollution, changes in water flow water levels, rate of sedimentation, salinisation, etc.

At present there is already a list of 61 important wetlands, the locations of which are shown in Figure II.2-9, with ranking from very important to minor value. Reference is made to the "Biodiversity Action Plan, 1994" (ref 13) for detailed information on type, size, threats and recommended actions for all the wetlands. From Figure II.2-9, some coastal zone wetlands have been selected for description of more details and these are summarised in Table II.2-6:

TABLE II.2-6 : NATURAL SYSTEM DATA - HABITATS AND SPECIES
Selected wetland areas in the coastal zone - priorities for protection
(Ref. Biodiversity Action Plan (1994))

Area:	Province:	Asset:	Recommended actions:
West Lake	Hanoi	Fresh lake	Clean-up pollution, ban reclamation
Xuan Thuy	Nam Ha (north)	Mudflats	RAMSAR site, full protection
Cua Day	Nam Ha (south)	Mudflats	Combine in RAMSAR, fully protect
Ba River	Phu Yen	Estuary	Establish reserve area
Duyen Hai	Ho Chi Minh City	Mangroves	Create reserve (seaward side)
Mekong Delta	Ca Mau (Minh Hai) Tram Chim (Dong Thap)	Mangrove Swamp	Fire protection, relocation? Ban hunting Avoid drainage



No	Name	Reserve
1	Ba Be Lake	NP
2	Cam Son Reservoir	NR
3	Nui Coc Reservoir	NR
4	Thac Ba Reservoir	NR
5	Chu Lake	
6	Hoa Binh Reservoir	
7	Chinh Cong	
8	Tam Dao Ponds	NP
9	Vac Swamp	
10	Suoi Hai Lake	
11	Dong Mo Lake	
12	West Lake	
13	Quang Ha Sand	
14	Cai Bau Mangroves	
15	Yen Lap Lake	
16	Hai Phong/Cat Ba	
17	Cat Ba Lake	NP
18	Xuan Thuy Delta	PR
19	Cua Day Flats	
20	Hoa Lu Swamp	
21	Bai Thuang Swamp	
22	Song Muc Lake (Ben En)	NP
23	Yen My Reservoir	
24	Ke Go Reservoir	
25	Pha Tam Giang Lagoon	
26	Dam Cau Hai Lagoon	
27	Son Tra	NR
28	Cu Lao Cham	NR
29	Phu Ninh Lake	
30	Dam Tra O	
31	Vinh Nuoc Ngoi	
32	Ya Li Reservoir	
33	Bien Lake	
34	Nui Mot Reservoir	
35	Quy Nhon Lagoon	
36	Cu Mong Lagoon	
37	Xan Dai Lagoon	
38	O Loan Lagoon	
39	Ba River Estuary	
40	Tay Son	PR
41	Ban Me Thuot	NR
42	Ninh Hoa	
43	Lah Lake	NR
44	Nam Ka	
45	Dan Kia Lake	
46	Don Duong Lake	
47	Cam Ranh Bay	
48	Dam Ninh Bay	
49	Cat Tien	NP
50	Dau Tieng	
51	Bien Lac Swamp	NR
52	Mui Ne/Mui Gia	
53	Phan Thiet	
54	Tri An	
55	Duyen Hai	
56	Tram Chim	PR
57	Mekong Estuary	
58	U Minh	PR
59	Bird Sanctuary	NR
60	Ca Mau	NR
61	Con Dao	NP

Vietnam VA Study

Wetlands map of Vietnam

Fig No II.2 - 9

II.2.3 Inventory of Study Area Characteristics : Socio-economic characteristics

A summary of the socio-economic system data for 1995 is given in Table II.2-7.

Recent historical setting

The second world war and the ensuing ousting of two centuries of French colonial rule in 1954 was soon followed by the civil war between the communist North Vietnamese and the (US-backed) South Vietnamese forces. The eventual reunification of Vietnam in 1975 marked the end of successive war campaigns which devastated its infrastructure and its progress in development. Huge political and social changes were required to face the challenges of recovery and rebuilding in a nation of more than 50 million people.

Immediate difficulties were faced in the post war years with deep economic crises, worsened by trade blockades from the US and its allies (EC etc.). The turning point for Vietnam came in the mid 1980's with a radical series of economic reforms and restructuring toward a market economy. Immediate attraction of foreign finance resulted with enormous investments, particularly by Asian partners in the early 1990's, joined by EC and US investors in 1995. Massive infrastructure improvements and important strategic decisions are being made and planned to optimise the opportunities now facing the country and to ensure that development is sustainable, nowhere more important than in the coastal zone.

Political developments and set-up

The centralised planning and management systems that had proved so important and effective in war-time conditions in mobilising the country's resources towards national liberation and reunification ran into difficulties when directed at market economics and world trade. Internally, the market oriented policies were set out and accepted in the mid 1980's followed by adoption of a new constitution by the National Assembly in 1992. Externally, recent important developments have been the restoration of relations with the US and the EC prompted in 1993 by declarations from the US and formalised in 1995 and the joining of ASEAN in 1995.

The new (1992) constitution maintains the role of the Socialist Party as leading and central organ for government in Vietnam with the National Assembly as the highest authority in the land and as the people's representation. The National Assembly, by definition an assembly of almost 400 elected party officials with a 5 year term, chooses the President, Vice President and Minister President and approves the further recommendations of the Minister president for other ministerial positions. The policies of the National Assembly are carried out by the "Council of Ministers" with tasks delegated to the various ministries and State Committees.

In regional context, the People's Committees in each Province have direct access to the National Assembly but on the People's Committees are representatives of various ministries and departments. Within the heirachy of the Provincial People's Committees the structure is repeated at district level and even at commune level in some areas.

TABLE 2C

TABLE II.2-7 SOCIO ECONOMIC SYSTEM DATA GENERAL INFORMATION	UNITS	WHOLE NATION	Total Coastal Region	COASTAL REGIONS Red River Delta	N.Central Coast	S.Central Coast	Mekong Delta
1995							
FINANCIAL INDICATORS							
GDP	mill.US$	21000	17701	4128	2084	7112	4377
Coastal region as % of national GDP	%	100	84	20	10	34	21
GDP/person	US$/pers.	284	312	247	192	551	270
GDP growth rate (1993 to 1994)	% p.a.	11	10	13	10	11	7
Capital value	mill.US$	52500	48176	11146	5627	21336	10067
Agriculture, forestry, fishery as % of national GDP	%	34	39	31	45	30	58
Industry and construction as % of national GDP	%	22	17	18	11	20	13
Transportation, finance, trade and services as % of national GDP	%	44	44	51	44	50	29
POPULATION							
Population in nation / region	mill.pers.	74.0	56.7	16.7	10.9	12.9	16.2
% of national population	%	100	76.6	22.6	14.7	17.4	21.9
Population density (ave.)	pers./km2	220	342	1010	187	245	422
Population growth (1993 to 1994) actual	% per year	2.10	1.95	1.74	2.35	2.12	2.18
EMPLOYMENT PATTERN OF THE COASTAL PROVINCES							
% employed in Agriculture	%	72					
% employed in Industry	%	11					
% employed in Construction	%	3			(not available)		
% employed in Forestry	%	1					
% employed in Trade & Services	%	13					
SUBSISTENCE FARMING							
Subsistence population	mill.pers.	7					
% of agricultural production as subsistence farmers (no crop sold)	%	13		15	11	9	5
% of farmers selling all or part of their crops to supplement income	%	87		85	89	91	95
Average % of crop sold	%	22		17	17	16	49
LAND USE							
Land area of nation	sq.km	331000					
Land area in coastal provinces	sq.km		165782	16536	58313	52573	38360
% of national land area	%	100	50	5	18	16	12
% of land in coastal provinces used for							
Rice production	%		30.6	56.0	16.1	16.6	60.9
Other crops	%		4.8	4.0	2.7	8.7	3.1
Fruit tree cultivation	%		2.7	0.2	0.7	3.8	5.2
Aquaculture	%		0.7	0.4	0.1	0.0	2.7
Forest (indigenous)	%		27.6	3.8	30.2	52.0	0.3
Forest (planted for timber)	%		1.6	0.5	4.1	0.4	0.0
Mangrove	%		1.5	0.2	0.5	1.3	3.8
Special lands (for construction etc.)	%		0.6	0.3	0.2	1.5	0.2
Urban residential	%		0.3	0.5	0.1	0.6	0.1
Rural residential	%		5.8	13.6	2.5	1.6	13.3
Grasslands	%		22.4	16.4	41.4	12.5	9.6
Surface water	%		1.4	4.1	1.4	1.0	0.8
TOTAL (Check)	%		100	100	100	100	100

Population

Vietnam's national population is 74 million (1995) with an average growth rate at present of about 2.1% per year. 75% of the population live in the coastal and delta provinces. The Red River Delta is the most densely populated coastal region (and about 1000 persons per sq.km.) with half the land area of the Mekong Delta but with a similar total population. Together, the Red River Delta and the Mekong Delta contain almost 50% of the population on less than 20% of the total land area. The central coast provinces are the least densely populated (less than 200 people per sq.km.). These trends are shown in Figure II.2-10 (provinces) and in Table II.2-7 (regions).

The three largest cities in Vietnam are Ho Chi Minh City (4.5 million people), Hanoi (3.5 million people) and Haiphong (1.5 million people) with no other cities inhabited by more than 1 million people. In the Ho Chi Minh City and Hanoi three largest cities, the population density exceeds 20000 people per sq.km.

Economic growth

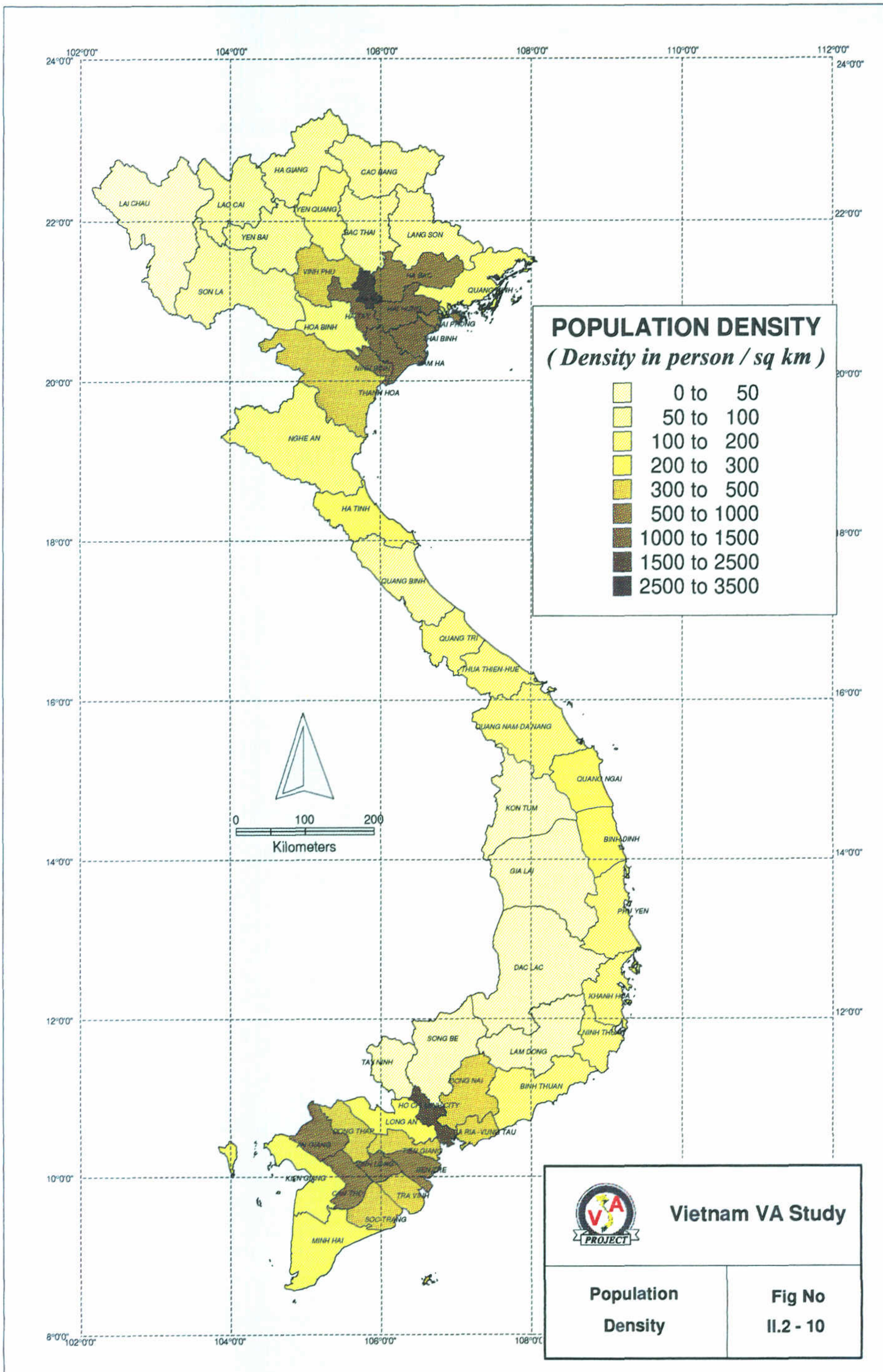
The reforms of the mid 1980's have caused a dramatic improvement in foreign trade and investments. The Doi-Moi policy of 1986 set a path of export driven trade with *open door* policies to attract foreign trade and investments. Setbacks were encountered in 1989 to 1991 by the collapse of trade with the former Soviet Union and its partners and by the US lead trade embargoes. However, by 1994 the economic growth averaged 8 % per annum as exports and imports grew rapidly. Special stimulus has been given to this by the increase in oil output and the exportation of rice. Vietnam is now the world's third largest exporter of rice, behind the US and Thailand.

Institutional arrangements for coastal zone management

The management of the coastline of Vietnam is a combined and parallel management on sectoral and territorial bases. Sectorially the ministries are charged with implementing nationwide policies and promoting the interests of the relevant industries they represent (eg fishery, forestry, agriculture, tourism etc.), while territorially the People's Committees have direct representation to the National Assembly and are responsible for the economic promotion and development of the Province within the laws and guidelines of the National Assembly Laws.

This has the result that the responsibility for decision making on important and sensitive coastal issues lies between the 3 main bodies the National Assembly, the Central Government (Ministries) and the Peoples Committees.

- The National assembly dictates policy, particularly in social and financial affairs, and exclusively dictates the pace and nature of foreign relations and foreign investments. In this context the National Assembly can make critical high level decisions which impact on the development trends in the coastal zone.


POPULATION DENSITY
(Density in person / sq km)
0 to 50
50 to 100
100 to 200
200 to 300
300 to 500
500 to 1000
1000 to 1500
1500 to 2500
2500 to 3500
0 100 200
Kilometers
LAI CHAU
LAO CAI
HA GIANG
CAO BANG
YEN QUANG
YEN BAI
BAC THAI
LANG SON
VINH PHU
SON LA
HOA BINH
HAI BINH
THANH HOA
NGHE AN
HA TINH
QUANG BINH
QUANG TRI
THUA THIEN-HUE
QUANG NAM-DA NANG
KON TUM
GIA LAI
DAC LAC
KHANH HOA
SONG BE
LAM DONG
BINH THUAN
LONG AN
KIEN GIANG
TRA VINH
MINH HAI
Vietnam VA Study
PROJECT
Population Density
Fig No II.2 - 10

- The Central Government, via the Ministers' Council, has important influence on regional strategic planning issues such as approval of large scale planning schemes, "special economic zones" and key decisions on major infrastructure items such as the location of the oil refinery.

- The Provincial People's Committees have freedom to approve and manage local affairs within the framework of the policies laid down by the National Assembly. To limit this freedom however, a financial criterion is imposed. Typically, all projects with a value less than US$45,000 can be approved by the Peoples Committee at the local District level. Projects above US$ 45,000 must be referred to the Peoples Committee at the provincial level but any project larger than US$ 225,000 must be referred to the Central Government or even the National Assembly in Hanoi for approval. All significant foreign contacts and investments are referred to Central Government for approval.

Important ministries have corresponding "Departments" as representatives within the Provincial Peoples Committees which advise on specific developments and projects. For coastal projects, most relevant are the Department of Science, Technology and the Environment (DoSTE) and the Department of Agriculture, Rural Development and Planning. DoSTE are charged with sampling and measurements programmes and environmental impacts while the Department of Agriculture, Rural Development and Planning is responsible for water related management, dykes and flood protection and coastal defences. In the case of dyke protection there is a special structure of organisation for disaster management and for routine maintenance and upkeep of the dykes, including regular safety inspections delegated to village level.

In the case of data collection and management of the important "boundary condition" data such as meteorology, water levels and coastal hydraulic data the Hydrometeorological service of Vietnam has a central role in data collection (through various agencies such as the Marine Hydrometeorlogical Center, Centre for Marine Hydrometeorology South, Institute of Hydrology etc.) but the analysis and interpretation of the data with respect to long term trends, to application for coastal studies and advice to Peoples Committees and Departments are often conducted by various Institutes of the National Centre for Natural Sciences, Technology and the Environment (eg Institute of Physics, Institute of geology, Institute of Mechanics, Haiphong Institute of Oceanology etc..) or by local Universities (Hanoi, Hue, Ho Chi Minh City etc.).

Problems with the present approaches to coastal zone management by the above structures appear mainly to relate to a lack of resources and technical capacity. Communication and Organisation is generally good but decision making is often hampered by strict heirachy structures with long delays. The technical appraisals of problems is also hampered by a lack of data and a lack of technical coordination of the local specialists and organisations. This results in duplication of efforts and a dissipation of the value of the advice.

Decision making is still economically driven and this creates one of the largest threats to sound coastal zone management. There is intense competition for new schemes that will elevate a specific province from underdeveloped to a "winning" status and political pressures to achieve and not be a drain on the nations small resources are immense.

Legislation for management of the coastal zone in Vietnam

There is no formal definition of the "coastal zone" in Vietnam. Legislation therefore rarely refers to the coastal zone specifically. This leads to a lack of focus on coastal management which can only be administered via a wide range of legal instruments.

In Vietnam the hierarchy of legal instruments is as follows :

Constitution - passed by the National assembly in 1992

Laws - made and amended by the National Assembly and added to the Constitution .

Ordinances - enacted by the Standing Committee of the National Assembly.

Legal resolutions - passed by the National Assembly to amend Decrees

Decrees - issued by the Government as the predominant method of law making.

Directives and circulars - issued by ministries and state bodies.

According to the Laws, the Central Government and People's Committees of the Provinces should draw up a Masterplan for development for the various local areas. Land allocations, construction planning, economic developments will all be permitted in accordance with accepted Masterplans. Examples are the Mekong and Red River Delta Masterplans. The Central Coast Masterplan is still to be prepared. Individual provinces (Peoples Committees) have to draw up a socio-economic plan to the year 2010 which sets out population density targets etc.

The Ministry of Science Technology and the Environment has issued a list of environmental standards to be adhered to (eg water quality, air quality etc.). In the National Environmental Agency (NEA) there is an EIA Department which is responsible for organisation of the EIA and EIA appraisal throughout the country.

Aside from the written instruments of law, there are also "communal laws" or agreements referred to as "*huong uoc*" (village's agreement). These are often related to public order as well as the economic and cultural behaviour of the community members. Many of these agreements are very long standing and passed down by generations. They are strictly adhered to within the commune and they are often enforced by imposition of fines.

Important legislation for the coastal zone is summarised in Box II-4.

BOX II-4 : A review of legislation affecting coastal zone developments

Important Laws for the coastal zone are the following ;

- The Land law (1994) : Land use types are set out in a local master plan for each area. Construction (eg hotels, tourist resorts etc.) is then only permitted in zoned "special lands" as laid down in the local master plans. Complicated procedures exist to change or reallocate land use types once accepted in the master plans.
- The Law on Environmental Protection (1994) : Individuals and organisations should present to the relevant government authorities a report on environmental impact assessment for appraisal. This report is then used as one of the tools for issuing construction licences (Article 18).
- The Law on Oil and Gas (1993)
- The Law on Protection and Development of Forestry (1991)

Important Ordinances are :

- The Ordinance on Natural Mineral Resources (1989). For the coastal zone this relates to sand mining. The Provincial peoples Committee has authority to approve sand mining projects up to 30,000 m3 provided these are carried out in "special lands" zones and "have no negative natural or social impacts".
- The Ordinance on the Protection and Development of Water Products (1990)
- The Ordinance on Dyke Protection. This prohibits construction within 15m of any part of the dyke structure

Important Decrees are :

- The Decree on State Management of Investment and Construction (1994). This states that all construction projects should be appraised by government authorities on land allocation, land use, architectural design, construction technology, natural resource use, environmental protection and social impacts. (Article 15)
- Decree (No.95 HDBT of March 1992) relates to Sand Mining regulations.
- Decree (N175 CP) on Guidelines for Implementation of the Law on Environmental Protection (1994) contains a special chapter on EIA. Within this there are 11 articles relating to the environmental impact procedure in Vietnam :
    - Article 9 : Who should conduct the EIA
    - Articles 10 & 11 : Contents of the EIA and report
    - Article 12 : Methodology requirements
    - Article 13 : Application forms for appraisal
    - Articles 14 to 19 : EIA appraisal procedure
    - Article 20 : EIA result implementation

Land use areas for the VA analysis

Specific socio economic indicators are required and have been determined for the VA analyses relating to land use areas, population densities and capital values.

As explained in *Report No.2* (ref 6), the land use dat for Vietnam has been digitised from maps provided by NIAPP. The maps are of a scale of 1 in 250,000 and originate from remote sensing data (Landsat TM-5 satellite images) from 1989-90. The land use categories used in the VA analysis were derived from a broader set of categories which is represented on the original maps. The categories are explained in Table II.2-8. The land use areas were deduced by GIS after digitisation of a full set of maps for north and south Vietnam. The topography, digitised from various scales ranging from 5,000 to 250,000, resulted in a topographical mapping of the coastal zone below +10m HD elevation. Examples of the resulting land use data are presented in Figures II.2-11a to II.2-11c for the north, central and southern parts of the coast respectively.

As explained in report No.3 (ref 7), overlying the topography and hydraulic information (water levels, dyke information, flooding scenarios) resulted in flooded area scenarios which, overlaid with land use and provincial boundaries resulted in deduction of land use areas distributed by province and by flooding probability.

Table II.2-9 provides a summary of the land use areas by region and by flooding impact zone for 1995 both before and after sea level rise.

Population densities for the VA analysis

Population densities were derived based on the gathered data (ref 6) and a matching of population density per land use class with land use areas and total populations per province. This was then used as the population density per land use class for the coastal impact zones. the ranges of values used for population density in 1995 are given in Table II.2-10.

Land Prices and Capital values for the VA analysis

In *Report No. 3* (ref 7), it is explained that capital values have been assigned to land use classes in various provinces such that the overall ratio of "capital value divided by GDP" is a factor in the range 1.5 to 5 depending on the wealth of the province concerned. The ratio is called the Incremental Capital to Output Ratio (ICOR) which is a measure of the capital investment needed to provide output. For example, an ICOR of 2.5 indicates that for every dollar of GDP to be generated it is needed to invest US$ 2.5 capital outlay.

In a country or province with a high level of development the ICOR is about 5 or 6 since the incremental cost to generate increased GDP is higher (eg increasing the GDP of a major developed city like Rotterdam in Holland by 10% will be far more expensive than increasing the GDP of Haiphong by 10%). The ICOR can also vary according to the sectoral emphasis. For example in the sector of services and infrastructure there is a large investment cost for a small return, compared to agriculture.

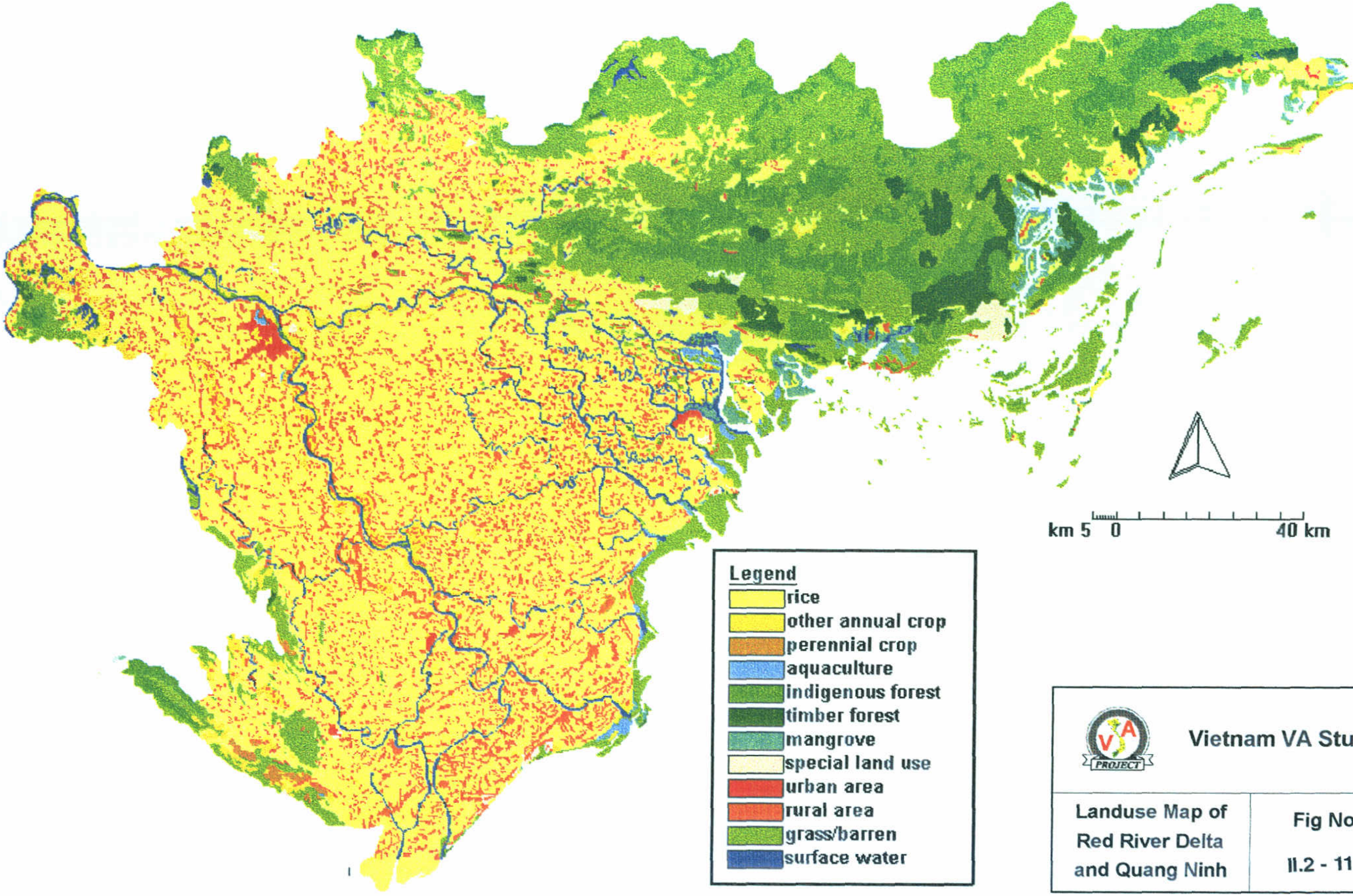
Typical ICOR values being used in economic planning in Vietnam are :

Agriculture and fisheries	ICOR = 1.5 to 2.5
Industry	ICOR = 2.5 to 3.5
Services & infrastructure	ICOR = 3 to 5

The ICOR also enables estimation of the capital investment required to sustain a specific required growth rate. For economic projections, the State Planning Committee (now Ministry of Investment Planning and Information) using an ICOR of 3 has estimated for a sustained growth rate of 8 to 10%, an annual investment of 30% of the GDP will be required at the turn of the millennium (2000). This is the comparable with China in 1996.

Land prices have been reported for the Vietnam VA Project by the State Planning Committee's Institute for Strategic Development Planning in *Report No.2* (ref 6). According to the report, in Vietnam, "land is a common property of the whole society." In 1994, a legal resolution has been promulgated in which the government fixes land prices for the whole country. For example, in the framework, land prices vary from US$ 50 per hectare on the mountain poor ground to over US$ 20,000 per hectare in the rich agricultural delta lands. Industrial land varies from US$ 1 per sq.m. in the mountain poor ground to US$ 150 per sq.m. in the lowland and delta cities.

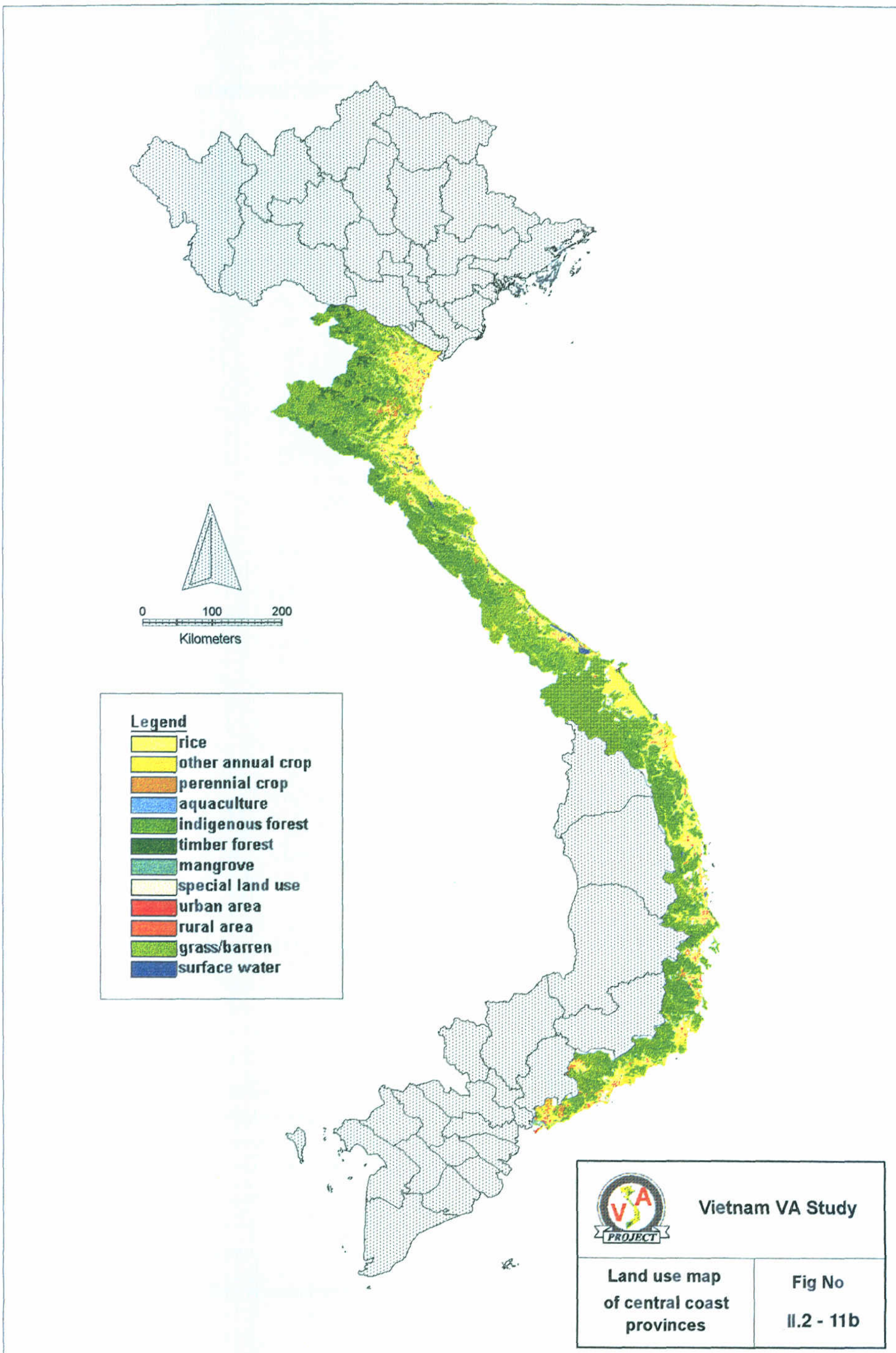
For the VA analysis, a range of land prices (capital values) per land use category has been derived based on the indicated framework and the compliance (by province and nationally) with the overall ICOR ratios described above. Table II.2-11 lists the range of prices per region for each land use category in the coastal zone.



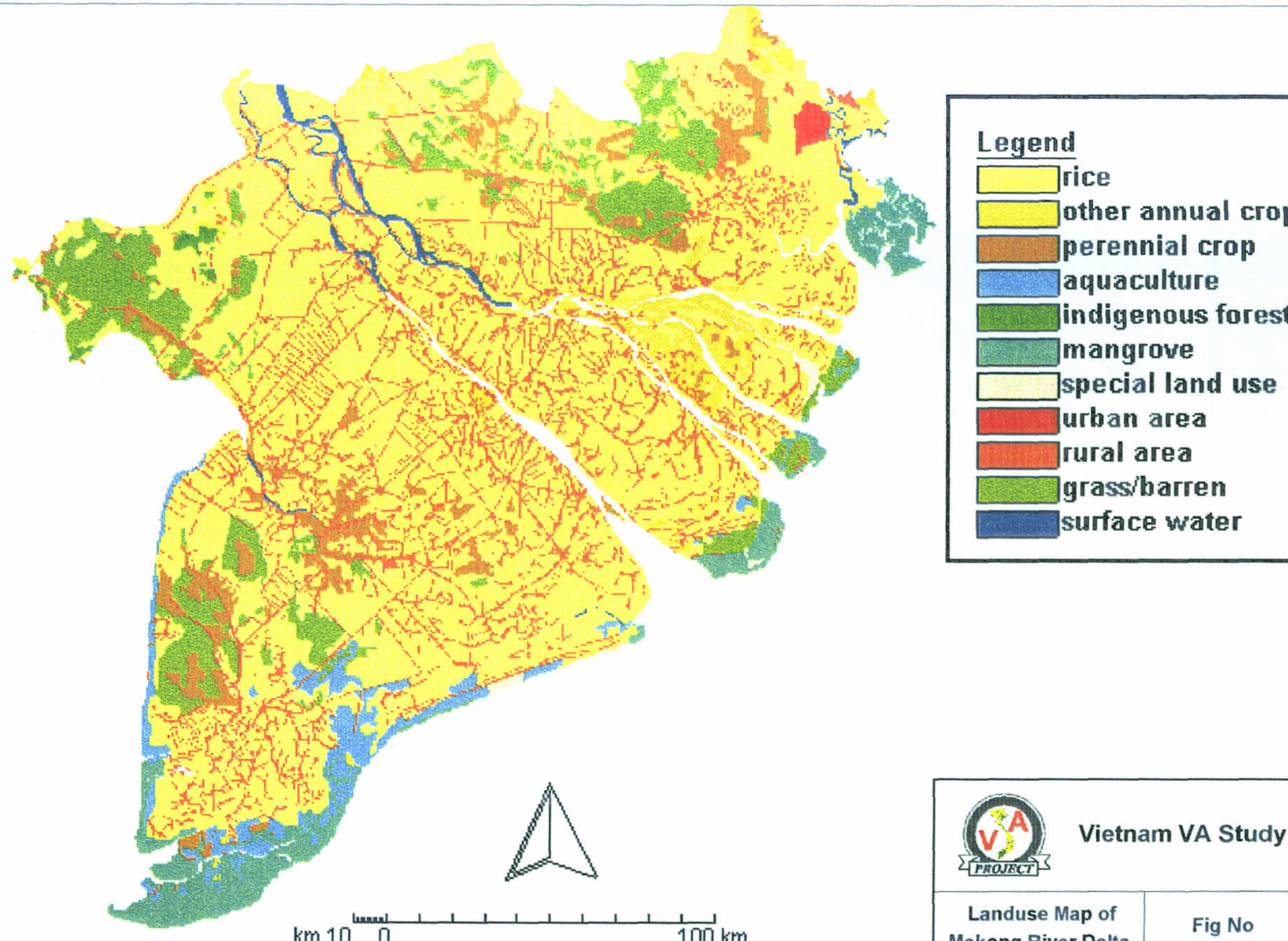
Vietnam VA Study

Landuse Map of Red River Delta and Quang Ninh

Fig No II.2 - 11a



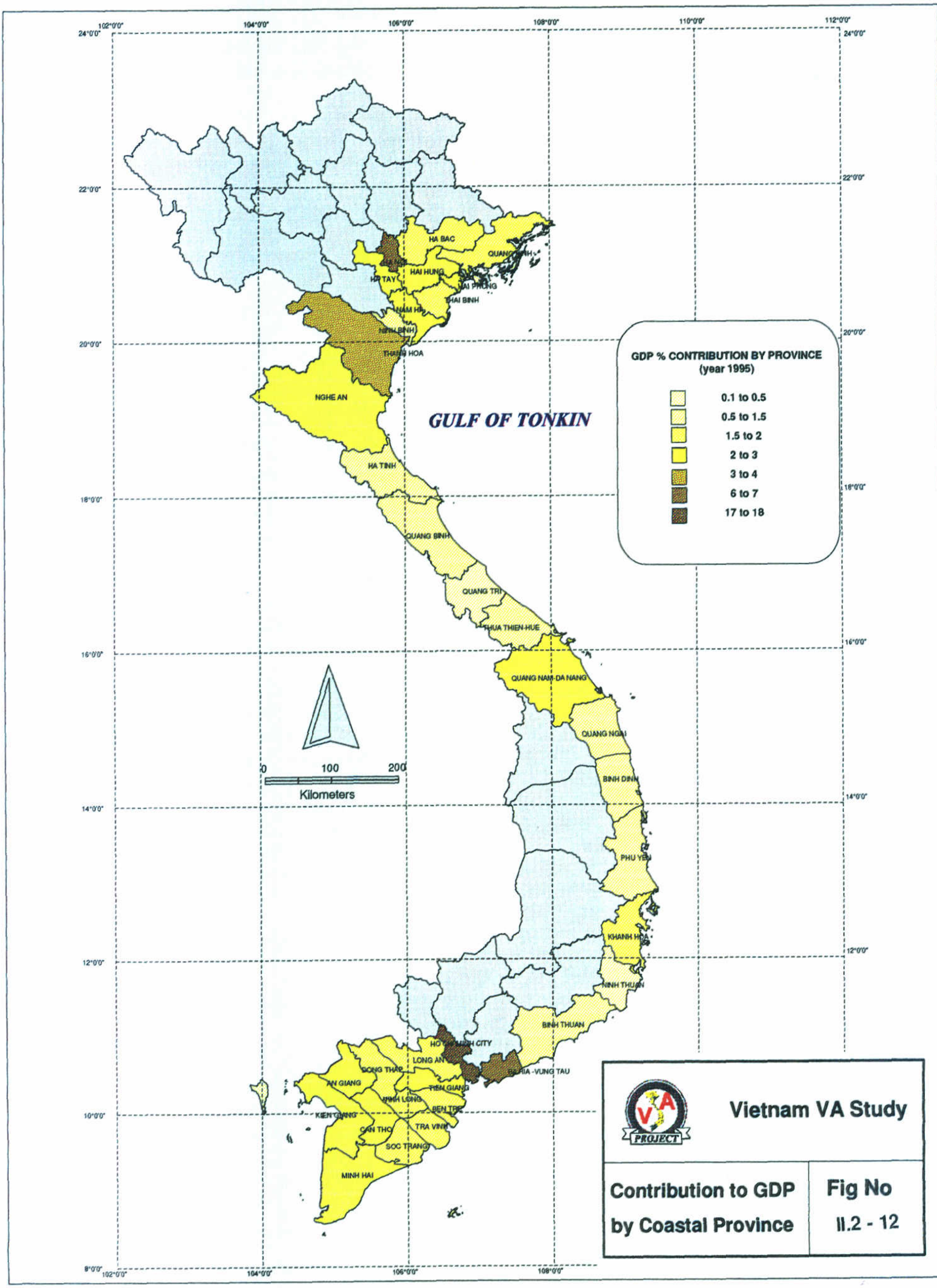
0
100
200
Kilometers
Legend
rice
other annual crop
perennial crop
aquaculture
indigenous forest
timber forest
mangrove
special land use
urban area
rural area
grass/barren
surface water
VA
PROJECT
Vietnam VA Study
Land use map of central coast provinces
Fig No
II.2 - 11b



Vietnam VA Study

Landuse Map of Mekong River Delta & HCMC

Fig No II.2 - 11c



Vietnam VA Study

Contribution to GDP by Coastal Province

Fig No II.2 - 12

TABLE II.2–8 : Classification of land use categories for the Vietnam VA Study

Original clasification (1992)	*VA Study reclassification (1995)*	Additional description
Annual crop		
1 lowland rice	*1 Rice*	All rice categories (single crop, multiple crop, upland, lowland rice etc.)
2 lowland rice – upland crop		
3 annual industrial crop & vegetables etc.	*2 Other annual crops*	All other annual crops such as vegetables, sugar cane, maize, soya etc.
4 upland crop		
Perennial crop		
5 Perennial fruit trees	*3 Perennial crop*	Orchards, trees and bush crops
6 Fruit trees		
7 Perennial crop (fruit/industrial)		
Other land		
8 Pasture	*12 Grasslands and barren lands*	Animal pasture lands for grazing of livestock
9 Water surface for aquaculture	*5 Aquaculture*	Aquaculture ponds (shrimp etc.)
Forestry lands		
10 Evergreen broad leafed trees/forest	*6 Indigenous forest*	Indigenous (native) forest
11 Semi–deciduous broad leafed trees/forest		
12 Deciduous broad leafed trees/forest		
13 Coniferous forest		
14 Mix stand forest		
15 Pure bamboo forest		
16 Mixed bamboo forest	*7 Timber forest*	Commercial timber and bamboo forests
17 Planted forest		
18 Mangrove	*8 Mangrove forest*	Mangrove forest
Special land use		
19 Land for construction	*10 Urban area*	Construction projects
20 Land for history, culture & tourism	*9 Special land use*	Special uses (historical sites, culture, tourism, mining, salt, other)
21 Land for mining		
22 Land for salt production		
23 Other special uses		
Residential land		
24 Urban area	*10 Urban area*	Residential lands in urban areas of towns and cities
25 Rural area	*11 Rural area*	Residential lands in rural areas, villages and settlements
Unused land		
26 Barren land	*12 Grasslands and barren lands*	Barren lands such as rock, coastal sediment, sand dunes etc.
27 Barren rock		
28 Coastal deposited area		
29 Sandy dune area		
30 Lowland fallow land		
31 Surface water area	*13 Surface water*	Water such as rivers, lakes, lagoons etc.
32 Low–tide sedimentary area	*12 Grasslands and barren lands*	Sandbanks and beaches, exposed tidal flats etc.

TABLE II.2-9 SOCIO ECONOMIC SYSTEM DATA INVENTORY OF POPULATION LAND USE TYPES AND CAPITAL VALUES IN THE STUDY AREA – 1995	UNIT	NO SEA LEVEL RISE: WHOLE NATION	NO SEA LEVEL RISE: COASTAL REGIONS Red River Delta	NO SEA LEVEL RISE: COASTAL REGIONS North Central Coast	NO SEA LEVEL RISE: COASTAL REGIONS South Central Coast	NO SEA LEVEL RISE: COASTAL REGIONS Mekong Delta	1m SEA LEVEL RISE: WHOLE NATION	1m SEA LEVEL RISE: COASTAL REGIONS Red River Delta	1m SEA LEVEL RISE: COASTAL REGIONS North Central Coast	1m SEA LEVEL RISE: COASTAL REGIONS South Central Coast	1m SEA LEVEL RISE: COASTAL REGIONS Mekong Delta
POPULATION BELOW +10m HD :											
Population in 1000 year flood zone	mill.pers.	22.60	9.36	3.55	0.42	9.23	33.87	14.31	3.96	1.14	14.46
Population in 100 year flood zone	mill.pers.	17.10	5.79	3.31	0.27	7.72	28.36	9.36	3.5	1.0	14.5
Population in 10 year flood zone	mill.pers.	11.60	1.75	2.60	0.16	7.13	21.29	3.25	3	1	14
Population in 1 year flood zone	mill.pers.	0.00	0.00	0.00	0.00	0.00	17.12	1.43	0.51	0.72	14.46
LAND USE BELOW +10m HD :											
Total area in 1000 year flood zone (TIZ)	sq.km.	34046	6847	5647	717	20835	56652	11343	6376	1673	37260
Percentage of national total	%	100	20	17	2	61	100	20	11	3	66
Distributed as											
Rice fields	sq.km.	22658	4707	3470	386	14095	35404	7754	3887	889	22874
Other crops, vegetables	sq.km.	1144	305	202	54	583	1902	434	235	76	1157
Orchards, tree and bush crops	sq.km.	1156	4	3	5	1144	2064	12	5	45	2002
Aquaculture	sq.km.	68	43	25	0	0	1045	67	26	1	951
Forest (indigenous)	sq.km.	96	0	39	42	15	140	0	45	61	34
Forest (planted for timber)	sq.km.	55	7	41	7	0	83	21	52.0	10.0	0.0
Mangrove	sq.km.	226	13	147	66	0	1796	20	163	334	1279
Special lands (for construction etc..)	sq.km.	35	20	15	0	0	102	36	24	1	41
Urban residential	sq.km.	117	63	18	25	11	153	75	19	46	13
Rural residential	sq.km.	4693	1135	637	30	2891	7727	1986	716	53	4972
Grasslands	sq.km.	2693	179	629	84	1801	4842	347	762	119	3614
Surface water	sq.km.	1106	372	420	19	295	1394	590	443	39	322
Total area in 100 year flood zone	sq.km.	26817	3351	5232	490	17744	51280	6847	5693	1480	37260
Percentage of national total	%	100	12	20	2	66	100	13	11	3	73
Distributed as											
Rice	sq.km.	17887	2438	3232	221	11996	31796	4708	3462	752	22874
Other crops	sq.km.	876	161	180	43	492	1732	305	204	66	1157
Fruit tree cultivation	sq.km.	958	4	3	1	950	2049	4	3	40	2002
Aquaculture	sq.km.	30	7	23	0	0	1019	43	25	0	951
Forest (indigenous)	sq.km.	95	0	39	40	16	130	0	41	55	34
Forest (planted for timber)	sq.km.	43	3	36	4	0	59	7	44	8	0
Mangrove	sq.km.	200	0	140	60	0	1787	13	161	334	1279
Special lands (for construction etc..)	sq.km.	19	6	12	1	0	78	20	16	1	41
Urban residential	sq.km.	94	50	18	16	10	135	63	18	41	13
Rural residential	sq.km.	3438	537	592	21	2288	6782	1134	633	43	4972
Grasslands	sq.km.	2355	35	557	65	1698	4557	178	663	101	3615
Surface water	sq.km.	822	110	400	18	294	1156	372	423	39	322
Total area in 10 year flood zone	sq.km.	22464	1422	4178	312	16552	45842	2810	4521	1251	37260
Percentage of national total	%	100	6	19	1	74	100	6	10	3	81
Distributed as											
Rice	sq.km.	15149	1109	2498	111	11431	28285	2152	2678	581	22874
Other crops	sq.km.	447	21	157	25	244	1458	90	156	55	1157
Fruit tree cultivation	sq.km.	876	2	2	1	871	2043	3	2	36	2002
Aquaculture	sq.km.	19	0	19	0	0	974	0	23	0	951
Forest (indigenous)	sq.km.	86	0	36	35	15	122	0	35	53	34
Forest (planted for timber)	sq.km.	37	3	31	3	0	47	3	39	5	0
Mangrove	sq.km.	167	0	112	55	0	1765	0	153	333	1279
Special lands (for construction etc..)	sq.km.	9	0	9	0	0	53	1	10	1	41
Urban residential	sq.km.	38	1	16	11	10	66	2	18	33	13
Rural residential	sq.km.	2823	238	461	8	2116	5936	460	470	34	4972
Grasslands	sq.km.	2104	17	470	47	1570	4272	26	550	81	3615
Surface water	sq.km.	709	31	367	16	295	821	73	387	39	322
Total area in 1 year flood zone	sq.km.	0	0	0	0	0	40768	1302	1138	1068	37260
Percentage of national total	%						100	3	3	3	91
Distributed as											
Rice	sq.km.						24737	1013	388	462	22874
Other crops	sq.km.						1235	16	21	41	1157
Fruit tree cultivation	sq.km.						2039	2	0	35	2002
Aquaculture	sq.km.						965	0	14	0	951
Forest (indigenous)	sq.km.						89	0	7	48	34
Forest (planted for timber)	sq.km.						65	2	23	40	0
Mangrove	sq.km.						1731	0	122	330	1279
Special lands (for construction etc..)	sq.km.						43	0	1	1	41
Urban residential	sq.km.						51	1	11	26	13
Rural residential	sq.km.						5276	221	64	19	4972
Grasslands	sq.km.						3929	17	233	64	3615
Surface water	sq.km.						645	30	255	38	322
CAPITAL VALUE											
CV of all land in 1000 year flood zone	mill.US$	18924	10252	1223	811	6638	31885	14126	1396	3484	12879
CV of all land in 100 year flood zone	mill.US$	14352	7016	1136	751	5449	27808	10253	1227	3449	12879
CV of all land in 10 year flood zone	mill.US$	7608	916	925	702	5065	18981	1787	995	3320	12879
CV of all land in 1 year flood zone	mill.US$	0	0	0	0	0	17171	847	221	3224	12879

TABLE2D_b

TABLE II.2–10 SOCIO ECONOMIC SYSTEM DATA POPULATION DENSITIES FOR DIFFERENT LAND USE TYPES IN THE STUDY AREA – 1995 & 2025		POPULATION DENSITIES 1995					POPULATION DENSITIES 2025				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
			Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
LAND USE TYPE IN THE COASTAL ZONE :	UNIT										
Rice fields	pers./sq.km (max)	1000	1000	500	530	500	1025	1025	700	500	500
	pers./sq.km (min)	200	200	300	200	200	300	400	400	350	300
Other crops, vegetables	pers./sq.km (max)	750	750	300	300	150	770	770	350	250	170
	pers./sq.km (min)	50	100	150	50	50	50	200	200	100	50
Orchards, tree and bush crops	pers./sq.km (max)	100	100	100	50	100	150	100	150	50	80
	pers./sq.km (min)	10	50	50	10	50	20	80	60	20	45
Aquaculture	pers./sq.km (max)	100	100	100	50	75	100	80	100	100	50
	pers./sq.km (min)	0	50	100	0	0	0	50	0	0	0
Forest (indigenous)	pers./sq.km (max)	100	100	100	100	50	100	100	80	100	50
	pers./sq.km (min)	0	40	40	25	0	40	40	40	40	30
Forest (planted for timber)	pers./sq.km (max)	100	100	100	100	50	100	100	100	60	50
	pers./sq.km (min)	0	50	40	50	0	40	40	40	40	40
Mangrove	pers./sq.km (max)	100	100	100	50	50	150	135	130	150	150
	pers./sq.km (min)	0	50	100	0	0	0	0	50	50	0
Special lands (for construction etc..)	pers./sq.km (max)	100	100	100	100	100	330	150	150	330	150
	pers./sq.km (min)	100	100	100	100	100	50	90	50	170	60
Urban residential	pers./sq.km (max)	25000	25000	10000	20000	10000	34000	34000	17000	32000	16000
	pers./sq.km (min)	1000	8000	2350	7000	1000	3000	14000	3000	9000	8000
Rural residential	pers./sq.km (max)	14000	12500	3000	14000	2000	18000	18000	4000	10000	5000
	pers./sq.km (min)	1000	1000	2000	1200	1100	1500	4000	1500	3000	1800
Grasslands	pers./sq.km (max)	100	400	67	100	100	400	400	80	100	100
	pers./sq.km (min)	40	50	40	45	50	40	50	40	50	50
Surface water	pers./sq.km (max)	0	0	0	0	0	0	0	0	0	0
	pers./sq.km (min)	0	0	0	0	0	0	0	0	0	0

TABLE II.2-11 SOCIO ECONOMIC SYSTEM DATA UNIT CAPITAL VALUES FOR DIFFERENT LAND USE TYPES IN THE STUDY AREA – 1995 & 2025		UNIT CAPITAL VALUES 1995					UNIT CAPITAL VALUES 2025				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
			Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
LAND USE TYPE IN THE COASTAL ZONE :	UNIT										
Rice fields	US$/sq.m. (max)	0.7	0.7	0.2	0.5	0.5	5	5	2.5	5	4
	US$/sq.m. (min)	0.05	0.3	0.1	0.05	0.15	1	2.5	1.5	1	2.5
Other crops, vegetables	US$/sq.m. (max)	0.5	0.5	0.3	0.5	0.2	5	5	2.5	5	4
	US$/sq.m. (min)	0.05	0.4	0.1	0.05	0.1	1	2.5	1.5	1	2.5
Orchards, tree and bush crops	US$/sq.m. (max)	0.2	0.2	0.1	0.2	0.1	2	2	1	2	2
	US$/sq.m. (min)	0.02	0.2	0.05	0.02	0.1	1	1	1	1	1
Aquaculture	US$/sq.m. (max)	0.1	0.1	0.1	0.1	0.1	1	1	1	1	1
	US$/sq.m. (min)	0.01	0.1	0.05	0.01	0.1	1	1	1	1	1
Forest (indigenous)	US$/sq.m. (max)	0.2	0.2	0.05	0.2	0.1	2	2	1	2	0.5
	US$/sq.m. (min)	0.02	0.1	0.02	0.02	0.1	0.3	1	0.3	0.2	0.3
Forest (planted for timber)	US$/sq.m. (max)	0.4	0.5	0.4	0.5	0.4	5	5	3.0	5.0	2.0
	US$/sq.m. (min)	0.1	0.5	0.15	0.1	0.4	0.3	3	3	2	2
Mangrove	US$/sq.m. (max)	0.1	0.1	0.1	0.1	0.1	1	1	1	1	1
	US$/sq.m. (min)	0.05	0.1	0.05	0.05	0.1	1	1	1	1	1
Special lands (for construction etc..)	US$/sq.m. (max)	30	30	5	30	15	1000	500	15	1000	20
	US$/sq.m. (min)	0.25	5	2	0.25	5	2	50	10	2	10
Urban residential	US$/sq.m. (max)	175	100	30	175	35	7000	3000	50	7000	30
	US$/sq.m. (min)	3	35	5	3	10	10	200	2	300	20
Rural residential	US$/sq.m. (max)	3	1	0.5	2	0.5	300	200	2	300	20
	US$/sq.m. (min)	0.2	0.7	0.3	0.2	0.2	1	3	1	2	3
Grasslands	US$/sq.m. (max)	0.5	0.5	0.1	0.05	0.01	1	1	1	0.1	0.2
	US$/sq.m. (min)	0.01	0.05	0.01	0.02	0.01	0.1	0.1	0.2	0.1	0.15
Surface water	US$/sq.m. (max)	0.05	0.05	0.01	0.05	0.01	0.5	0.5	0.5	0.5	0.5
	US$/sq.m. (min)	0.01	0.05	0.01	0.01	0.01	0.05	0.05	0.05	0.05	0.05

II.3 Step 3 : Future development factors

II.3.1 General development trends in the coming 30 years

From its present agriculture-based economy, Vietnam is undergoing an intense industrialisation phase which is evident in its rapid economic growth and social change. This process is expected to continue for most of the next 30 years.

The industrialisation will be accompanied by trends such as internal migration (rural areas to urban areas) but reduced birth rates, particularly in the prospering provinces. A polarisation of prosperous northern and southern provinces versus less prosperous central and mountainous provinces will emerge depending on the success of the Government in revitalising these "neglected" areas. Decentralisation policies will be given more importance to avoid this polarisation. Controls on limiting and regulating internal migration, presently enforced in Vietnam will become highly stressed.

Agricultural output will remain high but will be pressurised to improve yields to meet government targets. Such pressures are in danger of being at the expense of the environment. Particularly in the sensitive lowlands of the Mekong Delta where dyke protection, pumping and poldering is increasing yields but causing hydraulic impacts. In aquaculture a similar conflict arises in Minh Hai and near Vung tau where fish ponds are created in mangrove wetlands to bolster local economic activity and GDP growth at the expense of the important ecosystems. Aquacultural targets in the next 30 years are double the present output. If all of this is achieved by replacement of mangroves this will consume about half of the remaining mangrove areas within 30 years.

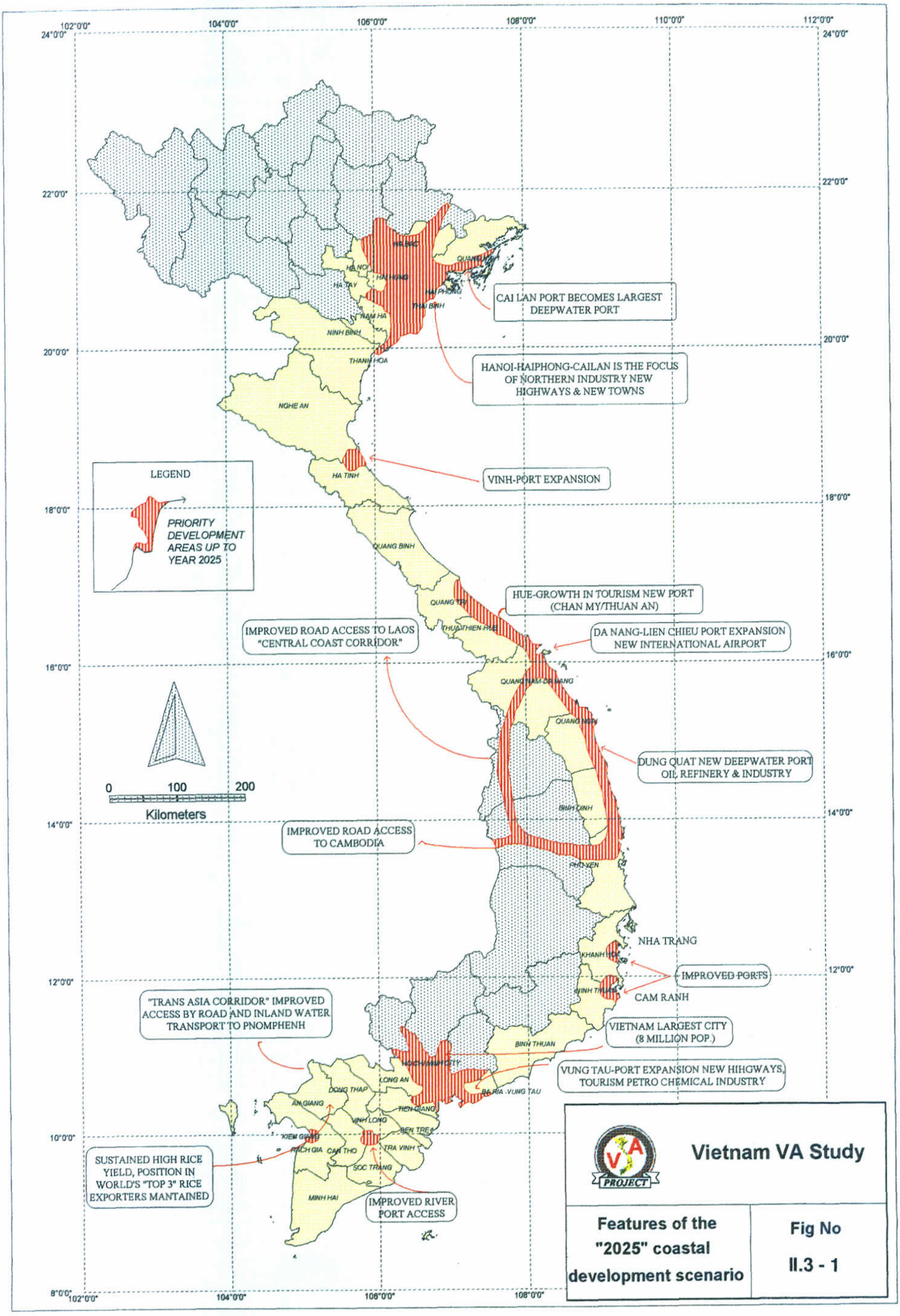
In almost all areas, the demands for fresh water will be more and more difficult to meet. Dam construction and groundwater pumping will increase with potential adverse effects on the coastal sediment supplies and coastal subsidence respectively.

II.3.2 30 year scenario for development plans

In Vietnam, the "winning" provinces in terms of increased output and general prosperity will be the focal economic zones (FEZ's) of the Hanoi-Haiphong-Quang Ninh area in the north and the Ho Chi Minh City-Song Be-Baria Vung Tau-Dong Nai area in the south. The main features of the 30 year development trends are depicted in Figure II.3-1 and the revised socio economic system data for 2025 are described in Table II.3-1.

Hanoi's population will grow to over 2 millions, and it will retain its historically important role as the center of Government and remain the focal point of important strategic planning and decision making for the nation. Infrastructure links will be upgraded from the capital to the nearby growth centres of Quang Ninh Province and Haiphong, by the provision of highways. In particular the road and rail route connecting Hanoi with the new deepwater port planned for Cai Lan and the existing Haiphong port (already Vietnam's busiest port) will be a high priority for upgrading. In turn this route will attract industrial developments, some of which will be heavy industries. The threats facing the Ha Long Bay area, a UNESCO site, will increase with increased shipping, mining industries and a boom in foreign (and local) tourism.

On the central coast, the coastal corridor from Thua Thien Hue through Quang Nam Danang



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Features of the "2025" coastal development scenario

Fig No II.3 - 1

TABLE2C

TABLE II.3-1 SOCIO ECONOMIC SYSTEM DATA GENERAL INFORMATION	UNITS	WHOLE NATION	Total Coastal Region	COASTAL REGIONS Red River Delta	N.Central Coast	S.Central Coast	Mekong Delta
2025							
FINANCIAL INDICATORS							
GDP	mill.US$	213772	194618	41423	12157	113977	27061
Coastal region as % of national GDP	%	100	91	19	6	53	13
GDP/person	US$/pers.	1831	2142	1644	922	4744	1031
GDP growth rate in 2025	% p.a.	7	7	7	6	8	6
Capital value	bill.US$	855	778	166	48	455	108
Agriculture, forestry, fishery as % of national GDP	%	10	20	10	20	20	30
Industry and construction as % of national GDP	%	40	35	40	35	35	30
Transportation, finance, trade and services as % of national GDP	%	50	45	50	45	45	40
POPULATION						10626	
Number of people in province	mill.pers.	116.7	90.9	25.2	15.4	24.0	26.3
% of national population	%	100	78	22	13	21	23
Population density (ave.)	pers./km2	353	548	1524	264	457	685
Population growth rate 1995 to 2025 (ave.)	% per year	1.5	1.5	1.4	1.2	2.1	1.6
EMPLOYMENT PATTERN OF THE COASTAL PROVINCES							
% employed in Agriculture	%	18					
% employed in Industry	%	35					
% employed in Construction	%	5			(not available)		
% employed in Forestry	%	2					
% employed in Trade & Services	%	40					
SUBSISTENCE FARMING							
Subsistence population	mill.pers.	<2					
% of agricultural production as subsistence farmers (no crop sold)	%	<10%			(not available)		
% of farmers selling all or part of their crops to supplement income	%	>90%					
Average % of crop sold	%	>20%					
LAND USE							
Land area of nation	sq.km	331000					
Land area in coastal provinces	sq.km		165782	16536	58313	52573	38360
% of land in coastal provinces used for							
Rice production	%		30	45	15	17	58
Other crops	%		4	3	3	7	3
Fruit tree cultivation	%		2	0	1	2	5
Aquaculture	%		1	0	0	0	3
Forest (indigenous)	%		28	13	30	54	0
Forest (planted for timber)	%		2	0	4	0	0
Mangrove	%		1	0	1	1	4
Special lands (for construction etc.)	%		1	1	0	2	0
Urban residential	%		0	1	0	1	0
Rural residential	%		7	12	4	3	16
Grasslands	%		23	21	42	13	10
Surface water	%		1	3	1	0	1
TOTAL (Check)	%		100	100	100	100	100

and Quang Ngai Provinces will be developed at higher speed than any other part of the region. An industrial focus will develop at Dung Quat in Quang Ngai Province, the site of the new oil refinery and a proposed heavy industry area. A tourism focus will develop near Hue with its ancient city, excellent beaches and picturesque lagoon system. New ports at Dung Quat and Chan May Bay will serve these developments. Existing ports at Danang and Cam Ranh Bay will be upgraded. A large international airport will be built at Danang (Chu Lai). The connections between the Central Coast and the inland states of Laos and Cambodia will be improved and this will provide important stimulus for the region to act as a sea-port facility for imports to these states. This will stimulate the inland areas as well the interior and strip developments along these routes will arise with new towns and industries.

In the south the clear focal points are the SFEZ and the Can Tho region. The oil industry at Vung Tau, plus its importance as new deepwater port location will give huge potential for growth of the hinterland both in Baria Vung Tau and Dong Nai Provinces. New cities such as Bien Hoa will be industrial centers with a good local freshwater supply (Dong Nai River and upstream dam) and easy access to port and road infrastructure. The additional momentum and impetus given by the commercially successful Ho Chi Minh City will result in massive growth potential for the region. The river port of Saigon will grow in importance, also as transhipment centre. In the Can Tho region, the economic developments of the Mekong Delta will be concentrated. Can Tho is also well placed to act as the key transhipment port for inland water transport across the delta to Cambodia (Phnom Penh).

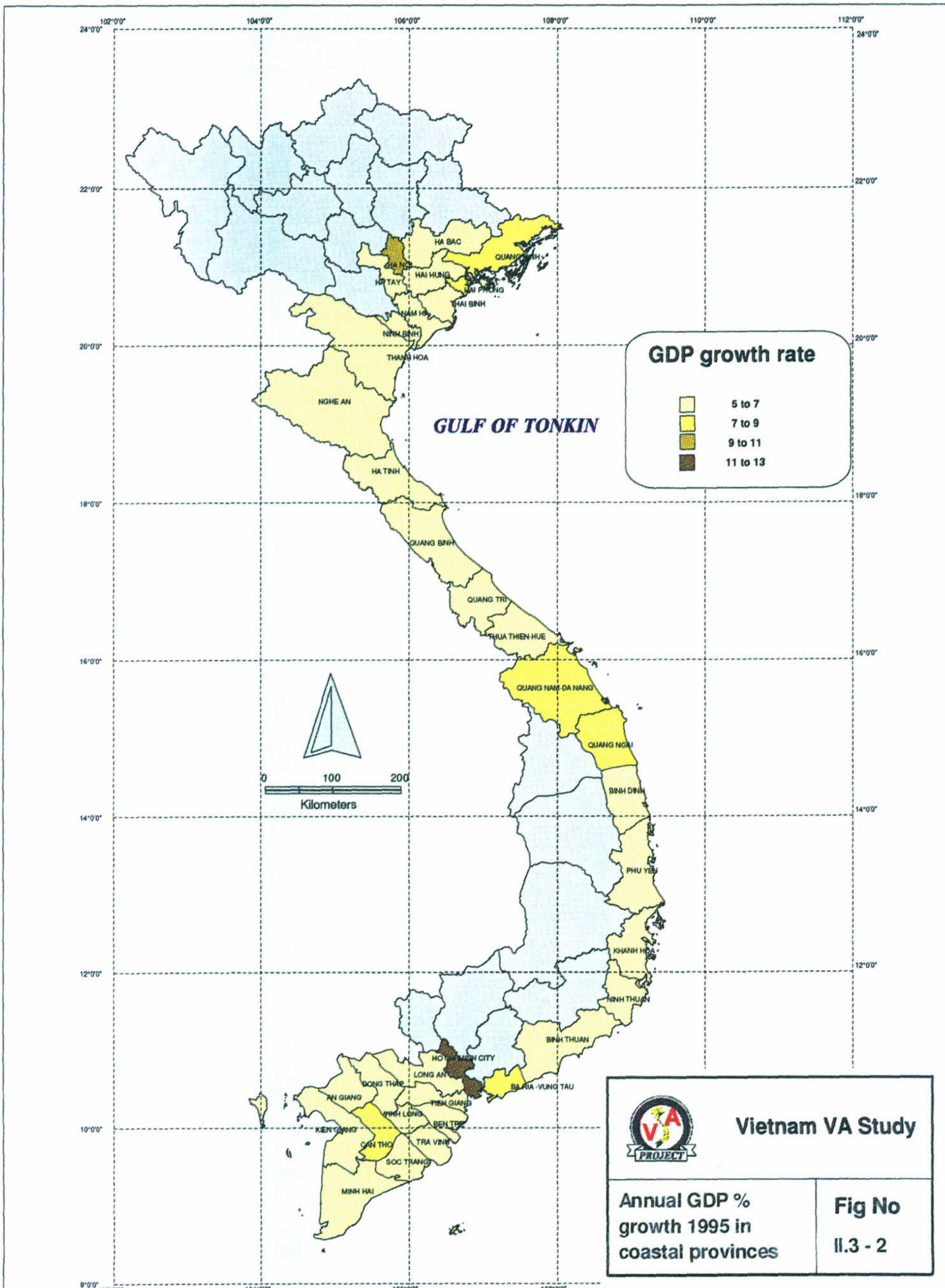
II.3.3 Economic trends and land use changes

As a reflection of its rapid industrialisation, in 1995, Vietnam's exports amounted to about 17% of the GDP. In 2025, a target figure for exports is 25 to 30% of the GDP with over 85% as manufactured products.

To achieve the Government planning targets an average GDP growth rate over the next 30 years of 8 to 10% per year is required and considered realistic, although by 2025 this will be reducing to about 7%. The indicated GDP for 2025 is US$ 214 billion (US$ 1,826/person). In Appendix A, 2025 GDP and GDP growth rates per region are given and summarised in Table II.3-1 and in Figure II.3.2. The range is from 8 to 10% in the "leading provinces" to 5% in the mountainous and upland provinces. Inflation is expected vary between 10 and 14% in the early part of the period but to reduce to below 10% after 2010.

Rice production needs to keep pace with the needs of feeding the population (60% increase in population to 2025) and with export targets. This will require almost a doubling of output that can only be achieved by increased occupation of lands or by increased yields. Increased occupation of lands requires reclamation of wetlands in the Mekong. Improved yields can be achieved by reaping of a third crop, made possible in the Mekong Delta by increased protection (dykes) from flooding and by increased freshwater irrigation. Serious hydraulic impacts can result from both strategies. Competition for arable land for use by more profitable crops and industrial crops/plantations will put the rice output targets under pressure. On balance, the rice production areas will not be significantly changed in extent.

Industrial and fruit-tree crops will increase into barren and forested lands as well as dune areas. Aquaculture areas will increase at the expense of wetlands and natural forests will decrease which industrial forests will increase slightly.



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Annual GDP % growth 1995 in coastal provinces

Fig No II.3 - 2

II.3.4 Demographics

The Vietnam Government General statistics Office has carried out population projections for the whole country using the 1989 census results. Based on these findings, the derived projection for 2005 has been further extrapolated to the year 2025 for each coastal province. In population growth rate estimates is the fact that, in fast developing and commercially successful provinces, the basic growth rate or birth rate, is lower than in the poorer, less developed provinces. The projections to 2025 also take account of the "internal migration" from mountains and rural provinces to the developing coastal provinces and the new industrialised economic zones and cities. The resulting growth rates per region are given in Tables II.3-1.

The internal migration will be stimulated, especially in the first part of the 30-year period, by the important trends in regional developments, job opportunities and social enhancements. For example, the southern central coastal provinces will show the largest population growth (ave. 2.1% p.a.). This is mainly due to the inclusion in this region of the SFEZ which will experience the highest population growth in the nation over the coming decades of about 2.5% p.a.. Similar trends in the north of Vietnam, toward the Northern Focus Economic Zone of Hanoi - Haiphong region will result in a mean annual growth rate of just over 2% over the coming decades in that area.

The population of the Central Coast Regions will also be subject to the demands of development in that region and the Government's success in promoting and revitalising the Central part of Vietnam.

Employment patterns will show a clear redistribution from agriculture towards industry, manufacturing, trade and construction. This will be reflected in agricultural employment from 72% in 1995 to below 20% in 2025.

II.3.5 30 year analysis factors

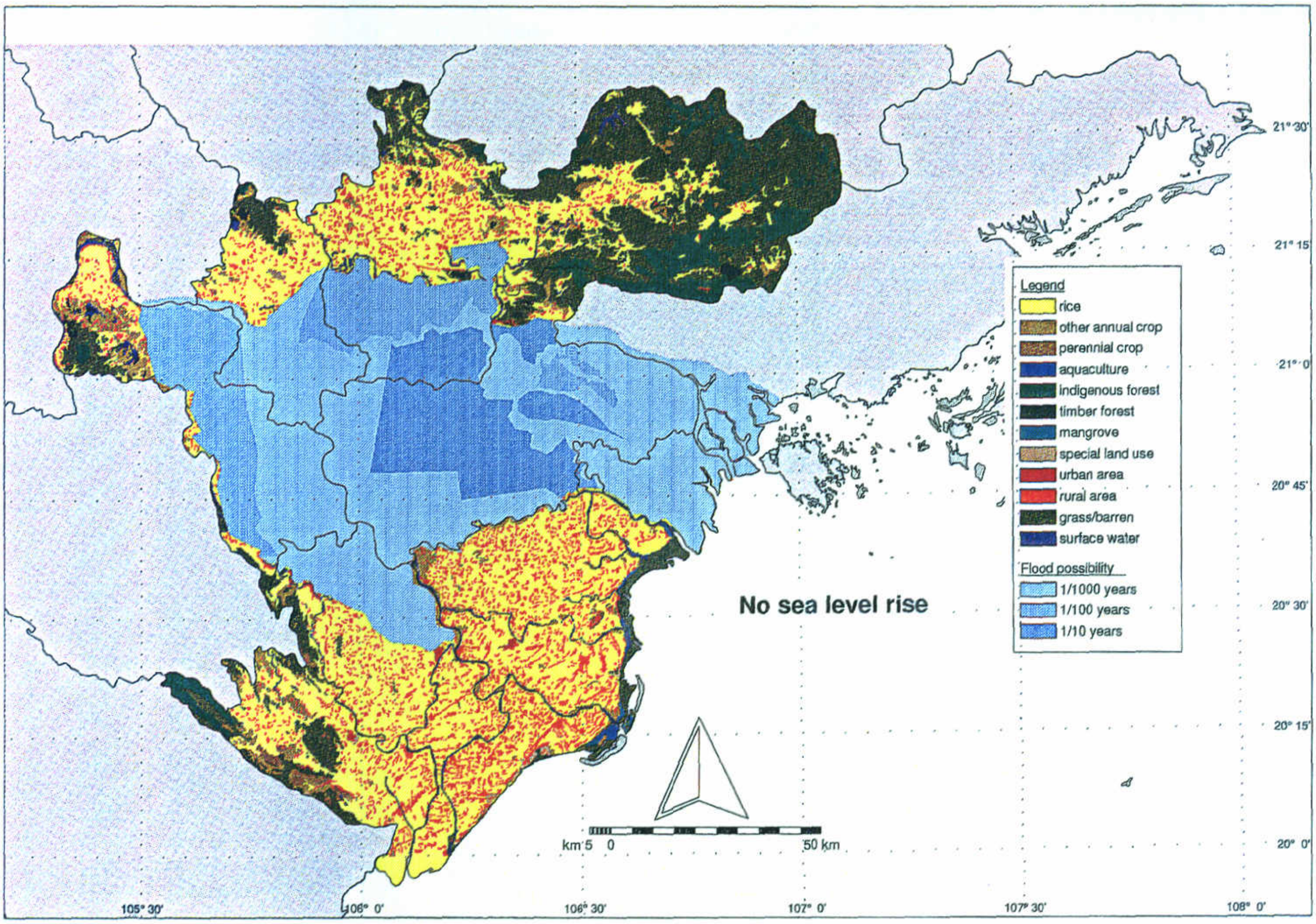
For the purposes of the VA analysis the analysis factors required for the year 2025 relate to projected land use patterns, population figures and capital values. The parameters were implemented by establishing the revised land use distribution in the impact zone and applying new population densities and capital values per sq.m. consistent with the reported demographic and economic trends.

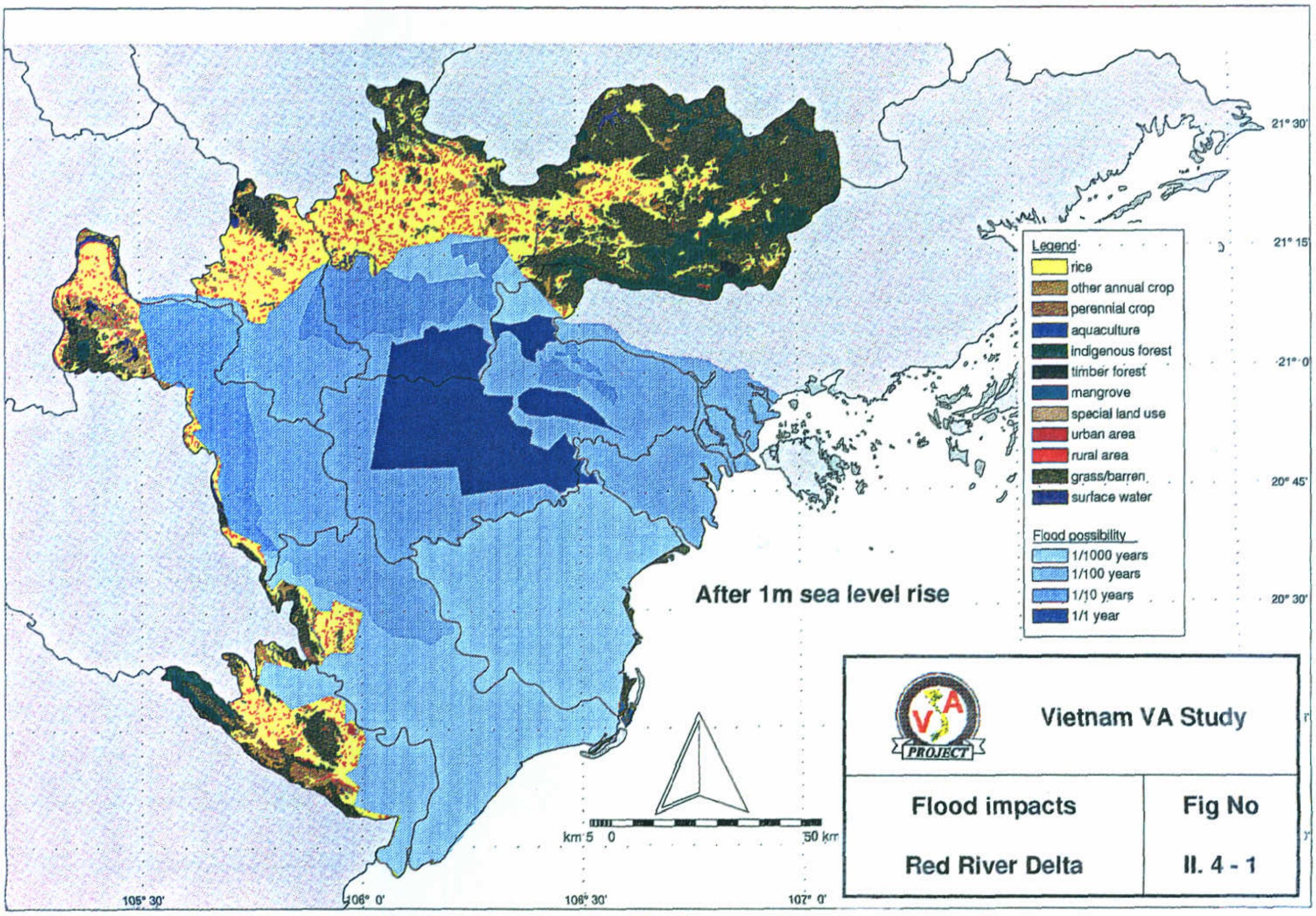
The effects of these factors can be seen in Table II.3-2 which provides an inventory of the population and areas per land use class and impact zone.

The land use changes in the impact zone were imposed by use of "redistribution factors" that varied from province to province. These factors were applied to redistribute areas in 2 categories :

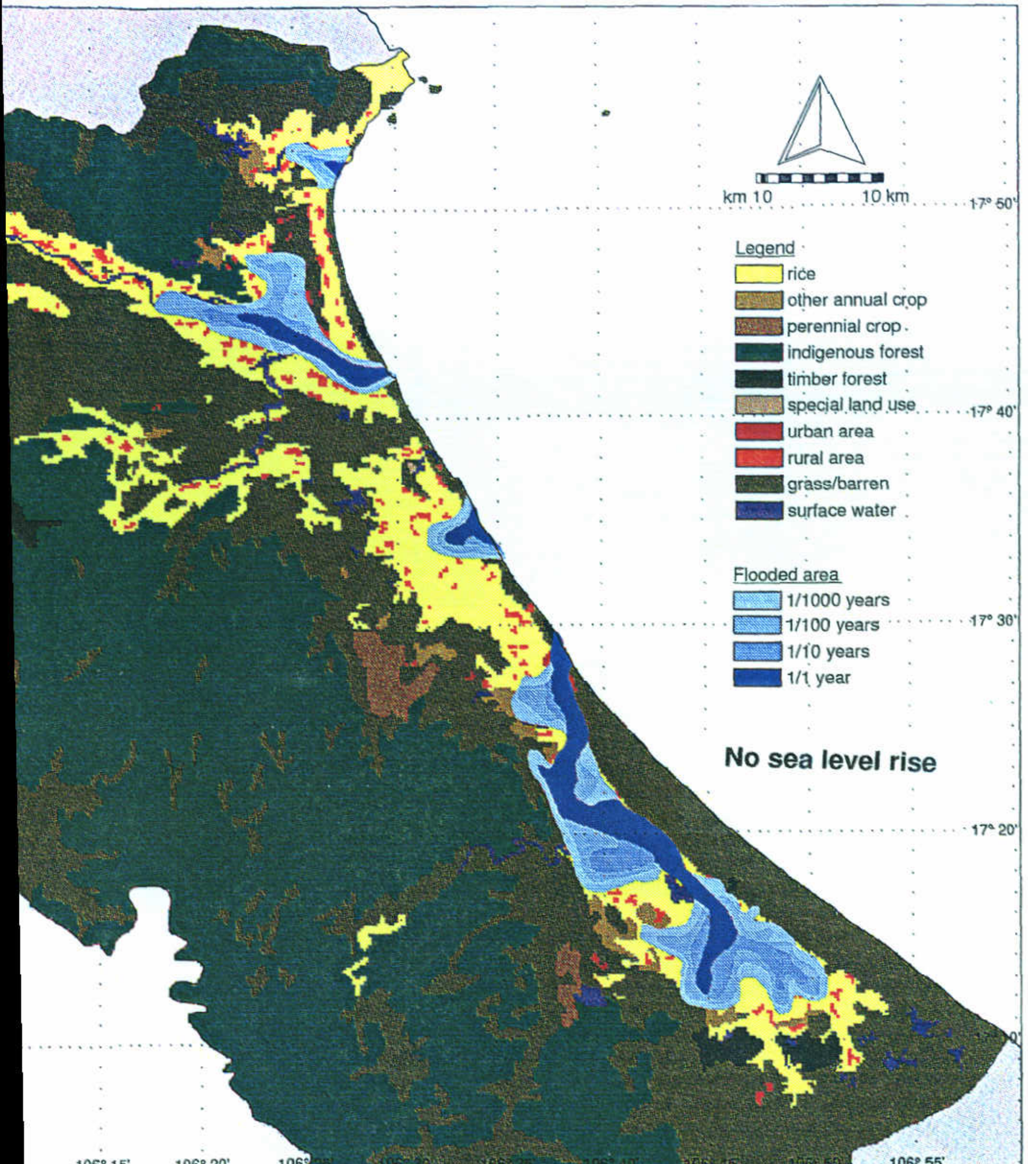
- agricultural lands to industrial and rural residential lands (farmlands to towns/villages)
- rural residential areas to urban residential areas (towns/villages to cities)

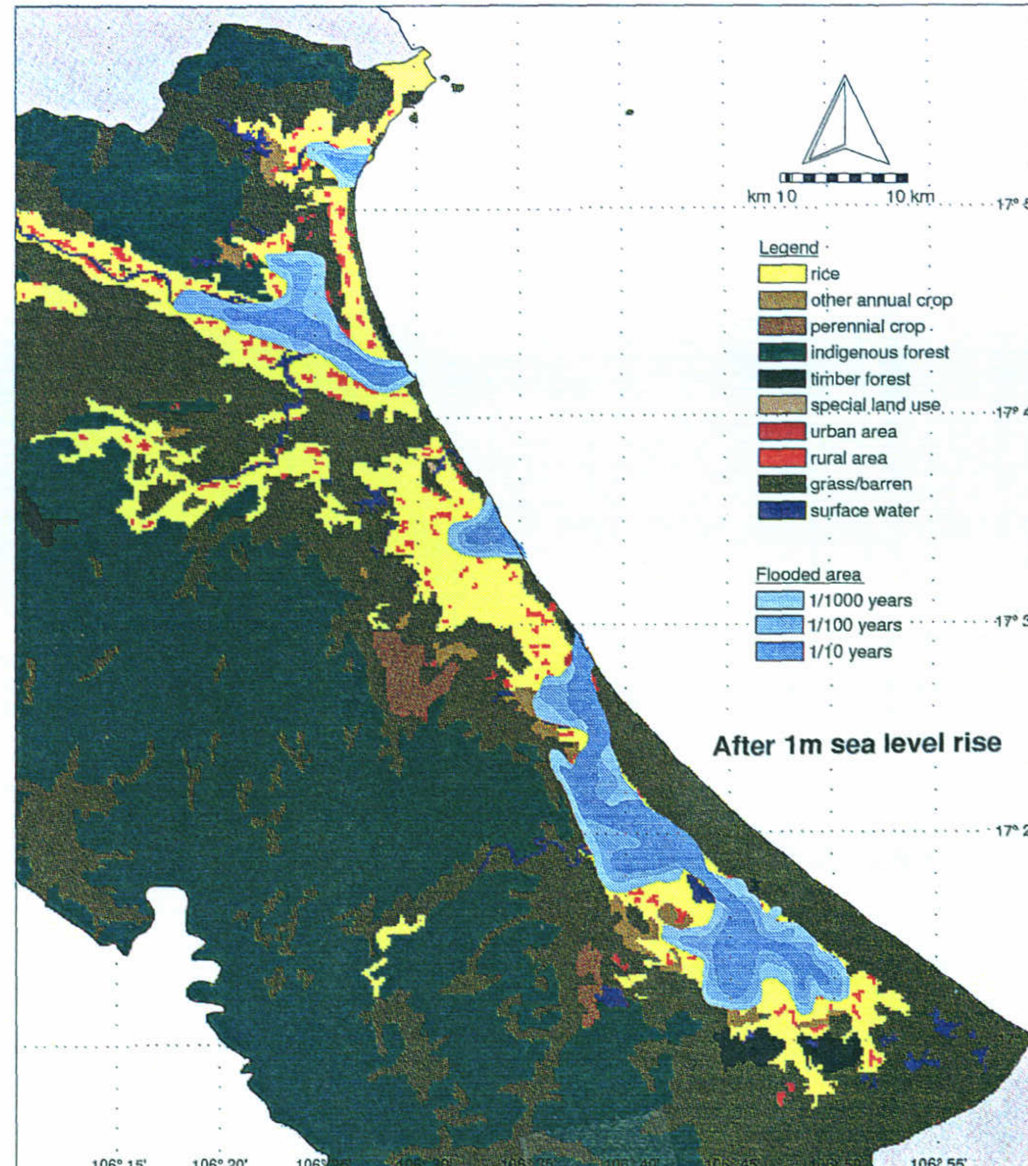
The factors used caused a redistribution of land annually which progressively led to the 30 year resulting distribution in 2025.



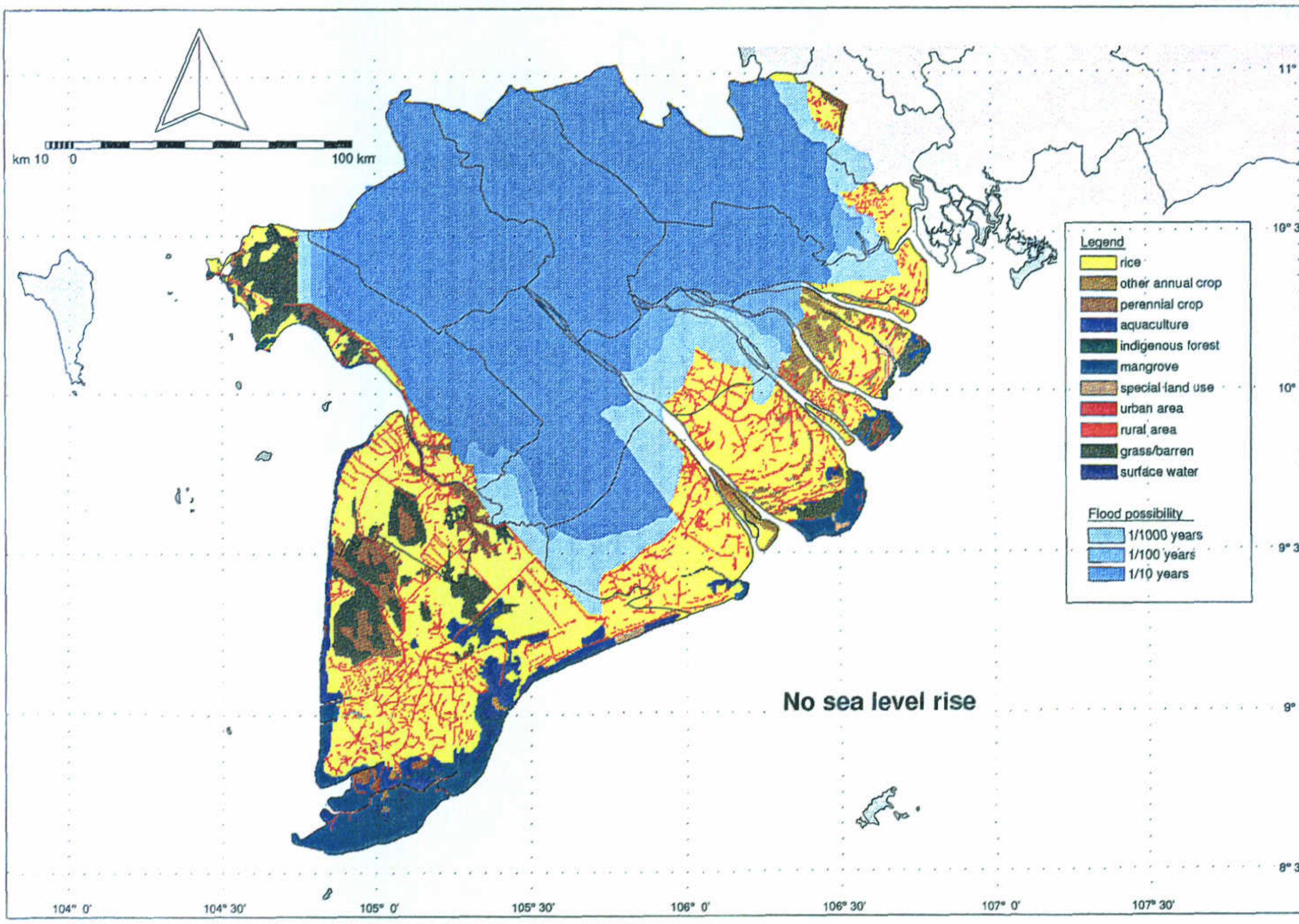


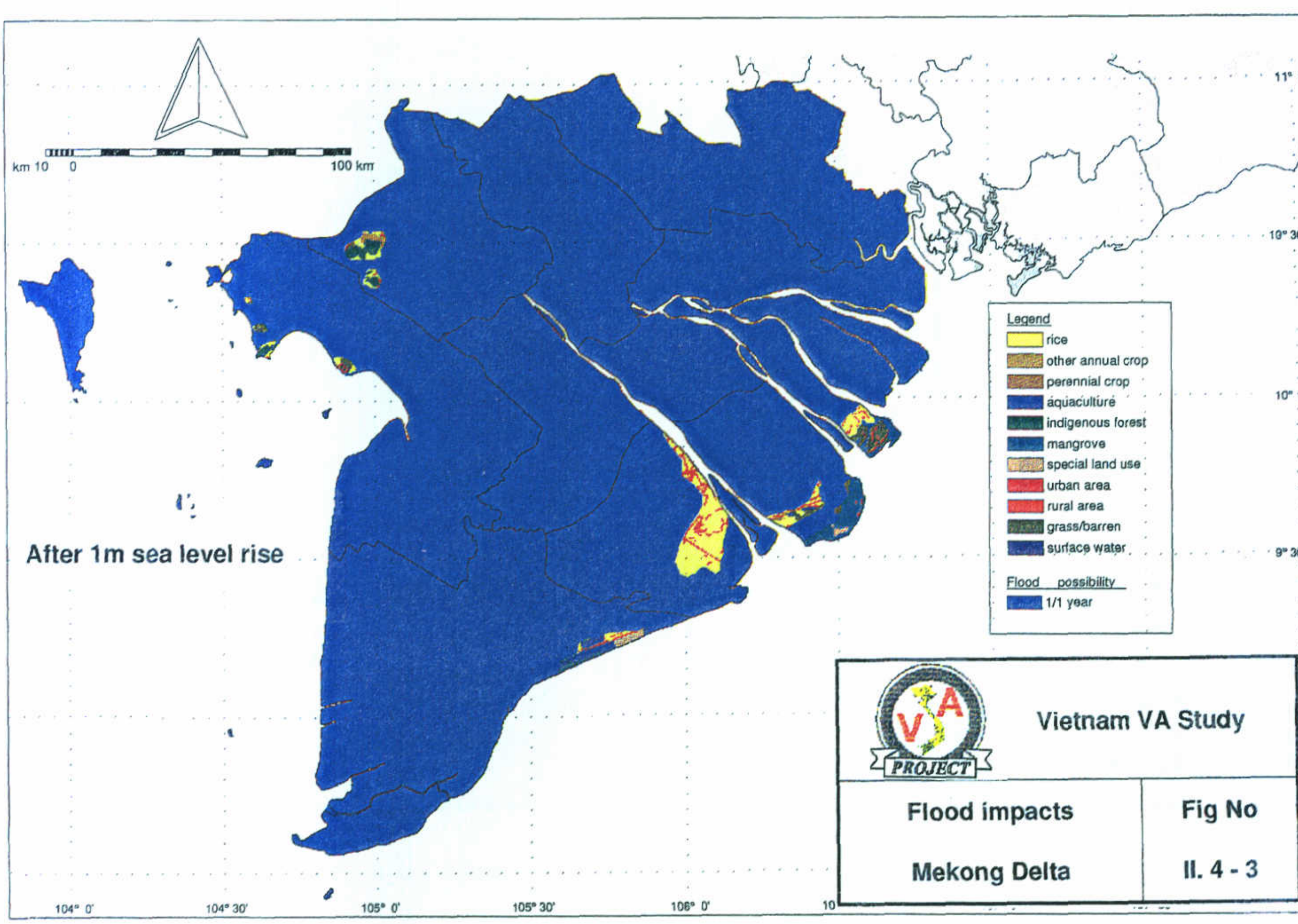
Vietnam VA Study	
Flood impacts	Fig No
Red River Delta	II. 4 - 1





Vietnam VA Study	
Flood impacts Quang Binh Province Central Coast	Fig No II. 4 - 2





Vietnam VA Study

Flood impacts	Fig No
Mekong Delta	II. 4 - 3

TABLE2D

Table II.3-2
SOCIO ECONOMIC SYSTEM DATA
INVENTORY OF POPULATION
LAND USE TYPES AND CAPITAL VALUES
IN THE STUDY AREA - 2025

		NO SEA LEVEL RISE					1m SEA LEVEL RISE				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
	UNIT		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
POPULATION BELOW +10m HD :											
Population in 1000 year flood zone	thous.pers.	30.33	11.67	4.63	0.57	13.46	44.51	17.15	5.15	1.46	20.75
Population in 100 year flood zone	thous.pers.	23.27	7.34	4.34	0.37	11.22	38.35	11.68	4.62	1.30	20.75
Population in 10 year flood zone	thous.pers.	18.14	2.07	3.42	2.25	10.40	29.42	4.00	3.57	1.10	20.75
Population in 1 year flood zone	thous.pers.	0.00	0.00	0.00	0.00	0.00	23.97	1.66	0.63	0.93	20.75
LAND USE BELOW +10m HD :											
Total area in 1000 year flood zone (TIZ)	sq.km.	34046	6847	5647	717	20835	56652	11343	6376	1673	37260
Distributed as											
Rice	sq.km.	21864	4543	3367	378	13576	33915	7383	3773	850	21909
Other crops	sq.km.	1110	293	197	53	567	1842	413	228	75	1126
Fruit tree cultivation	sq.km.	1115	4	3	5	1103	1971	11	5	41	1914
Aquaculture	sq.km.	67	42	25	0	0	986	64	25	1	896
Forest (indigenous)	sq.km.	93	0	37	41	15	136	0	43	60	33
Forest (planted for timber)	sq.km.	53	6	40	7	0	81	20	51	10	0
Mangrove	sq.km.	226	13	147	66	0	1797	20	163	335	1279
Special lands (for construction etc..)	sq.km.	148	66	38	2	42	284	115	48	3	118
Urban residential	sq.km.	284	132	51	27	74	427	193	56	49	129
Rural residential	sq.km.	5287	1197	693	35	3362	8977	2187	779	91	5920
Grasslands	sq.km.	2693	179	629	84	1801	4842	347	762	119	3614
Surface water	sq.km.	1106	372	420	19	295	1394	590	443	39	322
Total area in 100 year flood zone	sq.km.	26817	3351	5232	490	17744	51280	6847	5693	1480	37260
Distributed as											
Rice	sq.km.	17272	2356	3136	217	11563	30526	4543	3359	715	21909
Other crops	sq.km.	847	153	175	42	477	1683	293	199	65	1126
Fruit tree cultivation	sq.km.	922	3	3	1	915	1958	4	3	37	1914
Aquaculture	sq.km.	28	6	22	0	0	963	42	25	0	896
Forest (indigenous)	sq.km.	92	0	37	40	15	127	0	40	54	33
Forest (planted for timber)	sq.km.	42	3	35	4	0	56	6	42	8	0
Mangrove	sq.km.	200	0	140	60	0	1787	13	160	335	1279
Special lands (for construction etc..)	sq.km.	93	27	33	1	32	224	66	38	2	118
Urban residential	sq.km.	208	82	50	18	58	356	132	51	44	129
Rural residential	sq.km.	3933	575	643	24	2691	7886	1197	690	79	5920
Grasslands	sq.km.	2357	36	558	65	1698	4557	179	663	101	3614
Surface water	sq.km.	823	110	400	18	295	1156	372	423	39	322
Total area in 10 year flood zone	sq.km.	22464	1422	4178	312	16552	45842	2810	4521	1251	37260
Distributed as											
Rice	sq.km.	14629	1073	2424	110	11022	27142	2086	2599	548	21909
Other crops	sq.km.	430	20	153	24	233	1420	88	151	55	1126
Fruit tree cultivation	sq.km.	843	2	2	0	839	1952	3	2	33	1914
Aquaculture	sq.km.	19	0	19	0	0	918	0	22	0	896
Forest (indigenous)	sq.km.	84	0	35	34	15	120	0	34	53	33
Forest (planted for timber)	sq.km.	36	3	30	3	0	45	3	37	5	0
Mangrove	sq.km.	167	0	112	55	0	1764	0	153	332	1279
Special lands (for construction etc..)	sq.km.	64	10	25	1	28	163	17	26	2	118
Urban residential	sq.km.	120	15	41	12	52	235	28	43	35	129
Rural residential	sq.km.	3259	251	501	10	2497	6990	486	516	68	5920
Grasslands	sq.km.	2104	17	469	47	1571	4271	26	550	81	3614
Surface water	sq.km.	709	31	367	16	295	822	73	388	39	322
Total area in 1 year flood zone	sq.km.	0	0	0	0	0	40768	1302	1138	1068	37260
Distributed as											
Rice	sq.km.						23702	983	377	433	21909
Other crops	sq.km.						1201	15	20	40	1126
Fruit tree cultivation	sq.km.						1948	2	0	32	1914
Aquaculture	sq.km.						909	0	13	0	896
Forest (indigenous)	sq.km.						86	0	7	46	33
Forest (planted for timber)	sq.km.						28	2	22	4	0
Mangrove	sq.km.						1731	0	122	330	1279
Special lands (for construction etc..)	sq.km.						130	9	2	1	118
Urban residential	sq.km.						184	14	14	27	129
Rural residential	sq.km.						6276	230	73	53	5920
Grasslands	sq.km.						3928	17	233	64	3614
Surface water	sq.km.						645	30	255	38	322
CAPITAL VALUE											
CV of all land in 1000 year flood zone	mill.US$	314616	203856	10338	14344	86078	481638	221617	11806	106380	141835
CV of all land in 100 year flood zone	mill.US$	271284	177475	9510	13216	71083	461667	203857	10399	105576	141835
CV of all land in 10 year flood zone	mill.US$	94454	8455	7480	12496	66023	266300	13270	8034	103161	141835
CV of all land in 1 year flood zone	mill.US$	0	0	0	0	0	249129	4394	1391	101509	141835

A revised population density per land use class was assigned to all the coastal provinces, taking care that the demographic trends of the overall 30-year scenario were well adhered to. The revised population densities were a result of not only the reported growth rates from 1995 to 2025 per province but also the result of increased population densities in cities and towns within the coastal zone. These secondary trends were applied with adjustment factors similarly to land area redistribution. (The revised population densities per land use class and per region are shown in Table II.2-10).

Revised land prices (capital values) were assigned for use with land use results for the 2025 scenario. These were assigned in the same way as for the 1995 prices but by using reported inflation trends and elevated ICOR values which reflect the increased prosperity of the various categories.

II.4 Step 4 : Physical effects and natural system responses

Flooding - inundation by dyke failure and inadequate drainage

The dominant physical impact of sea level rise will be increased flooding. What is in 1995 an extreme high water level may become, in 100 years' time, a commonplace or annual water level. This holds true for the coastal sea levels as well as for the river flood levels which, due to morphological development of the river bed in the flood plains and deltas, will closely follow the rate of rise of the downstream sea levels.

At the coastline the sea water level rise of 1m exceeds the present increase from the 1 in 1 year sea level to the 1 in 1000 year water level, indicating that the event which has a 1000 year return period in 1995 may occur annually in 100 years time. Inland, in the rivers, the water levels in extreme events are significantly higher than at the coast due to the extreme run-off which occurs in heavy rainfall and the backwater effects. In the rivers, the effects of a 1m sea level rise will increase the frequency of a 100 year event to approximately a 10 year event in the north and an annual event in the south.

In the Red River Delta provinces the nature of flooding is predominantly river flooding at present, most severe during occasions of high storm surges which lift the sea water level and inhibit the discharge of high runoff from heavy rain downpours in the catchment areas. These two events are likely to occur simultaneously and serious flooding can result. At certain locations in the delta the dykes are weaker and lower, relative to their exceedence water levels. At these weak locations in each dyke ring the first flooding normally occurs and this can relieve the flood damage at other locations. Certain parts are flooded in this way as a strategy to dissipate the river flood wave. Severe flooding from the sea due to sea dyke failure is normally prevented by a second line of dyke defences behind the seaward dyke. Managed retreat strategies are applied for the most critical parts of the Red River Delta coast. However, flooding from rivers is more hazardous and more frequent.

In the far south, in the Vung Tau to Ho Chi Minh City areas, the extreme sea water level regime is remarkably stable. At the coast, the absence of severe coastal storms or severe storm surges above the annual monsoon events means that there is only a very small difference between the 1 in 10 year water level and the 1 in 1000 year water level, often less than 20cm difference. In Vung Tau for example, there is no record of serious flooding and the People's Committee are among the fortunate few PC's in the country with no flood mitigation problems. This has led to an infrastructure which takes advantage of these stable water levels. Entire towns and settlements live with almost no protection from water levels above the annual maxima. In Ho Chi Minh City itself the port and riverside developments have been designed to cope only with the tidal range and a small allowance for some monsoon storm surge or river flooding, with generally low freeboard at high spring tide.

In the Mekong Delta, severe flooding is frequent due to the high run off from the Mekong River catchments. However, because of the broad and flat delta and the wide river mouths, a similarly stable regime exists even 100 km inland at locations such as Can Tho City (88 km inland) and Long Xuen (150 km inland). The severe river floods that frequently (less than 1 in 10 years) occur cause an elevation of about 1 to 1.5 m at these locations. Less frequent hence more extreme floods only cause a small increase in this level of less than 20cm.

As a result of the stability of the extreme sea water levels in the far south and on the Mekong Delta, the effects of a rise in the mean sea level will be devastating on these regions requiring major protection efforts and infrastructure changes.

In the GIS analyses, flooded areas were deduced and overlayed with land use to provide the land use areas within various flood frequency bands. After sea level rise the new elevated water levels and flood frequencies were applied from the coast upstream along rivers to the elevation contour of +10m HD. Examples for the Red River Delta, Quang Binh Province - Central Coast and the Mekong Delta are shown in Figures II.4-1 to II.4-3 respectively.

Following the GIS and FFR analyses performed on the topographical, land use, population and capital value data, the resulting losses and risks due to flooding were quantified (in the event of a no response being made).

With respect to land areas and land use, a summary of the results is provided in Table II.4-1 for the four coastal regions and for the whole nation. In Appendix A the details per province are provided. The summary shows the following :

ASLR0 (with no sea level rise):

- just over 2,000 km2 of the coastal zone of Vietnam is at risk of annual flooding and that the Mekong Delta accounts for 75% of that total and the Red River Delta less than 10%;

ASLR1 (with 1m sea level rise) - and no additional protection measures:

- about 40,000 km2 of the coastal zone of Vietnam will be subject to annual flooding after a sea level rise of 1m. Over 90% of this land will be in the Mekong Delta provinces which will be almost completely inundated annually;

The analysed impacts of these losses and risks on population and capital value are expressed in Step 5 (Section II.5).

Salinity intrusion

Salinity intrusion in the coastal zone is increasing due to fresh water extraction for irrigation

TABLE II.4–1
PHYSICAL EFFECTS AND NATURAL SYSTEM RESPONSES :
REGIONAL AND NATIONAL SUMMARY
1995 & 2025

		NO SEA LEVEL RISE					1m SEA LEVEL RISE				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
	UNIT		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
COASTAL WATER LEVELS :											
Representative province			Nam Ha	TT–Hue	Phu Yen	Minh Hai		Nam Ha	TT–Hue	Phu Yen	Minh Hai
1000 year sea level	m HD		2.6	1.6	1.3	1.3		3.6	2.6	2.3	2.3
100 year sea level	m HD		2.5	1.5	1.2	1.2		3.5	2.5	2.2	2.2
10 year sea level	m HD		2.2	1.3	1.1	1.2		3.2	2.3	2.1	2.2
1 year sea level	m HD		1.8	0.5	1.0	0.8		2.8	1.5	2.0	1.8
LAND AREAS											
Land area of whole nation / region	sq.km.	331000	16536	58313	52573	38360	331000	16536	58313	52573	38360
Land area affected (1000 year flood prone area)	sq.km.	34046	6847	5647	717	20835	56652	11343	6376	1673	37260
Land area affected as percentage of national area	%	10.3	2	2	0.3	6	17.1	3	2	0.3	11
Land area affected as percentage of regional area	%		41	10	1	54		69	11	3	97
Land area at risk (of annual flooding)	sq.km.	2020	149	161	39	1670	793	198	518	79	50
Land area at risk as percentage of national area	%	0.6	0.05	0.05	0.01	0.50	0.2	0.1	0.2	0.02	0.02
Land area at risk as percentage of regional area	%		0.90	0.28	0.07	4.35		1.2	0.9	0.2	0.1
Land area lost (annually flooded)	sq.km.	0	0	0	0	0	40768	1302	1138	1068	37280
Land area lost as percentage of national area	%	0	0	0	0	0	12.3	0.4	0.3	0.3	11.3
Land area lost as percentage of regional area	%		0	0	0	0		8	2	2	97
LAND USE AREAS AT LOSS 1995 (annually inundated) :											
Rice fields	sq.km.	0	0	0	0	0	24737	1013	388	462	22874
Other crops, vegetables	sq.km.	0	0	0	0	0	1194	16	21	0	1157
Orchards, tree and bush crops	sq.km.	0	0	0	0	0	2039	2	0	35	2002
Aquaculture	sq.km.	0	0	0	0	0	965	0	14	0	951
Forest (indigenous)	sq.km.	0	0	0	0	0	90	0	8	48	34
Forest (planted for timber)	sq.km.	0	0	0	0	0	29	2	23	4	0
Mangrove	sq.km.	0	0	0	0	0	1731	0	122	330	1279
Special lands (for construction etc..)	sq.km.	0	0	0	0	0	41	0	0	0	41
Urban residential	sq.km.	0	0	0	0	0	51	1	11	26	13
Rural residential	sq.km.	0	0	0	0	0	5276	221	64	19	4972
Grasslands	sq.km.	0	0	0	0	0	3928	17	233	64	3614
Surface water	sq.km.	0	0	0	0	0	645	30	255	38	322
LAND USE AREAS AT LOSS 2025 (annually inundated) :											
Rice	sq.km.	0	0	0	0	0	23700	983	377	432	21908
Other crops	sq.km.	0	0	0	0	0	1202	16	20	40	1126
Fruit tree cultivation	sq.km.	0	0	0	0	0	1948	2	0	32	1914
Aquaculture	sq.km.	0	0	0	0	0	909	0	13	0	896
Forest (indigenous)	sq.km.	0	0	0	0	0	86	0	7	46	33
Forest (planted for timber)	sq.km.	0	0	0	0	0	28	2	22	4	0
Mangrove	sq.km.	0	0	0	0	0	1731	0	122	330	1279
Special lands (for construction etc..)	sq.km.	0	0	0	0	0	130	9	2	1	118
Urban residential	sq.km.	0	0	0	0	0	184	14	14	27	129
Rural residential	sq.km.	0	0	0	0	0	6276	230	73	53	5920
Grasslands	sq.km.	0	0	0	0	0	3928	17	233	64	3614
Surface water	sq.km.	0	0	0	0	0	645	30	255	38	322

and drinking water and due to dam constructions in some catchments. Accelerated rates of sea level rise will cause a higher penetration of saline water into rivers, creeks and streams as well as into the groundwater systems. This will cause an increased freshwater pumping requirement in some areas from deeper wells leading to subsidence and a worsening of the problem.

In this study, due to the localised nature and complexity of the problem, salinity intrusion problems have been dealt with only in a qualitative manner. It is important that this aspect receives more attention in site specific follow on work. The same was indicated in the Mekong Masterplan Report (ref 12) which estimated that a sea level rise of only 30cm would cause an additional intrusion of the salinity limit (1 part per thousand) of up to 10km in the main branches of the tributaries of the Mekong Delta. However it was noted that more detailed studies were required. A sea level rise of 1m could push the saline water tens of kilometers inland and could be devastating for rice production. This effect has not been quantified in this analysis. For the case of no additional protection measures being taken for flooding the flooding problems will dominate. In many areas and particularly in the Mekong Delta, the salinity damage to crops will be outweighed by the flood damage.

Coastal erosion

Losses due increased beach and foreshore erosion will also be severe but have not been quantified in this study. The increase in coastal water levels will cause increased wave attack on the coastal beaches. In turn, the beaches and foreshores will require nourishment and if this is not provided artificially by beach nourishment then the demand for material may be met naturally by erosion of the coastal dune systems. The areas most sensitive to this effect are the north central coast where the narrow coastal dune field protects lagoons and low lying areas of hinterland, (at the Tam Giang Lagoon in Thua Thien Hue Province for example).

II.5 Step 5 : Response strategies

II.5.1 Strategy options

One response option to the threat of accelerated sea level rise is the *"no measures"* response which simply is the response of only continuing with the present maintenance effort without any additional response to prepare for sea level rise impacts.

Options for actively responding to the impacts of an accelerated rate of sea level rise are summarised into three main categories as follows:

Full protection

"Full protection" implies a response which implements sufficient protection to preserve the present status of the study area in the face of accelerated sea level rise. In Vietnam, a strategy of full protection would require a complete raising of all dykes and strengthening of coastal defences, including the addition of dykes in some areas. Additional salinity intrusion prevention measures would be required and a huge pumping effort would be required to alleviate drainage problems. Raising of land would also be required to offset these effects.

Adaptation

"Adaptation" is a response which implements changes to the infrastructure and life styles of the affected area and its population such that the impacts of accelerated sea level rise can be tolerated. This implies accepting some losses and investing in new "adaptive" infrastructure and agricultural techniques. Raising of houses to avoid more frequent floods of deeper inundation would be part of an adaptation strategy.

Retreat

"Retreat" is the response of withdrawal. The natural impacts of accelerated sea level rise are escaped by relocating of housing and infrastructure and abandoning of coastal lands. Creation of a set-back line within which no building or development activity can take place would be an example of the retreat strategy. Also, retreat can be used to allow the natural landward migration of wet lands as a response to sea level rise.

In practice, for a small local area, any one of the above can be realistic and feasible. However, over the whole region or province or nation, a realistic response strategy is a combination of each of these strategies. For example in the Red River Delta which already has a reasonable well established system of dyke protection, it may be feasible to consider dyke raising and additional pumping as "realistic" response strategies that are physically achievable. However, in the Mekong Delta where the existing dykes are weak and very low and where dyke building can have hazardous consequences on upstream water levels (eg in neighbouring Cambodia) a full protection strategy will be dangerous and damaging and a combined strategy of protection-adaptation-retreat measures would be more realistic.

The strategies will need to be developed over time to keep pace with the impacts both occurring and predicted.

For the purposes of this report we adopt a definition of "protection" as :

"the implementation of all feasible protection measures to minimise losses and risks of losses of land in the coastal zone, and to minimise impacts and risks to the inhabitants as well as the capital value of such lands, preserving and protecting as far as possible the present physical, socio-economic and ecological status and quality of life of the study area".

This will be a combination of the three strategies described above. To meet the requirements of the defined "protection" strategy will require the following three steps :

(i) continued maintenance of existing defences, without any sea level rise

(ii) implementation of a development plan for upgrading of existing protection defences to reduce risks of flooding, without any sea level rise

(iii) construction and implementation of new measures specifically to protect against accelerated sea level rise (1m)

In this report we define three main protection strategies:

"No measures" = (i) only
"Development plan for improved protection" = (i) + (ii)
"Protection" = (i) + (ii) + (iii)

Quantification of the efforts and investments required to carry out these steps has been set-out in the Appendices of *Report No.2* (ref 6). A summary is provided below.

In Table II.5.1a & II.5.1b a breakdown in initial and annual costs (respectively) is given for each of (i), (ii) and (iii) above. Table II.5.2 provides the unit costs applied and Table II.5.3 provides the lengths and areas of protective measures. A detailed breakdown per province is given in Appendix A.

II.5.2 Maintenance of existing defences, without any sea level rise

Continued maintenance of existing dykes

The total cost of dyke maintenance per year at present is US$ 4.3 million p.a. with the highest cost being US$ 579,000 p.a. in Nam Ha Province of the Red River Delta.

Sea and estuary dykes

The total annual budget for maintenance of sea and estuary dykes is US$ 1.54 million.

In general the sea and estuary dykes are underdesigned for the natural forces and processes that they are required to withstand and this results in high maintenance requirements or acceptance of high damage and some land losses. Armouring is often limited to stone sizes that may be placed by women labourers. Typical cross sections of existing sea dykes in some provinces are provided in Figure II.5-1.

Construction and maintenance of sea and estuary dykes in the north are routinely supported by government investment funds whereas in the central and southern coastal areas only the improved revetment of selected dyke lines is centrally funded. Government funding is called in for repair of dykes in the case of emergency rehabilitation. The highest national cost for annual maintenance is in Nam Ha Province where serious annual erosion and overtopping of sea dykes occurs, requiring about US$ 2656 per km per year. Elsewhere in the north, maintenance costs are about US$1,000 per km per year, while in the central and southern provinces they are about US$300 to 800 per km per year.

In most cases, throughout the nation, the existing maintenance costs present great difficulty and a strain on limited resources, often resulting in a shortfall. Local people are expected to contribute 10 working days per person per year to upkeep of their local dykes.

A strategy of managed retreat by necessity is implemented on the most sensitive parts of the Red River coast where stretches of some sea dyke lines are abandoned and new dykes are built in a second row about 200m behind the failing seaward dyke. The result is that flooding from sea is limited to the area between the dyke lines which is "lost".

TABLE II.5–1a SUMMARY OF IMPLEMENTATION COSTS PROTECTION STRATEGY : REGIONAL AND NATIONAL SUMMARY 1995		NO SEA LEVEL RISE NO DEVELOPMENT PLAN					NO SEA LEVEL RISE WITH DEVELOPMENT PLAN					1m SEA LEVEL RISE WITH DEVELOPMENT PLAN AND ADDITIONAL MEASURES				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
			Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
	UNIT															
SUMMARY OF INITIAL COSTS																
MAINTENANCE OF EXISTING DYKES :		(no initial costs, only annual costs)														
DEVELOPMENT PLANS :																
Upgrade sea & estuary dykes	US$ mill.						320.0	135.8	121.6	45.6	17.0	320.0	135.8	121.6	45.6	17.0
Upgrade river dykes	US$ mill.						271.5	237.2	33.5	0.7	0.0	271.5	237.2	33.5	0.7	0.0
Upgrade other dykes	US$ mill.						21.2	0.0	0.0	0.0	21.2	21.2	0.0	0.0	0.0	21.2
Construct new sea dykes	US$ mill.						79.5	0.9	31.8	31.0	15.9	79.5	0.9	31.8	31.0	15.9
Construct new river dykes	US$ mill.						21.2	0.0	3.6	17.6	0.0	21.2	0.0	3.6	17.6	0.0
Raise land	US$ mill.						70.3	0.0	36.0	34.3	0.0	70.3	0.0	36.0	34.3	0.0
Raise houses	US$ mill.						3,663.8	0.0	150.0	41.6	3,472.2	3,663.8	0.0	150.0	41.6	3,472.2
Improve pumping	US$ mill.						2,032.5	1,622.8	127.6	5.5	276.6	2,032.5	1,622.8	127.6	5.5	276.6
Beach nourishment (1st year of annual strategy)	US$ mill.						4.4	1.4	1.0	2.0	0.0	4.4	1.4	1.0	2.0	0.0
Construct new groynes	US$ mill.						14.3	5.0	0.9	8.5	0.0	14.3	5.0	0.9	8.5	0.0
TOTAL	US$ mill.	0	0	0	0	0	6498.6	2003.1	506.1	186.5	3802.9	6498.6	2003.1	506.1	186.5	3802.9
ADDITIONAL MEASURES :																
Raise sea dykes	US$ mill.											164.9	38.5	60.5	38.7	27.2
Raise river dykes	US$ mill.											113.5	80.1	24.2	9.2	0.0
Raise other dykes	US$ mill.											58.1	0.0	0.0	0.0	58.1
More raised houses	US$ mill.											1,000.0	0.0	40.9	11.3	947.7
More pumping	US$ mill.											1,000.0	798.4	62.8	2.7	136.1
More beach nourishment	US$ mill.											67.0	0.0	17.0	50.0	0.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,403.5	917.0	205.5	111.9	1,169.1
TOTAL INITIAL COSTS	**US$ mill.**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6,498.6**	**2,003.1**	**506.1**	**186.5**	**3,802.9**	**8,902.1**	**2,920.2**	**711.5**	**298.4**	**4,972.0**

TABLE 4b

TABLE II.5-1b
SUMMARY OF IMPLEMENTATION COSTS
PROTECTION STRATEGY :
REGIONAL AND NATIONAL SUMMARY
1995

		NO SEA LEVEL RISE NO DEVELOPMENT PLAN					NO SEA LEVEL RISE WITH DEVELOPMENT PLAN					1m SEA LEVEL RISE WITH DEVELOPMENT PLAN AND ADDITIONAL MEASURES				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
	UNIT		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
SUMMARY OF ANNUAL COSTS																
MAINTENANCE OF EXISTING DYKES :																
Sea & estuary dykes	US$mil	1.5	0.6	0.7	0.2	<0.1	1.5	0.6	0.7	0.2	<0.1	1.5	0.6	0.7	0.2	<0.1
River dykes	US$mil	2.7	2.2	0.5	<0.1	<0.1	2.7	2.2	0.5	<0.1	<0.1	2.7	2.2	0.5	<0.1	<0.1
Other dykes (polder embankments etc.)	US$mil	0.1	<0.1	0.0	0.0	<0.1	0.1	<0.1	0.0	0.0	<0.1	0.1	<0.1	0.0	0.0	<0.1
TOTAL	US$mil	4.3	2.8	1.2	0.2	0.1	4.3	2.8	1.2	0.2	0.1	4.3	2.8	1.2	0.2	0.1
MAINTENANCE DUE TO DEVELOPMENT PLANS :																
ADDITIONAL MAINTENANCE DUE TO UPGRADING OF DYKES :																
Sea & estuary dykes	US$mil						3.2	1.4	1.2	0.5	0.2	3.2	1.4	1.2	0.5	0.2
River dykes	US$mil						2.7	2.4	0.3	0.0	0.0	2.7	2.4	0.3	0.0	0.0
Other dykes (polder embankments etc.)	US$mil						0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
ADDITIONAL MAINTENANCE OF NEW DYKES :																
Sea & estuary dykes	US$mil						0.8	<0.1	0.3	0.3	0.2	0.8	<0.1	0.3	0.3	0.2
River dykes	US$mil						0.3	<0.1	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	<0.1
MAINTENANCE OF HOUSE RAISING																
House raising	US$mil						3.7	0.0	0.2	0.0	3.5	3.7	0.0	0.2	0.0	3.5
PUMPING MAINTENANCE & RUNNING COSTS :																
10% p.a. of initial pump cost	US$mil						203.2	162.3	12.8	0.5	27.7	203.2	162.3	12.8	0.5	27.7
BEACH NOURISHMENT COSTS :																
Assume 5 years nourishment life	US$mil						4.4	1.4	1.0	2.0	<0.1	4.4	1.4	1.0	2.0	<0.1
TOTAL	US$mil	0	0	0	0	0	218.5	167.4	15.8	3.5	31.7	218.5	167.4	15.8	3.5	31.7
ADDITIONAL MEASURES :																
Raise sea dykes	US$ mill.											1.6	0.4	0.6	0.4	0.3
Raise river dykes	US$ mill.											1.1	0.8	0.2	0.1	0.0
Raise other dykes	US$ mill.											0.6	0.0	0.0	0.0	0.6
More raised houses	US$ mill.											1.0	0.0	0.0	0.0	0.9
More pumping	US$ mill.											100.0	79.8	6.3	0.3	13.6
More beach nourishment	US$ mill.											67.0	0.0	17.0	50.0	0.0
TOTAL	US$mil	0	0	0	0	0	0	0.0	0.0	0.0	0.0	171.4	81.0	24.2	50.8	15.4
TOTAL ANNUAL COSTS	US$mil	4.3	2.8	1.2	0.2	0.1	222.9	170.2	17.0	3.7	31.8	394.2	251.2	41.1	54.5	47.2

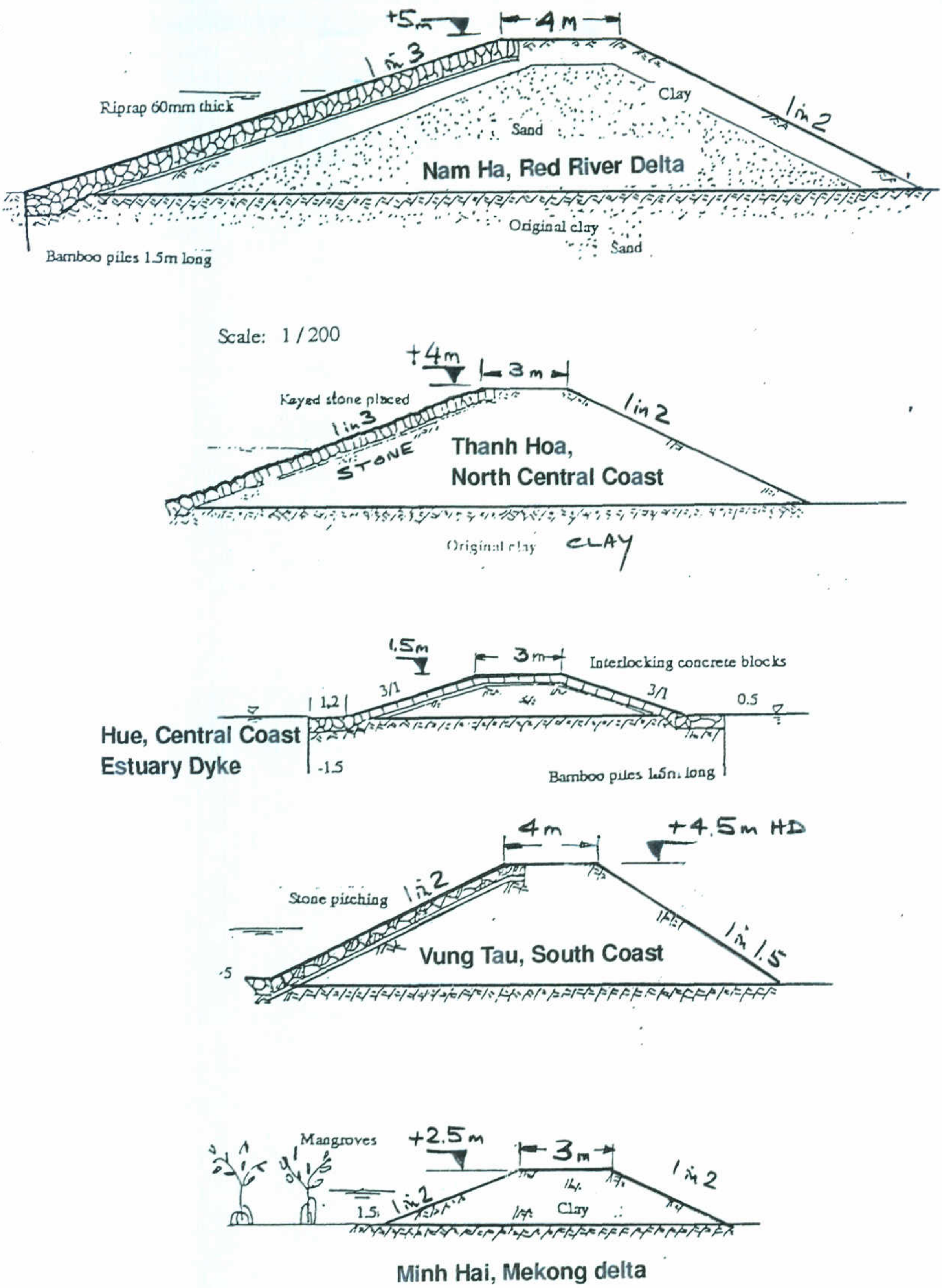
TABLE II.5–2
SUMMARY OF IMPLEMENTATION COSTS
PROTECTION STRATEGY :
REGIONAL AND NATIONAL SUMMARY
1995

	UNIT	WHOLE NATION	COASTAL REGIONS: Red River Delta	North Central Coast	South Central Coast	Mekong Delta
SUMMARY OF INITIAL UNIT COSTS						
MAINTENANCE OF EXISTING DYKES				(annual costs only)		
DEVELOPMENT PLANS :						
Upgrade sea & estuary dykes	US$/km	118,574	368,065	98,405	79,919	32,504
Upgrade river dykes	US$/km	177,081	228,998	69,225	55,231	
Upgrade other dykes	US$/km	6,410				6,410
Construct new sea dykes	US$/km	135,962	110,000	191,765	170,176	69,227
Construct new river dykes	US$/km	58,501		84,558	55,000	
Raise land	US$/ha	40,143		40,000	40,294	
Raise houses	US$/ha	28,509		15,000	15,000	30,000
Improve pumping	US$/ha	2,913	4,716	4,014	1,091	873
Beach nourishment (To be spread over 5 years)	US$/km	1,560,714	1,400,000	1,650,000	1,650,000	
Construct new groynes	US$/km	280,000	380,769	215,000	249,118	
ADDITIONAL MEASURES :						
Raise sea dykes	US$/km	50,217	102,093	43,150	50,764	36,659
Raise river dykes	US$/km	42,161	54,280	27,220	28,034	
Raise other dykes	US$/km	12,000				12,000
Raise houses	US$/ha	28,509		15,000	15,000	30,000
More pumping	US$/ha	2,913	4,716	4,014	1,091	873
Beach nourishment (To be spread over 5 years)	US$/ha	1,560,714	1,400,000	1,650,000	1,650,000	0
SUMMARY OF ANNUAL UNIT COSTS						
MAINTENANCE OF EXISTING DYKES :						
Sea & estuary dykes	US$/km	570	1,617	566	351	
River dykes	US$/km	588	688	362		
Other dykes (polder embankments etc.)	US$/km	36				366
MAINTENANCE DUE TO DEVELOPMENT PLANS :						
ADDITIONAL MAINTENANCE DUE TO UPGRADING OF DYKES : (1% of initial costs)						
Sea & estuary dykes	US$/km	1,186	3,681	984	799	325
River dykes	US$/km	1,771	2,290	692	552	
Other dykes (polder embankments etc.)	US$/km	64				64
ADDITIONAL MAINTENANCE OF NEW DYKES : (1% of initial costs)						
Sea & estuary dykes	US$/km	1,360	1,100	1,918	1,702	692
River dykes	US$/km	585		846	550	
RAISED HOUSES						
0.1% of initial cost	US$/ha	285	0	150	150	300
PUMPING MAINTENANCE & RUNNING COSTS :						
10% p.a. of initial pump cost	US$/ha	291	472	401	109	87
BEACH NOURISHMENT COSTS :						
Assume 5 years nourishment life	US$/km	312,143	280,000	330,000	330,000	0
ADDITIONAL MEASURES :						
Raise sea dykes (1% of initial cost)	US$/km	502	1,021	432	508	367
Raise river dykes (1% of initial cost)	US$/km	422	543	272	280	0
Raise other dykes (1% of initial cost)	US$/km	120	0	0	0	120
More raised houses (0.1% of initial cost)	US$/ha	29	0	15	15	30
More pumping (10% of initial cost)	US$/ha	291	472	401	109	87
More beach nourishment (5 year life)	US$/km	312,143	280,000	330,000	330,000	0

TABLE4 - km&ha

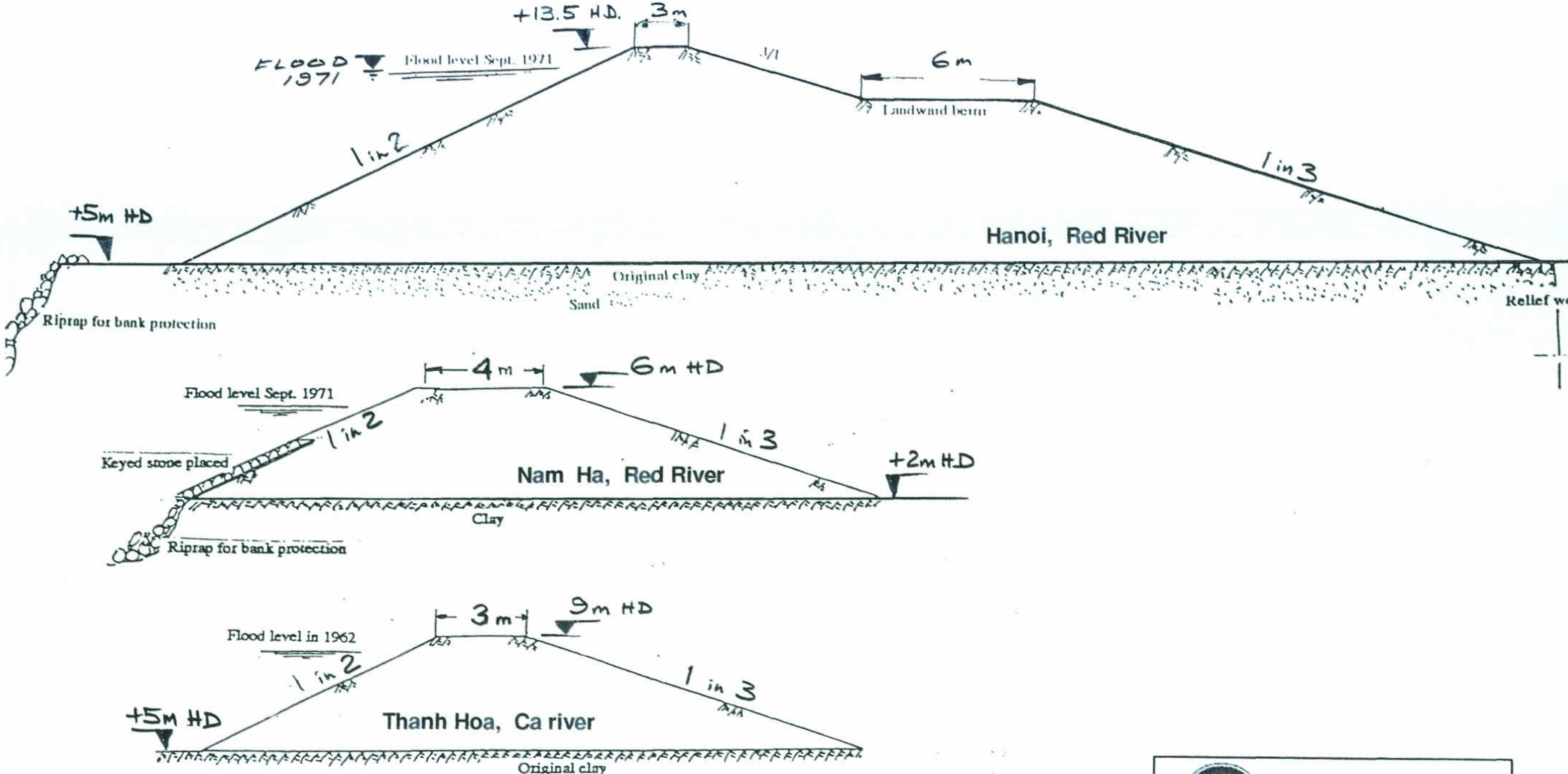
TABLE II.5-3
SUMMARY OF IMPLEMENTATION COSTS
PROTECTION STRATEGY :
REGIONAL AND NATIONAL SUMMARY
1995

		NO SEA LEVEL RISE NO DEVELOPMENT PLAN					NO SEA LEVEL RISE WITH DEVELOPMENT PLAN					1m SEA LEVEL RISE WITH DEVELOPMENT PLAN AND ADDITIONAL MEASURES				
		WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS				WHOLE NATION	COASTAL REGIONS			
			Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta		Red River Delta	North Central Coast	South Central Coast	Mekong Delta
	UNIT															
SUMMARY OF LENGTHS AND AREAS																
MAINTENANCE OF EXISTING DYKES :																
Sea & estuary dykes	km	2701	371	1236	570	524	2701	371	1236	570	524	2701	371	1236	570	524
River dykes	km	4593	3197	1383	13	0	4593	3197	1383	13	0	4593	3197	1383	13	0
Other dykes (polder embankments etc.)	km	2754	0	0	0	2754	2754	0	0	0	2754	2754	0	0	0	2754
DEVELOPMENT PLANS :																
Upgrade sea & estuary dykes	km						2699	369	1236	570	524	2699	369	1236	570	524
Upgrade river dykes	km						1533	1036	484	13	0	1533	1036	484	13	0
Upgrade other dykes	km						3306	0	0	0	3306	3306	0	0	0	3306
Construct new sea dykes	km						585	8	166	182	229	585	8	166	182	229
Construct new river dykes	km						363	0	43	320	0	363	0	43	320	0
Raise land	ha						1750	0	900	850	0	1750	0	900	850	0
Raise houses	ha						128510	0	10000	2770	115740	128510	0	10000	2770	115740
Improve pumping	ha						697765	344100	31800	5000	316865	697765	344100	31800	5000	316865
Beach nourishment	km						14.0	5	3	6	0	14	5	3	6	0
Construct new groynes	km						51	13	4	34	0	51	13	4	34	0
ADDITIONAL MEASURES :																
Raise sea dykes	km											3,284.0	377.0	1,403.0	762.0	742.0
Raise river dykes	km											2,691.0	1,476.0	888.0	327.0	
Raise other dykes	km											4,844.0				4,844.0
More raised houses	ha											35,076.1		2,729.4	756.1	31,590.6
More pumping	ha											343,305.7	169,299.8	15,645.8	2,460.0	155,900.0
More beach nourishment	km											214.6		51.5	151.5	



Scale 1 in 200
Levels to Hon Dau Datum
Dimensions in meters

VA PROJECT	Vietnam VA Study
Examples of Sea Dykes	**Fig No II.5 - 1**



Scale 1 in 200
Levels to Hon Dau Datum
Dimensions in meters

Vietnam VA Study	
Examples of River Dykes	Fig No II.5 - 2

River dykes

The annual maintenance cost for river dykes is US$ 2.8 million p.a..

River dykes are also underdesigned (crest too low) for the natural forces and processes that they are required to withstand and this increases the maintenance requirements and lowers the safety level. Typical cross sections of existing river dykes in some provinces are provided in Figure II.5-2.

The highest national cost for annual maintenance of river dykes is in Hoa Binh Province and Hanoi where annual maintenance costs are about US$2,300 to 2,800 per km per year. Elsewhere in the north, maintenance costs are about US$1,000 per km per year, while in the central and southern provinces they reduce to as little as US$100 per km per year (Quang Nam Da Nang Province). Maintenance costs vary as a result of the size of the structure and its physical stability in the face of high river flows and saturating water levels. Some of the variation in the cost is also due to the low efforts applied to maintenance in some areas, perhaps as a result of a lower strategic importance. In some cases (eg Mekong Delta) highly motivated local communities implement their own embankment raising and maintenance with own funds.

As in the case of sea and estuary dykes shortfalls exist in many maintenance budgets and external help is needed to sustain the safety levels of existing dykes in some areas (eg Huong River near Hue, Ma River in Thanh Hoa etc.).

II.5.3 Implementation of a protection development plan

The information in this section has been extracted from the plans drafted by the Vietnamese Government Ministry of Agriculture and Rural Development (Department for Dyke Management and Flood Control). The plans address the upgrading of Vietnam's defences to achieve improved safety levels and improved quality of life. They do not take into account the effects of accelerated sea level rise. The total cost of the upgrading described is summarised as US$ 0.7 billion for sea, river and estuary dykes and US$ 5.8 billion for upgrading of other defence measures (including raising houses, pumping etc.).

Upgrading of sea and estuary dyke system

Plans have been developed which outline priorities to address the shortfall in design strengths of the important existing sea and estuary dykes. The required upgrading has been examined per province and it is estimated that to improve safety levels to acceptable design standards a height increase of 1.5 to 2m is required in the north, 1 to 1.5m in the south and 0.3 to 1m in the central provinces. A total of 2,700 km of sea and estuary dykes need to be upgraded.

International aid programmes such as the World Food Programme and the Disaster Management Unit of the UNDP are implemented to help meet the shortfall and reduce the potential for flood disasters in the northern and central coastal areas. For example, a joint funding agreement between the Vietnam Government and the World Food Programme has been set up. A total of 815 km of sea and estuary dykes is being upgraded in two programmes at cost of US$ 66 million of which US$ 38 million provided by WFP and the remainder from the Vietnam Government. Additional funding from other NGO's (OXFAM, ICCO) is also being implemented on a smaller scale (US$ 2.5 million). This still only deals with upgrading of 30% of the total sea and estuary dyke system. The upgrading of the remaining 70% will require new funds which are beyond present resources and hence cannot be done. The upgrading costs being carried out in the WFP/Vietnam Government programme averages about US$110,000/km in the northern provinces and US$50,000/km in the central provinces. The total upgrading requirement of existing sea and estuary dykes is estimated at US$320 million.

In addition to upgrading existing dykes, new sea and estuary dykes are also required over a total length of 585 km to protect new development and new agricultural areas and to increase the area available for double cropping (of rice). Costs for new dykes vary from US$45,000/km (south) to US$260,000/km (north). The total costs for new sea and estuary dykes is estimated at US$ 80 million.

For the upgrading and new dyke works an additional annual maintenance will be required of about 1% of the initial costs of the works.

Upgrading of river dyke system

The total length of river dykes nationally is 4,600 km. After a review of upgrading priorities, the Ministry of Agriculture and Rural Development has identified a length of 1552 km for upgrading. The upgrading concerns an increase in the safety level by raising the dyke crest elevation by 0.5 to 2m. In general a safety level of 1 in 100 years is required. On the dykes which are not listed as priority, a safety level well below the required design level exists and overtopping is "tolerated" by necessity at frequencies as low as 1 in 5 to 1in 10 years.

By example, in Hanoi the required design safety level is 1 in 100 years, but the existing dykes are too low by 0.3 to 0.8m, creating a dangerous situation. In Thai Binh, the river dykes require an increase of almost 2m for the same safety level. An ADB funded programme is presently assisting with the required upgrading over a length of 50km of dyke at Hanoi at a cost of about US$ 1 million /km. In some provinces the unit costs of the upgrading requirement is only US$ 20,000 /km. Available funding for the upgrading of the entire requirement falls far short. It is estimated that the total cost of the upgrading of 1533 km of river dyke will be US$ 270 million (ave. US$ 176,000/km).

In addition to dyke raising, development plans for new river dykes mainly relate mainly to the need to protect against early floods that occur before harvesting the Autum crops in new area in the Central Provinces. The total length of such dykes is 363 km, mostly concentrated in Binh Dinh. Unit costs range from US$ 50,000/km to US$ 136,000/km. The estimated total cost of these new river dykes is US$ 21.2 million.

For the upgrading and new dyke works an additional annual maintenance will be required of about 1% of the initial costs of the works.

Upgrading of Mekong delta embankments

In the Mekong Delta, in order to protect crops against early floods about 3,300 km of ring embankments need to be raised about 0.5m. The total estimated cost to improve these embankments is US$ 21.3 million at an average unit cost of US$ 6,000/km (including some sluice gates and small bridges etc.). At present this work is only be tackled at a very low level by some local labour schemes which amount to self protection by local villages. No foreign funding is being applied.

Maintenance costs of about 1% annually can be assumed.

Upgrading and development of other measures

Raised lands

New lands for special industrial areas which are part of the Vietnamese Government's development plans will be raised. A total of 1800 ha is involved at an estimated cost of US$72.5 million.

Raised houses

In the Mekong Delta and some specific central coast locations, the strategy of raising houses rather than constructing new dykes is preferred both economically and environmentally. A raising in height of about 1m above the highest flood level will be required to improve the present safety level of the population in some areas (in the absence of sea level rise). Unit costs are estimated to vary from US$ 10,000/ha to US$ 30,000/ha. The total number of hectares considered for priority attention for raising of houses is 128,550 ha (1.3 million homes). The total cost is estimated at US$ 3.7 billion. While it is recognised that this strategy is the best for some areas the high cost for this strategy is far beyond the present means of the people or the government. (see Box II-5)

Pumping

Pumping to relieve floods in waterlogged areas where rain water and infiltration water collects behind the dykes is generally undersized at present. The most severe problems are in the Red River Delta and the Mekong Delta. In the Red River Delta a large new pump station is proposed, whereas in the Mekong Delta small pump stations are recommended at selected locations.

In total almost 700,000 ha suffer from poor drainage and improved pumping capacity is required at unit costs ranging from US$ 700 (south) to US$ 6000 /ha (north) depending on pump capacity, depth and duration of flooding tolerated and the channel system.

In addition annual maintenance and operating costs including power charges amount an annual cost of 10% p.a. Nationally, throughout the coastal zone, total costs for pumping installations and upgrading works is estimated at US$ 2 billion with an annual operating and maintenance cost required of US$ 200 million.

BOX II-5 : Raising houses as an "adaptation" response in the Mekong Delta ref. "Vietnam News" October 12, 1995

Houses on raised mounds suggested

HCM CITY — A simple solution has been decided on to the problem of houses submerged in the Meking floods.

Officials in the An Giang province suggested that the ground level of the houses be raised by filling in earth.

The suggestion was approved of Deputy Prime Minister Phan Van Khai during his visit to the delta last Monday.

The government will now be asked to grant VND100 billion so poor families in flooded areas can borrow money to buy land.

The land will be used to build ponds for fish farming and the excavated soil used to raise the houses. Each family will need an estimated VND5 million to buy 1,000 sqm with the loan being repaid over two years.

It is estimated that turnover from fish farming could reach between VND40 and VND50 million each year allowing sufficient profit for the repayment.

The province will set the year 2000 as the target date for salvaging the submerged houses with the financial support from the government.

The deputy prime minister approved the An Giang proposal as a test before other provinces are permitted to do the same.

The Mekong Delta has recently been flooded almost annually. This year's flood, which has continued for more than a month now, has killed almost 90 people.

Hardest hit are Dong Thap and Kien Giang provinces, with property losses estimated at VND112 billion (US$10.1 million).

Last year, the region was also submerged over a long period in autumn during which 407 people lost their lives. Damage caused to property was put at approximately VND1.5 billion. — **VNS**

Beach nourishment

Beach nourishment is understood in Vietnam to be a requirement only a s a last resort and mainly in locations of touristic value where good beaches are required. It is not seen as a serious defence measure as part of a protection strategy, perhaps because of the expensive dredging exercise required. In this respect, the proposed plans for beach nourishment cover only 14 km of coastline in tourist areas at a total cost of US$ 22 million (unit cost US$ 1.5 million/km). The implementation for the beach nourishment can be expressed as an annual cost considering a beach nourishment lifetime assumed to be 5 years. This indicates an annual cost of US$ 4.4 million per year.

Groynes

Existing groynes are rock groynes in the north and timber groynes (permeable) in the central provinces (Ninh Thuan, Binh Thuan). A small length of coastline of not more than 50km is nominated for groyne protection at a total cost of US$ 14.3 million. This will carry an annual maintenance costs requirement of about 1%.

II.5.4 Construction and implementation of new measures specifically to protect against accelerated sea level rise (1m)

In discussion with the Vietnamese Government (Ministry of Agriculture and Rural Development) dyke raising will be a priority response strategy specifically implemented in response to accelerated sea level rise. The additional dyke improvements to protect against sea level rise of 1m were estimated as US$ 335 million. This allows for a raising of sea and estuary dykes by 1 to 1.5m (1m sea level rise plus allowance for extra wave run up) over a distance of 3,285 km and a raising of river dykes by 1m over a length of 7.536 km.

Additional measures such as beach nourishments and pumping requirements have not been rigorously estimated due to the huge response costs inferred and the accuracy of the computations. It will be sufficient to estimate that the pumping requirement will increase by 50% and the area for raising of houses will increase by 25%. This already implies an additional US$ 2 billion for additional measures in response to sea level rise.

For beach nourishments to protect dune coasts it is likely that considerable additional funds will be required. On a total dune coast length of 944 km and an average cost of about US$ 1.0 million/km, the full nourishment cost would be close to US$ 1 billion and this provision. However, it is expected that only about 25% of the dune coast will become critical and the initial capital cost of beach nourishment for this length have been included in the strategy costs as a first estimate. It is also assumed that beach nourishment costs will be represented as annual costs assuming a beach nourishment life of 5 years.

II.5.5 Summary of "protection" strategy

Table II.5-4 provides a summary of the adopted protection strategy costs. The sums of money mentioned in the table are all expressed as present values assuming the works will be carried out at present day costs.

Initial capital costs

The total requirement is US$ 8.9 billion, about 42% of the annual GDP. 85% of the protection costs are derived from implementation of new measures such as pumping and raising of houses. 75% of the protection costs relate to the development programme that is required for increased safety levels prior to accelerated sea level rise.

Annual costs

Annual costs have been deduced as 1% of the initial capital cost of dykes, (with the exception of the small embankments in the Mekong Delta where a multiplier of 0.1% has been used) For pumping the annual operating and maintenance cost is assumed to be about 10% of the initial cost.

The annual costs of the no response strategy remain at present levels, US$ 4.3 million. The annual costs of the partial protection strategy where only the present maintenance and the development programmes are carried out are therefore in total about US$ 720 million. Annual costs for the total protection strategy, including protection against sea level rise, is estimated at US$ 394 million which is 1.9% of the present GDP. This result puts Vietnam in the league of the most vulnerable nations to sea level rise. Only several small island states have a higher projected annual expenditure relative to GDP. (By comparison, in the Netherlands less than 0.001% of the annual GDP is spent at present on coastal protection and maintenance combined, expected to rise to 0.05% after sea level rise).

In reality, the existing annual maintenance costs alone, US$ 4.3 million, are funded only with some difficulty and upgrading costs for dykes (US$ 713 million) are poorly underfunded due to limited capital resources. As money becomes available, priorities for protection need to be set carefully with a cost benefit analysis. The most likely scenario is that the present funding levels will increase only slightly and that urgent priorities only will be dealt with. Foreign aid money will be called for to address these urgent problems (eg Hanoi Dykes Project etc. US$40 million from ADB).

Projection to 2025

At present growth and inflation rates the protection costs will increase at a rate of about 12% p.a. whereas the GDP will increase at a rate of about 8 to 9%. This divergence will increase the protection strategy initial costs to over 100% of the GDP by the year 2025 if not implemented sooner. Maintenance costs for the protection strategy will be about 4% of the GDP by 2025.

Table II.5-4 : Summary of adopted protection strategy costs

Measure	Initial (capital) cost of measure US$ million	Annual maintenance & operating cost US$ million
(i) Continued maintenance of existing dykes (no sea level rise)		
Continued maintenance at present efforts	0	4.3
Total (i)	0	4.3
(ii) Government development plan for improved protection (no sea level rise)		
Upgrading and construction of dykes	713	7.1
Raising land	70	0
Raising houses	3,664	3.7
Pumping	2,033	203.3
Beach nourishment	4	4.2
Groynes	14	0.2
Total (ii)	6498	218.5
Raising of all dykes assuming above development measures are implemented) (1m sea level rise)		
Total of dyke raising costs (1m sea level rise)	336	3.4
Additional raising of houses	1,000	1
Additional pumping requirements	1,000	100
Additional beach nourishments	67	67
Total (iii)	2,403	171.4
Strategy "No measures" (i)	0	4.3
Strategy "Partial protection" (i) + (ii)	6498	218.4
Strategy "Full protection" (i) + (ii) + (iii)	8902	394.2

II.6 Step 6 : Vulnerability profile

A vulnerability profile can be formed in a standard way according to the guidelines of The Common Methodology (ref 1). It is possible to express the findings of the analysis in such a way that the vulnerability of the nation can be compared broadly with other nations. This is the basis of the vulnerability profile.

In Table II.6-1 is shown the aggregated results of the vulnerability assessment for the nation expressed in categories of LAND, POPULATION,CAPITAL VALUE and WETLANDS for the response scenario "no measures" estimated for 1995 and 2025, with and without sea level rise. In Table II.6-2, the results for the "protection" scenario are presented. Key issues are the following :

No sea level rise (ASLR0)

- US$ 720 million of capital value are presently at risk and in 30 years time this figure will rise more than 10 fold. These figures represent 3 and 5% of the respective GDP's in 1995 and 2025.

- based on the 1995 population scenario, almost 1 million people are at risk of annual flooding with the Mekong Delta accounting for 70% of the total and the Red River Delta almost 20%. Based on the 2025 population and development projections the numbers of people at risk would rise by about 60%;

- A development plan for protection (without sea level rise) is planned by the Vietnamese Government to reduce the people and capital value at risk. The strategy will cost US$ 6.5 billion representing about one-third of the present GDP. If delayed until 2025 this strategy will then cost about 92% of the projected GDP at that time.

- If the development plan is carried out it can be expected that losses and risks will reduce considerably, approximately to 10% of the present values.

- a low area of wetlands is at risk at present. This is based on threats from excessive high waters only, not from degradation by other means.

1m sea level rise (ASLR1)

- based on the 1995 population scenario and with no new measures beyond the existing maintenance efforts then the following has been determined :

    - 17 million people will be subject to annual flooding and thus will be required to be relocated. Over 14 million of these will be in the Mekong Delta provinces;

    - US$ 17 billion of capital value will be lost by annual flooding, representing 82% of the national GDP. At a 30 year development scenario, the capital value lost will be close to US$ 270 billion which will be 128% of the GDP at that time.

TABLE II.6-1 : VULNERABILITY ASSESSMENT : BASELINE VULNERABILITY TO COASTAL FLOODING					
IMPACT CATEGORY		NO SEALEVEL RISE ASLR0		1m SEALEVEL RISE ASLR1	
	UNITS	1995	2025	1995	2025
SOCIO ECONOMIC VALUES BASELINE					
GDP of whole nation	mill.US$	21000	213772	21000	213772
Capital value affected (within 1000 year flood prone area)	mill.US$	18924	314616	31885	481638
Capital value affected as percentage of national GDP	%	90	147	152	225
Population in whole nation	mill.pers.	74	117	74	117
Population affected (living within 1 in 1000 year flood prone area)	mill.pers.	22.6	30.3	33.9	44.5
Affected population as percentage of whole nation population	%	30.5	26	46	38
Total wetlands area in Vietnam (including mangroves)	sq.km.	3000	3000	3000	3000
Wetlands areas at change (within 1000 year flood prone area)	sq.km.	1333	1333	2800	2800
Wetlands areas at change as percentage of national total	%	44	44	93	93

TABLE II.6-1 : VULNERABILITY ASSESSMENT : RESPONSE "NO MEASURES"					
IMPACT CATEGORY		NO SEALEVEL RISE ASLR0		1m SEALEVEL RISE ASLR1	
	UNITS	1995	2025	1995	2025
SOCIO ECONOMIC VALUES AT LOSS					
Capital value lost (annually flooded)	mill.US$	0	0	17170	273163
Capital value lost as percentage of national GDP	%	0	0	82	128
Population to be moved (annually flooded)	mill.pers.	0	0	17.12	28.16
Population to be moved as a percentage of national population	%	0	0	23	24
SOCIO ECONOMIC VALUES AT RISK					
Capital value at risk (at risk of annual flooding)	mill.US$	719	9762	323	5646
Capital value at risk as percentage of national GDP	%	3	5	2	3
Population at risk (at risk of annual flooding)	mill.pers.	1.0	1.6	0.6	0.9
Population at risk as percentage of whole nation population	%	1.4	1.4	0.8	0.8
SOCIO ECONOMIC VALUES AT CHANGE					
Land use damage by salinity intrusion	(only a qualitative assessment has been made)				
ECOLOGICAL VALUES AT CHANGE					
Wetlands					
Wetlands areas at risk	sq.km.	18	18	13	13
Wetlands areas at risk as percentage of national wetlands area	%	0.6	0.6	0.4	0.4
Wetlands areas at loss (annually flooded)	sq.km.	0	0	1732	1732
Wetlands areas at loss as percentage of national wetlands area	%	0	0	58	58
COSTS OF RESPONSE "NO MEASURES" (continue maintenance at 1995 efforts, no additional measures)					
Capital cost					
Response strategy capital cost	mill.US$	0	0	0	0
Response strategy capital cost as % of GDP	%	0	0	0	0
Annual costs (maintenance & operational)					
Total annual cost	mill.US$/year	4.3	128.8	4.3	128.8
Total annual cost (as percentage of GDP)	%	0.02	0.1	0.02	0.1

TABLE II.6-2 : VULNERABILITY ASSESSMENT : RESPONSE "PROTECTION"

IMPACT CATEGORY	UNITS	NO SEALEVEL RISE ASLR0 1995	NO SEALEVEL RISE ASLR0 2025	1m SEALEVEL RISE ASLR1 1995	1m SEALEVEL RISE ASLR1 2025
SOCIO ECONOMIC VALUES AT LOSS					
Capital value lost (annually flooded)	mill.US$	0	0	0	0
Capital value lost as percentage of national GDP	%	0	0	0	0
Population to be moved (annually flooded)	mill.pers.	0	0	0	0
Population to be moved as a percentage of national population	%	0	0	0	0
SOCIO ECONOMIC VALUES AT RISK					
Capital value at risk (at risk of annual flooding)	mill.US$	72	976	72	976
Capital value at risk as percentage of national GDP	%	0.3	0.5	0.3	0.5
Population at risk (at risk of annual flooding)	mill.pers.	0.10	0.16	0.10	0.16
Population at risk as percentage of whole nation population	%	0.14	0.14	0.14	0.14
SOCIO ECONOMIC VALUES AT CHANGE					
Land use damage by salinity intrusion		(only a qualitative assessment has been made)			
ECOLOGICAL VALUES AT CHANGE					
Wetlands					
Wetlands areas at risk	sq.km.	18	18	13	13
Wetlands areas at risk as percentage of national wetlands area	%	0.6	0.6	0.4	0.4
Wetlands areas at loss (annually flooded)	sq.km.	0	0	1732	1732
Wetlands areas at loss as percentage of national wetlands area	%	0	0	58	58
COSTS OF RESPONSE "PROTECTION" (development plan for ASLR0 plus additional measures for ASLR1)					
Capital cost					
Response strategy initial cost	mill.US$	6499	195000	8902	266700
Response strategy initial cost as % of GDP	%	31	92	42	126
Annual cost (maintenance & operating)					
Total annual costs	mill.US$/year	222.8	6674	394	11810
Total annual costs as percentage of GDP	%	1	3	2	6

- A protection strategy against 1m sea level rise involving dyke raising and additional pumping and beach nourishment will cost a further 3.4 billion, when assuming that the development plan is already completed. This will bring the total protection strategy cost to US$ 8.9 billion, about one-third of the 1995 GDP. By the year 2025 the protection costs will exceed the GDP.

- the wetlands lost due to sea level rise could be as much as 1732 sq.km. representing 58% of Vietnam's coastal wetlands. Most threatened areas will be Minh Hai and Vung Tau-HCMC mangrove areas, the Xuan Thuy RAMSAR site at the Red River mouth since these cannot migrate landward. Wetland losses cannot feasibly be prevented by the protection strategies applied.

To express these results in a standard and qualitative manner, a classification of the results is proposed in the Common Methodology (ref 1). This leads to the vulnerability classes shown in Table II.6-3.

The resulting vulnerability profile is given in Table II.6-4.

The profile shows :

- in terms of an inventory of the study area, the impact zone (within 1 in 1000 year flood area) is classed as CRITICAL with respect to its value to the nation and the population in the zone, "people affected" is HIGH. These (qualitative) results remain the same in 2025 and with sea level rise.

- for the "no measures" response strategy, after sea level rise values lost will be CRITICAL with respect to capital value, people to be moved and wetlands losses.

- for the "protection" response strategy, after sea level rise losses will be LOW but strategy costs will be CRITICAL. People at risk remains LOW as a percentage of the total population but HIGH as an absolute value.

II.7 Step 7 : Relevant actions and priorities

In assessing the relevant actions and priorities the Common Methodology (ref 1) makes use of a qualitative review of the implementation feasibility.

In the standard manner, Table II.7-1 provides the results of this review in the case of Vietnam.

Legal / Institutional / Organisational aspects of implementation feasibility :

These aspects are at present a serious threat to good coastal zone management in Vietnam. There is a lack of written legislation governing specifically activities and developments in the coastal zone. Many organisations can contribute to a better understanding of the coastal zone but coordination and communication is weak, duplication of efforts is often encountered and no clear framework of roles, responsibilities and activities exists beyond the heirachal structures of the present party and government system. There is a high degree of "vertical"

TABLE II.6−3 : VULNERABILITY CLASSES				
IMPACT CATEGORY	VULNERABILITY CLASSES			
	LOW	MEDIUM	HIGH	CRITICAL
VALUES AFFECTED				
Values within the 1000 year flood zone and below +10m HD :				
Capital value affected as a percentage of national GDP	<5%	5 to 10%	10 to 50%	>50%
Population affected as a percentage of national population	<1%	1 to 10%	10 to 50%	>50%
Wetlands affected as a percentage of national wetlands total	<5%	5 to 10%	10 to 50%	>50%
VALUES AT LOSS				
Values within the annually flooded areas :				
Capital value lost as percentage of national GDP	<1%	1 to 3%	3 to 10%	>10%
Population to be moved as a percentage of national population	<0.5%	0.5 to 2%	2 to 5%	>5%
Wetlands at loss as a percentage of national wetlands total	<3%	3 to 10%	10 to 30%	>30%
VALUES AT RISK				
Values in risk of annual flooding :				
Capital value at risk as percentage of national GDP	<2.5%	2.5 to 5%	5 to 25%	>25%
Population at risk as percentage of whole nation population	<1%	1 to 5%	5 to 10%	>10%
Population at risk (x 1000)	<10	10 to 100	100 to 1000	>1000
Wetlands at risk of a percentage of national wetlands total	<2.5%	2.5 to 5%	5 to 25%	>25%
COSTS OF RESPONSE MEASURES				
Total protection strategy initial cost as % of GDP	<0.05%	0.05 to 0.25%	0.25 to 1%	>1%
Total maintenance annual costs as % of GDP	<0.01%	0.01 to 0.05%	0.05 to 0.1%	>0.1%

TABLE II.6–4 : VULNERABILITY ASSESSMENT : BASELINE VULNERABILITY TO COASTAL FLOODING				
	VULNERABILITY CLASSES			
IMPACT CATEGORY	NO SEA LEVEL RISE ASLR0		1m SEA LEVEL RISE ASLR1	
	1995	2025	1995	2025
VALUES AFFECTED BY COASTAL ZONE FLOODING				
Values within the 1000 year flood zone and below +10m HD :				
Capital value affected as a percentage of national GDP	CRITICAL	CRITICAL	CRITICAL	CRITICAL
Population affected as a percentage of national population	HIGH	HIGH	HIGH	HIGH

TABLE I.4

TABLE II.6–4 cont.: VULNERABILITY ASSESSMENT : RESPONSE STRATEGY "NO MEASURES"				
	VULNERABILITY CLASSES			
IMPACT CATEGORY	NO SEA LEVEL RISE ASLR0		1m SEA LEVEL RISE ASLR1	
	1995	2025	1995	2025
VALUES AT LOSS				
Values within the annually flooded areas :				
Capital value lost as percentage of national GDP	LOW	LOW	CRITICAL	CRITICAL
Population to be moved as a percentage of national population	LOW	LOW	CRITICAL	CRITICAL
Wetlands at loss as a percentage of national wetlands total	LOW	LOW	CRITICAL	CRITICAL
VALUES AT RISK				
Values in risk of annual flooding :				
Capital value at risk as percentage of national GDP	MEDIUM	HIGH	MEDIUM	MEDIUM
Population at risk as percentage of whole nation population	MEDIUM	MEDIUM	LOW	LOW
Population at risk (x 1000)	CRITICAL	CRITICAL	HIGH	HIGH
Wetlands at risk of a percentage of national wetlands total	LOW	LOW	LOW	LOW
COSTS OF RESPONSE MEASURES ("NO MEASURES")				
Total protection strategy initial cost as % of GDP	LOW	LOW	LOW	LOW
Total maintenance annual costs as % of GDP	LOW	MEDIUM	LOW	MEDIUM

TABLE I.4

TABLE II.6–4 cont.: VULNERABILITY ASSESSMENT : RESPONSE STRATEGY "PROTECTION"				
	VULNERABILITY CLASSES			
IMPACT CATEGORY	NO SEA LEVEL RISE ASLR0		1m SEA LEVEL RISE ASLR1	
	LOW	MEDIUM	HIGH	CRITICAL
VALUES AT LOSS				
Values within the annually flooded areas :				
Capital value lost as percentage of national GDP	LOW	LOW	LOW	LOW
Population to be moved as a percentage of national population	LOW	LOW	LOW	LOW
Wetlands at loss as a percentage of national wetlands total	LOW	LOW	CRITICAL	CRITICAL
VALUES AT RISK				
Values in risk of annual flooding :				
Capital value at risk as percentage of national GDP	LOW	LOW	LOW	LOW
Population at risk as percentage of whole nation population	LOW	LOW	LOW	LOW
Population at risk (x 1000)	HIGH	HIGH	HIGH	HIGH
Wetlands at risk of a percentage of national wetlands total	LOW	LOW	LOW	LOW
COSTS OF RESPONSE MEASURES				
Total protection strategy initial cost as % of GDP	CRITICAL	CRITICAL	CRITICAL	CRITICAL
Total maintenance annual costs as % of GDP	CRITICAL	CRITICAL	CRITICAL	CRITICAL

TABLE II.7-1 : COMMENTS RELATED TO IMPLEMENTATION FEASIBILITY

IMPLEMENTATION ASPECTS	PROBLEM	PARTIAL PROBLEM	NO PROBLEM
VA-LIO : Vulnerability Assessment - Legal / Institutional / Organisational			
Level A			
- existing legislation re CZMP	■		
- existing institutions / organisations involved in CZMP	■		
- executive powers for CZMP	■		
Level B			
- specification of tasks and responsibilities	■		
- communication structure	■		
- staffing / facilities	■		
- existing CZM plan, regulations, control etc.	■		
Level C			
- staff education level		■	
- knowledge & management capabilities			■
- staff motivation and working conditions		■	
VA-ECF : Vulnerability Assessment - Economic & Financial			
Level A			
- national economic bearing capacity for protection	■		
Level B			
- national / regional funding potential	■		
- international funding potential		■	
Level C			
- financial management capability		■	
VA-TEC : Technical			
Level A			
- technical knowledge and experience	■		
- technical institutes		■	
Level B			
- operational structures		■	
- staffing and facilities		■	
Level C			
- staff education level		■	
- technical qualification / capability		■	
- staff motivation		■	
- data availablity		■	
VA-CSO : Cultural & Social			
Level A			
- cultural constraints		■	
- socio economic constraints	■		
Level B			
- cultural programmes	■		
- socio economic programmes	■		
Level C			
- recent cultural achievements		■	
- recent socio economic achievements			■

decision making with a low degree of consensus and solution at lower authority levels.

Staff are well motivated and knowledgable with excellent organisational abilities. Working conditions and facilities are reasonable.

Economic and Financial aspects of implementation feasibility

This is the most serious of all problems. The present capital spent on coastal zone defences is far short of that required to meet objectives of improved safety levels, even without sea level rise. Improved safety levels are crucial for development of the coastal zone infrastructure and industrialisation. However, at present funding levels the danger of flooding is fast becoming an obstacle to development. Agriculture targets will also require more pumping and more dyke protection than appears to be economically feasible. This can lead to serious shortages, even eventually to food shortages. A change in the land use planning and economic activities of the population will be forced by Vietnam's inability to deal with its protection requirements. The economic feasibility of even the "partial protection" measures is very low.

Technical aspects of implementation feasibility

Technical levels of staff and facilities for CZM studies is reasonable. Further training and experience is required to improve knowledge of coastal zone processes and coastal zone protection methods. Data availability is not a serious problem in the sense that it a large amount of good CZM data exists but exchange of data and readiness for distribution is limited. Important critical constraints in the past have been the datum "shifts" both horizontally and vertically within the country and between North and South Vietnam. These shifts are rapidly being solved and common reference datums will soon be available nationally. Measurements of difficult technical attributes such as wave action and beach erosion rates are still poorly covered but this is also being addressed in joint funding programmes with foreign aid organisations.

Cultural and social aspects of implementation feasibility

In general, the cultural climate in Vietnam is strongly dominated by the political organisation that is very strong and well organised at all levels. This is partly a help towards the level of organisation and order needed to communicate and participate in CZM. However, freedom to move across disciplinary boundaries and be innovative, communicative and have a broader perspective is not part of the present cultural setting. Horizontal consultation is uncertain, tentative and inhibited by years of vertical structured authority and discipline.

Overall vulnerability

The overall vulnerability is expressed in Table II.7-2 with respect to implementation of the feasibility of the selected protection scenario. The legislative / institutional / organisational issues present a high vulnerability due to the lack of specific emphasis and focus on the coastal zone in existing legislation. Economic feasibility is CRITICAL since the protection scenario costs are not feasibly achievable and careful prioritisation will have to be applied on a case by case basis. Technical feasibility is not a serious issue for Vietnam as there is a very high average education level and many well trained and well motivated specialists exist.

TABLE II.7–2 : VULNERABILITY RELATED TO IMPLEMENTATION FEASIBILITY

	FOR PROTECTION RESPONSE STRATEGY			
	LOW	MEDIUM	HIGH	CRITICAL
VA–LIO Legislative / Institutional / Organisational Vulnerability				
VA–ECF Economic & Financial Feasibility				
VA–TEC Technical Feasibility				
VA–CSO Cultural and Social Feasibility				

Cultural and social issues present no problem for implementation of protection measures, in fact the high level of organisational ability, awareness and motivation among coastal authorities and specialists presents an opportunity rather than a constraint for implementation of measures..

The enormous funding required, even for upgrading of coastal defences without sea level rise is a very heavy burden on Vietnam. It is not at all feasible to expect that even the development plan for coastal zone flood prevention will be significantly carried out. This means that unsafe dyke levels and frequent flooding problems will persist for at least several decades.

The geographical character of Vietnam with its long coastline and narrow hinterland creates an exceptionally high ratio of coastline per sq.km. of landmass. Coastal zone flooding is mainly a result of high river flood discharges, elevated sea levels during typhoons and weak dyke protection. Flooding is already a serious impediment to growth especially in the central coast and Mekong Delta areas.

Increasingly, industrialisation will replace agriculture as greatest contributor to GDP and within 30 years the contribution from agriculture is expected to fall from 34% to 10%. This will prompt a prioritising of investments towards land reclamations in flood prone areas and towards expansion of industry in flood free areas. It is not by coincidence that the powerhouse of Vietnam's present industrial growth, the Special Focal Economic Zone near Ho Chi Minh City is in one of the most flood free coastal zones of the nation.

There is a danger that the focus on rapid economic expansion and industrialisation will absorb development funds needed to protect and sustain the agricultural yields necessary for Vietnam to feed its own population and meet export quotas.

A large contribution to the critical vulnerability of Vietnam is the need to increase pumping and raise houses. Particularly in the Mekong Delta, raising houses is only feasible in a very piecemeal way and will probably occur in makeshift fashion by locals using own resources of labour and materials. Increasing pumping and raising embankments to lengthen the summer crop season has been very successful but this has to be carefully managed to avoid serious upstream or downstream hydraulic and water quality problems.

In summary, Vietnam's overall vulnerability level to a 1m sea level rise over the next 100 years is CRITICAL, and its vulnerability can be ranked along with small island states.

PART III -

FOLLOW UP STEPS TOWARDS ICZM IN VIETNAM

PART III - FOLLOW UP STEPS TOWARDS ICZM IN VIETNAM

III.1 General

In such a vulnerable state, Vietnam urgently needs to increase its readiness to cope with the challenges and problems associated with accelerated sea level rise. The present coastal defences are inadequate to ensure the necessity safety levels for sustained growth in the coastal zone and increasingly flooding, erosion and salinity intrusion will control growth rates in the coastal zone.

Integrated Coastal Zone Management (ICZM) is a powerful tool for ensuring that the necessary awareness, activities and responses can be made to both present day problems and projected future problems. "Everything affects everything" is an often quoted phrase in CZM to emphasise the importance of multi-disciplinary and circumspect management in the coastal zone. ICZM can be used to focus the needs and disperse the ideas, data and initiatives.

III.2 Short term actions

Within the scope of the VA project a series of follow on actions can be implemented to publicise the findings, maintain momentum and awareness for ICZM in Vietnam and improve accessibility to data and results. In view of this an "Interim Phase" is planned,

In the period from 1 May 1996 to 31 December 1996 (8 months), the primary objectives will be the following:

(i) Avoid a sudden loss of momentum at the end of the Vietnam VA Project at the end of April 1996. This could result in deterioration of the data base and dissipation of the well trained Vietnamese GIS, GMS and data management teams. Also the project equipment and facilities need to be maintained rather than decommissioned or used on other projects;

(ii) Continue publicizing the Vietnam VA Project findings and raising awareness of the issues highlighted;

(iii) Obtain formal approval from the Vietnamese Government for acceptance of the Vietnam VA as a "first step" towards ICZM in Vietnam;

(iv) Together with the Vietnamese authorities, design and promote the longer term project for implementation of ICZM in Vietnam by the year 2000;

(v) Optimize use of the Vietnam VA data and results by UNDP and other ICZM related projects in Vietnam;

(vi) Continue interaction with the Vietnam Country Team for compliance with UNFCCC Convention, UNCED and WCC'93 commitments for ICZM by the year 2000 (refer to Appendix B for a summary of the Country Programme for Vietnam in response to the UNFCCC commitments).

The following activities are proposed to meet the objectives of this period and to satisfy the preliminary requirements of the Vietnamese counterparts :

1 Tidy and prepare the database and tools for wider accessibility by UNDP and others;

2 Compile an Executive Summary of the Vietnam VA project findings in brochure format for maximum circulation opportunities, both in English and Vietnamese;

3 Conduct large two workshops, one in Hanoi and one in Ho Chi Minh City, to publicize the Vietnam VA findings and obtain acceptance from the Vietnam VA Steering Committee and Vietnamese Ministerial and provincial authorities;

4 Continue to train and enhance the capabilities of the Vietnamese counterparts in the use of the data bases and the GIS/GMS tools;

5 To provide for Vietnam VA / ICZM office and facilities, including transportation, for the Interim Phase in 1996. This will provide a focus and centre for operations concerning the workshops and other activities;

7 Finalise the Long Term Project proposal and obtain Vietnamese and Netherlands Government permission, funding and contractual arrangements;

8 Interact with other projects and initiatives in ICZM in Vietnam in the period, including Norwegian, Australian, Canadian, UNDP projects as well as other Netherlands Government projects such as Land Water Impulse Programme (foreign Pilot Study) and dyke/flood assistance of Rijkswaterstaat;

9 Interact with the Vietnamese Country Team and Country Programme and tighten links between ICZM planned activities and the UNFCCC Convention compliance;

10 Short Term Missions to Vietnam by Netherlands advisors, lead by RIKZ, to attend workshops, provide training, improve the data base and tools, ensure communication and continued activities in all the above points. It is envisaged that after the return of the LTRA (Long Term resident Advisor) to The Netherlands at the end of April 1996 there will be a need for approximately 2.5 man months of short term visits and 8 return airfares will be required.

III.3 Medium and long term actions

Following from the Interim Phase, a full ICZM planning project is planned to commence in 1997 and end in 2000.

It is proposed in the long term plan, (preliminary proposal only, full plan to be prepared in detail in the Interim Phase), that an *ICZM Centre* should be established in Vietnam, operating within the framework of a proposed *Strategy and Action Plan for Integrated Coastal Zone Management*.

Main objectives for the *ICZM Centre* will be :

* to extend the knowledge and understanding of the land and water resources of the low lying coastal areas of Vietnam, including possible resource conflicts, through the development of coastal information systems and/or decision support systems;

* to support the set-up and development of an ICZM-plan as well as the coordination of the planning for coastal zone development and management of the coastal zone of Vietnam through training of the staff of the Centre with respect to concepts and tools for ICZM, through extension and management of strategic ICZM information and through strengthening of capabilities and facilities of Vietnamese counterparts for ICZM

* to strengthen the cooperation between Vietnam and The Netherlands in the field of ICZM

Main themes of the long term proposal are as follows:

* dissemination and exchange of information
* harmonisation of assessment and planning methodologies
* development and dissemination of decision support and planning tools
* training
* conferences, workshops, seminars
* coordination of bilateral and multilateral development projects (eg DMU/UNDP, WFP etc.)

Examples of actions based on the above activities will be :

* establish an *ICZM Centre* in Hanoi, comprising joint Vietnamese and foreign teams;
* establish a framework for development of ICZM by drafting and implementing, together with Vietnamese counterparts, a *Strategy and Action Plan for ICZM (SAPICZM)*. THE *SAPICZM* will act as a framework within which all ICZM-related projects can be coordinated and exchange data, information and findings;
* conduct multidisciplinary studies and assessments (pilot studies)
* establish a short term institutional mechanism to review benefits and costs of developing the ICZM programme;
* establish a long term institutional mechanism (*initial leadership*) to prepare, recommend and coordinate the implementation of a long term ICZM programme
* set up a continuing monitoring and assessment programme to collect ICZM-data, assess results and identify improvements in ICZM-data collection, analysis and storage;
* establish and coordinate an on-going research programme to improve the analytical foundation for decision making in ICZM;
* promote and assist with a policy to increase the availability and accessibility of ICZM related information to all interested parties;
* actively support local initiatives and enhancement of public participation;
* education, training and public awareness for ICZM;
* coordination of financial support for relevant activities and investigation of innovative funding sources for additional support.

PART IV -

CONCLUSIONS AND RECOMMENDATIONS

IV.1 CONCLUSIONS AND RECOMMENDATIONS

From November 1994 to April 1996 the Vietnam VA Project has been successfully conducted to assess the vulnerability of the coastal zone of Vietnam to the impacts of accelerated sea level due to global warming. The project was conducted according to the Common Methodology recommended by the Intergovernmental Panel on Climate Change.

The findings show the high sensitivity of Vietnam to a rise in mean sea level. Vietnam's vulnerability was ranked as CRITICAL and required protection measures are estimated to be immense and not economically feasible. Most sensitive areas are the Mekong Delta and the region of Ho Chi Minh City and Vung Tau.

Vietnam ranks with the small island states as being among the most vulnerable nations in the world for the impacts of accelerated sea level rise.

Increased momentum towards Integrated Coastal Zone Management is required with associated actions to strengthen local capabilities for coastal management. It is strongly recommended that the proposed follow up activities in the Intermediate (1996) and Long Term Phases (1997-2000) be given approval and support.

Further, additional attention should be given to

* establishment of clear concise data bases with important clarifying definitions and descriptions. Data bases need to be made completely accessible to coastal managers and well documented. The information age and the explosion of data availability worldwide will not escape Vietnam and reluctance to publish and share data needs to be removed

* drafting of clear coastal boundary condition baselines, to be frequently updated. For example the present confusion about storm surge levels versus high water levels needs to be cleared up, datum levels for water level recording need to be clearly summarised, datum levels and coordinate systems need to be clarified , differences published and a standard reference system used;

* checking of strategic plans for agricultural production and industrial growth against realistic scenarios of dyke maintenance, pumping costs and new works. Prioritization of local "hotspots" will be important to ensure wise use of limited Government funds

Finally the Vietnam VA Project has fulfilled the requirement to conduct the "First Steps" towards ICZM and the project has achieved acclaim and wide recognition within Vietnam, giving ICZM a strong initial impetus. The challenges of the next phases are to capitalise on this success and take optimum advantage of the opportunities that this provides for effective support to ICZM planning and actions in Vietnam in the near future.

References

1 "The Seven Steps to the Assessment of the Vulnerability of Coastal Areas to Sea Level Rise. A Common Methodology." Intergovernmental Panel on Climate Change, Response Strategies Working Group, Advisory Group on Assessing Vulnerability to Sea Level Rise and Coastal Management. September 1991.

2 "Preparing to meet the coastal challenges of the 21st Century." Intergovernmental Panel on Climate Change. Conference Report, World Coast Conference 1993 held in Noordwijk, The Netherlands, November 1993.

3 "Vulnerability Assessment Project in Vietnam, Report of Project Identification Mission", Ministry of Transport, Public Works and Water Management, The Netherlands, December 1993

4 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal zone Management - Project Document (Uitvoeringsdocument)", IBW-PAN, Frederic R Harris - Delft Hydraulics, The Netherlands, October 1994

Plus the following Vietnam VA Technical Reports :

5 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.1, Inception Report", March 1995

6 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.2, Data Collection", June 1995

7 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.3, Methodology Report", March 1995

8 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.4, Pilot Study - Sea Dyke Erosion in Nam Ha Province", July 1995

9 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.5, Pilot Study - Flooding and Lagoon Management, Thua Thien Hue Province", November 1995

10 "Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management, Report No.6, Pilot Study - Coastal Management and Planning, Baria-Vung Tau Province", March 1996

Plus reports from other projects in Vietnam :

11 "Red River Delta Masterplan Reports" - report series. UNDP / World Bank / Ministry of Science, Technology and The Environment, Government of S.R. Vietnam, October 1994

12 "Mekong Delta Masterplan Reports" - report series. UNDP / World Bank / State Planning Committee, Government of S.R. Vietnam, November 1992

*13 "Biodiversity Action Plan for Vietnam" GEF / Government of Vietnam, November 1994

*14 "World Bank Environment Programme" World Bank / Government of Vietnam, 1996

*15 "Tropical Forests Action Plan Report" 1994

(references will be more fully described in the Final Submission)

APPENDIX A
Additional tables of the VA analysis

VA RESULTS:

CENTRAL COAST – NORTH plus QUANG NINH

	Unit	QU.NINH	TH.HOA	NGHE AN	HA TINH	QU.BINH	QU.TRI	T.T.HUE	**TOTAL**
ASLR0									
Area at loss	km2	0	0	0	0	0	0	0	**0**
Area at risk	km2	40	14	10	9	12	15	60	**160**
Total impact zone	km2	589	1578	1131	1007	234	326	782	**5647**
Population to be moved 1995	pers.	0	0	0	0	0	0	0	**0**
Population at risk 1995	pers.	6633	10881	6883	5001	5327	7180	42020	**83925**
Population to be moved 2025	pers.	0	0	0	0	0	0	0	**0**
Population at risk 2025	pers.	9464	15931	9904	7254	5885	10807	57254	**116499**
CV at loss 1995	US$mill.	0	0	0	0	0	0	0	**0**
CV at risk 1995	US$mill.	6	4	2	1	3	2	15	**33**
CV at loss 2025	US$mill.	0	0	0	0	0	0	0	**0**
CV at risk 2025	US$mill.	66	39	20	18	15	19	79	**256**
ASLR1									
Area at loss	km2	366	0	0	0	105	114	552	**1137**
Area at risk	km2	67	138	95	91	24	52	50	**517**
Total impact zone	km2	683	1650	1224	1157	349	431	883	**6377**
Population to be moved 1995	pers.	38203	0	0	0	43875	48011	383605	**513694**
Population at risk 1995	pers.	32569	109067	60557	50319	10611	27457	37462	**328042**
Population to be moved 2025	pers.	54968	0	0	0	47324	72806	522515	**697613**
Population at risk 2025	pers.	46423	159689	87383	72996	12971	40673	51260	**471395**
CV at loss 1995	US$mill.	45	0	0	0	25	16	135	**221**
CV at risk 1995	US$mill.	15	43	17	15	4	8	12	**114**
CV at loss 2025	US$mill.	501	0	0	0	123	138	714	**1476**
CV at risk 2025	US$mill.	216	386	178	178	31	61	78	**1128**

VA RESULTS:			COASTAL REGIONS			
ASLR0	Unit	TOTAL NATION	RED RIVER DELTA	N.CENTRAL COAST	S.CENTRAL COAST	MEKONG DELTA
Area at loss	km2	0	0	0	0	0
Area at risk	km2	2020	150	160	40	1670
Total impact zone	km2	34047	6847	5647	718	20835
Population to be moved 1995	mill.pers.	0.000	0.000	0.000	0.000	0.000
Population at risk 1995	mill.pers.	0.992	0.167	0.084	0.021	0.721
Population to be moved 2025	mill.pers.	0.000	0.000	0.000	0.000	0.000
Population at risk 2025	mill.pers.	1.591	0.232	0.116	0.032	1.210
CV at loss 1995	US$mill.	0	0	0	0	0
CV at risk 1995	US$mill.	719	102	33	72	512
CV at loss 2025	US$mill.	0	0	0	0	0
CV at risk 2025	US$mill.	9762	1183	256	1309	7014
ASLR1						
Area at loss	km2	40769	1302	1137	1068	37262
Area at risk	km2	792	195	517	80	0
Total impact zone	km2	56655	11342	6377	1674	37262
Population to be moved 1995	mill.pers.	17.119	1.426	0.514	0.724	14.456
Population at risk 1995	mill.pers.	0.632	0.248	0.328	0.056	0.000
Population to be moved 2025	mill.pers.	28.162	1.955	0.698	1.243	24.267
Population at risk 2025	mill.pers.	0.927	0.373	0.471	0.082	0.000
CV at loss 1995	US$mill.	17170	847	221	3223	12879
CV at risk 1995	US$mill.	323	182	114	27	0
CV at loss 2025	US$mill.	273163	7844	1476	114327	149516
CV at risk 2025	US$mill.	5646	4019	1128	499	0

VA RESULTS:	CENTRAL COAST – SOUTH										
	Unit	Q.DNANG	Q.NGAI	B.DINH	PHU YEN	KH.HOA	N.THUAN	B.THUAN	VUNGTAO	HCMC	TOTAL
ASLR0											
Area at loss	km2	0	0	0	0	0	0	0	0	0	**0**
Area at risk	km2	6	3	10	1	9	1	1	9	0	**40**
Total impact zone	km2	125	72	166	52	169	21	15	98	0	**718**
Population to be moved 1995	pers.	0	0	0	0	0	0	0	0	0	**0**
Population at risk 1995	pers.	4536	972	4219	831	6462	324	89	3454	0	**20887**
Population to be moved 2025	pers.	0	0	0	0	0	0	0	0	0	**0**
Population at risk 2025	pers.	6627	1376	6770	1474	9217	563	150	5420	0	**31597**
CV at loss 1995	US$mill.	0	0	0	0	0	0	0	0	0	**0**
CV at risk 1995	US$mill.	4	0	1	0	1	0	0	66	0	**72**
CV at loss 2025	US$mill.	0	0	0	0	0	0	0	0	0	**0**
CV at risk 2025	US$mill.	99	9	17	3	16	1	0	1164	0	**1309**
ASLR1											
Area at loss	km2	46	19	93	4	84	13	23	143	643	**1068**
Area at risk	km2	15	10	17	8	25	3	1	1	0	**80**
Total impact zone	km2	166	108	235	78	216	37	32	159	643	**1674**
Population to be moved 1995	pers.	41333	7478	38157	584	53335	2494	4810	58463	516881	**723535**
Population at risk 1995	pers.	4525	3886	7556	8184	29451	1179	80	955	0	**55816**
Population to be moved 2025	pers.	61400	10688	67711	797	76411	4300	8103	93334	920322	**1243066**
Population at risk 2025	pers.	5557	5756	11195	14576	41591	2058	142	1571	0	**82446**
CV at loss 1995	US$mill.	36.0	2	7	0	13	0	1	998	2166	**3223**
CV at risk 1995	US$mill.	2	1	1	3	5	0	0	15	0	**27**
CV at loss 2025	US$mill.	979	65	167	6	145	9	14	18626	94316	**114327**
CV at risk 2025	US$mill.	31	41	29	25	65	3	0	305	0	**499**

VA RESULTS:

MEKONG DELTA PROVINCES

	Unit	DONG THAP	AN GIANG	CAN THO	VINH LONG	T.GIANG	BEN TRE	TRA VINH	S.TRANG	MINH HAI	LONG AN	K.GIANG	TOTAL
ASLR0													
Area at loss	km2	0	0	0	0	0	0	0	0	0	0	0	**0**
Area at risk	km2	325	314	249	23	158	4	0	57	0	337	203	**1670**
Total impact zone	km2	3255	3172	2942	1099	1817	555	61	1459	176	3879	2420	**20835**
Population to be moved 1995	pers.	0	0	0	0	0	0	0	0	0	0	0	**0**
Population at risk 1995	pers.	145550	184629	153598	15857	62656	2242	27	20903	112	79873	55067	**720514**
Population to be moved 2025	pers.	0	0	0	0	0	0	0	0	0	0	0	**0**
Population at risk 2025	pers.	252234	309523	253323	25642	104657	3352	40	34364	197	129135	97929	**1210396**
CV at loss 1995	US$mill.	0	0	0	0	0	0	0	0	0	0	0	**0**
CV at risk 1995	US$mill.	46	94	136	10	61	1	0	23	0	57	84	**512**
CV at loss 2025	US$mill.	0	0	0	0	0	0	0	0	0	0	0	**0**
CV at risk 2025	US$mill.	960	1416	1878	135	769	19	0	281	1	590	965	**7014**
ASLR1													
Area at loss	km2	3261	3179	2942	1437	2265	2065	1849	2716	7515	4409	5624	**37262**
Area at risk	km2	0	0	0	0	0	0	0	0	0	0	0	**0**
Total impact zone	km2	3261	3179	2942	1437	2265	2065	1849	2716	7515	4409	5624	**37262**
Population to be moved 1995	pers.	1456966	1859296	1818340	1027554	865609	1222579	899406	1008953	1721916	1249435	1326341	**14456395**
Population at risk 1995	pers.	0	0	0	0	0	0	0	0	0	0	0	**0**
Population to be moved 2025	pers.	2524600	3115423	3008412	1674271	1451183	1934853	1453778	1645665	3063075	2032758	2362582	**24266600**
Population at risk 2025	pers.	0	0	0	0	0	0	0	0	0	0	0	**0**
CV at loss 1995	US$mill.	465	944	1503	660	927	1369	792.0	1146	2310	825	1938	**12879**
CV at risk 1995	US$mill.	0	0	0	0	0	0	0	0	0	0	0	**0**
CV at loss 2025	US$mill.	9623	14266	22260	8702	11224	9620	7061	13656	22222	8532	22350	**149516**
CV at risk 2025	US$mill.	0	0	0	0	0	0	0	0	0	0	0	**0**

NATURAL SYSTEM DATA: PHYSICAL CHARACTERISTICS	RED RIVER DELTA									
	Unit	HANOI	HA BAC	HA TAY	HAI HUNG	H'PHONG	THAI BINH	NAM HA	N.BINH	TOTAL
COASTAL CHARACTERISTICS										
Total overall coastline length (incl. small bays)	km	0	0	0	0	110	50	65	17	242
High rock cliff, no beach	km					0	0	0	0	0
High rock cliff with beach	km					15	0	0	0	15
Low rocky coast with beach	km					0	0	0	0	0
Low sand/mud coast and beach	km					70	40	50	16	176
Low coast with sand/mudflats, river mouths etc.	km					25	10	15	1	51
Sand dunes with beach	km					0	0	0	0	0
Total coastline length	km	0	0	0	0	110	50	65	17	242
Total area of province	km2	1200	4600	2100	2874	708	2067	2450	1330	17329
% of province below +10m HD	km2	67	37	63	100	81	100	96	68	73
Area below +10m HD	km2	806	1691	1329	2874	574	2067	2364	898	12603
Area below +5m HD	km2	118	934	694	2537	506	2065	2230	691	9775
Area below +2.5m HD	km2	0	105	32	1646	409	1847	1683	541	6263
Area below 0m HD	km2	0	0	0	0	41	41	17	0	99
Sea dyke with no revetment	km					30	19	45	17	111
Sea dyke with stone or concrete revetment	km					33	31	20	0	84
Sea dyke plus seawall	km					0	0	0	0	0
Ports, quays etc.	km					4	0	0	0	4
Total protected coastline	km					67	50	65	17	199
Total protected coastline	%					61	100	100	100	82
Sea dyke crest height (ave.) above MSL	m					4.5	3.7	4.5	4	16.7
Sea dyke crest width (ave)	m					3.5	2.5	4	3	13
Mangroves in front of shoreline type	km					25	5	5	0	35
Coast with groynes	km					0	3	0	0	3
Coastline length of islands within 100 km only	km					251	20	32	0	303
Natural (geological) subsidence	mm/yr	1 to 2	1 to 2	1 to 2	1 to 2	0 to 1	1 to 2	1 to 2	1 to 2	1 to 2
Man induced subsidence	mm/yr	20 to 40	no data	no data	no data	no data	no data	no data	no data	no data
RIVER CHARACTERISTICS										
Name of major river entering the sea							ThaiBinh	Red R.		
Name of major river entering the sea										
Number of major rivers entering the sea	#					0	1	1	0	2
Total average annual discharge to sea (combined)	m3						37.8	85.2		123
Average discharge rate to sea	m3/s						1200	2700		3900
Peak discharge rate to sea	m3/s						10000	25000		35000
Total annual sediment load discharged to sea	mill.t						29	186		215
Measuring station		Hanoi	Phai lai	Son Tay	HunYen	no data	Ba lat	Ba lat	no data	
Distance from coast (along the river)	km	180	120	220	100		9	9		
1 per 10 years maximum water level	m	12.5	6.6	15.0	7.5		2.2	2.2		
1 per 50 years maximum water level	m	13.8	7.2	15.9	8.0		2.4	2.4		
1 per 100 years maximum water level	m	14.2		16.2	8.5		2.5	2.5		
Number of major lagoons	#					0	0	0	0	0
Total length of river and estuary dykes	km	152	464	531	458	409	391	941	222	3568
Salinity (0=no problem to 5 = severe)	index	0	0	0	5	5	5	5	5	ave. 3
Drainage (0=no problem to 5 = severe)	index	3	5	5	5	3	5	5	5	ave. 5
Sluice gates in operation in dyke systems	#	0	0	0	0	59	97	30	22	208
Annual flooding (0=no problem to 5 = severe)	index	3	5	5	5	3	3	3	3	ave. 4
MARINE HYDRAULICS & METEOROLOGY										
High high water of spring tide (HHWS)	m					1.7	1.6	1.6	1.5	1.6
Low low water of spring tide (LLWS)	m					−1.8	−1.6	−1.5	−1.5	−1.6
Tidal range (HHWS−LLWS)	m	<0.5	<0.5	<0.5	0.5	3.5	3.2	3.1	3	3.2
approx. extreme storm surge range at the coast	m					2 to 2.5	2 to 2.5	1.5 to 2	1.5 to 2	1.5 to 2.5
1 per 10 years maximum water level at the coast	m					2.2	2.2	2.1	2.1	2.1 to 2.2
1 per 50 years maximum water level at the coast	m					2.5	2.4	2.3	2.2	2.2 to 2.5
1 per 100 years maximum water level at the coast	m					2.6	2.5	2.4	2.3	2.3 to 2.6
1 per 10 yrs max. significant deepwater wave hgt.	m					8 to 9	9 to 10	9 to 10	9 to 10	8 to 10
Ave. number of typhoons crossing coast per year	#									2
Average annual rainfall	mm/yr	1800	1700	1700	1800	2000	1800	1800	1800	2000
Wettest month		August	August	August	August	August	Sept.	Sept.	Sept.	Sept.
Average rainfall in wettest month	mm/m	600	5−600	5−600	5−600	6−700	6−700	5−600	5−600	5−700
Driest month		January	January	January	January	January	January	January	January	January
Average rainfall in driest month	mm/m	100	100	100	100		all at 150 to 200 mm/month			150−200
Winter months (January)	deg.C	17	17	17	17	17	17	17	17	17
Summer months (July)	deg.C	28	28	28	28	28	28	28	28	28

NATURAL SYSTEM DATA: PHYSICAL CHARACTERISTICS	CENTRAL COAST – NORTH plus QUANG NINH								
	Unit	QU.NINH	TH.HOA	NGHE AN	HA TINH	QU.BINH	QU.TRI	T.T.HUE	TOTAL
COASTAL CHARACTERISTICS									
Total overall coastline length (incl. small bays)	km	495	83	83	130	115	65	105	1076
High rock cliff, no beach	km	105	0	3	19	8	0	13	148
High rock cliff with beach	km	35	0	0	0	0	13	0	48
Low rocky coast with beach	km	45	0	10	4	0	0	0	59
Low sand/mud coast and beach	km	285	75	62	92	0	0	5	519
Low coast with sand/mudflats, river mouths etc.	km	25	8	8	15	5	0	7	68
Sand dunes with beach	km	0	0	0	0	102	52	80	234
Total coastline length	km	495	83	83	130	115	65	105	1076
Total area of province	km2	5617	11180	16621	6013	7943	4639	4968	56981
% of province below +10m HD	km2	31	18	9	25	8	17	26	17
Area below +10m HD	km2	1724	2000	1507	1487	621	796	1279	9414
Area below +5m HD	km2	729	1249	853	1002	262	438	822	5355
Area below +2.5m HD	km2	496	526	289	447	53	202	582	2595
Area below 0m HD	km2	5	0	0	0	0	0	0	5
Sea dyke with no revetment	km	172	26	12	3	0	2	0	215
Sea dyke with stone or concrete revetment	km	126	12	5	0	2	0	0	145
Sea dyke plus seawall	km	8	0	1	0	0	0	0	9
Ports, quays etc.	km	4	0	2	0	0	0	0	6
Total protected coastline	km	310	38	20	3	2	2	0	375
Total protected coastline	%	63	46	24	2	2	3	0	35
Sea dyke crest height (ave.) above MSL	m	4	3.2	3.2	2.2	4.5	2	–	19.1
Sea dyke crest width (ave)	m	2.5	2.7	2	2	3.5	2	–	14.7
Mangroves in front of shoreline type	km	100	22	0	2	0	0	0	124
Coast with groynes	km	0	0	0	0	0	0	0	0
Coastline length of islands within 100 km only	km	1150	15	5	7	9	0	5	1191
Natural (geological) subsidence	mm/yr	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1
Man induced subsidence	mm/yr	no data	no data	no data	no data	no data	no data	no data	
RIVER CHARACTERISTICS									
Name of major river entering the sea		Tien yen	Ma		Ca	Giang	Ben Hai	Huong	
Name of major river entering the sea		Bache	Yen			K.Giang	Qu.Tri		
Number of major rivers entering the sea	#	2	2		1	2	2	1	10
Total average annual discharge to sea (combined)	m3	4.1	19		22	12	6	6	69.1
Average discharge rate to sea	m3/s	129	596		695	390	189	179	2178
Peak discharge rate to sea	m3/s	4725	11000		12300	7499	4672	3170	43366
Total annual sediment load discharged to sea	mill.t	0.4	5.3		3.7	1.2	0.7	0.5	11.8
Measuring station		no data	Hoa.Tan	no data	Cua Hoi	no data	no data	Hue	
Distance from coast (along the river)	Km		7		2			10	
1 per 10 years maximum water level	m		2.7		2.4			appr.5.5	
1 per 50 years maximum water level	m		3.1		3.3				
1 per 100 years maximum water level	m		3.4		3.8				
Number of major lagoons	#	0	0	0	0	0	0	2	2
Total length of river and estuary dykes	km	310	1009	412	340	160	140	240	2611
Salinity (0=no problem to 5 = severe)	index	3	4	5	5	4	4	5	ave. 4
Drainage (0=no problem to 5 = severe)	index	2	4	5	3	1	1	3	ave. 2
Sluice gates in operation in dyke systems	#		79	103	100	55	26	59	207
Annual flooding (0=no problem to 5 = severe)	index	1	4	4	4	1	1	5	ave. 3
MARINE HYDRAULICS & METEOROLOGY									
High high water of spring tide (HHWS)	m	1.8	1.5	1.4	1.3	0.8	0.5	0.4	0.4 to 1.8
Low low water of spring tide (LLWS)	m	−1.9	−1.4	−1.4	−1.2	−0.8	−0.5	−0.4	−2 to −0.4
Tidal range (HHWS−LLWS)	m	3.7	2.9	2.8	2.5	1.6	1	0.8	.8 to 3.7
approx. extreme storm surge range at the coast	m	2 to 2.5	1.5 to 2.0	1.5 to 2.0	1.5 to 2.0	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1 to 2.5
1 per 10 years maximum water level at the coast	m	2.3	2	1.9	1.8	1.4	1.3	1.3	1.3 to 2.3
1 per 50 years maximum water level at the coast	m	2.5	2.1	2	1.9	1.6	1.5	1.5	1.5 to 2.5
1 per 100 years maximum water level at the coast	m	2.6	2.2	2.1	2	1.7	1.7	1.6	1.6 to 2.6
1 per 10 yrs max. significant deepwater wave hgt.	m	6.5 to 7	9 to 10	9 to 10	10 to 11	11 to 12	11 to 12	11 to 12	6.5 to 12
Ave. number of typhoons crossing coast per year	#								2 to 3
Average annual rainfall	mm/yr	2200	1800	2000	2500	2200	2400	3000	2−3000
Wettest month		August	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.
Average rainfall in wettest month	mm/m	600−700	600−700	700−800	800−900	700−800	800−900	>900	600−1000
Driest month		January	March	March	March	March	March	March	March
Average rainfall in driest month	mm/m	200	250	all at 150 to 200 mm/month					150−250
Winter months (January)	deg.C	16	18	18	18	20	20	20	18
Summer months (July)	deg.C	29	29	30	30	30	30	30	30

NATURAL SYSTEM DATA: PHYSICAL CHARACTERISTICS	CENTRAL COAST – SOUTH										
	Unit	Q.DNANG	Q.NGAI	B.DINH	PHU YEN	KH.HOA	N.THUAN	B.THUAN	VUNGTAO	HCMC	TOTAL
COASTAL CHARACTERISTICS											
Total overall coastline length (incl. small bays)	km	189	122	206	204	422	115	216	104	51	1629
High rock cliff, no beach	km	60	30	61	66	175	4	13	5	0	414
High rock cliff with beach	km	0	0	7	0	17	40	5	7	0	76
Low rocky coast with beach	km	0	0	5	30	55	0	0	0	0	90
Low sand/mud coast and beach	km	30	0	40	50	75	15	0	37	45	292
Low coast with sand/mudflats, river mouths etc.	km	0	3	7	2	10	8	2	9	6	47
Sand dunes with beach	km	99	89	86	56	90	48	196	46	0	710
Total coastline length	km	189	122	206	204	422	115	216	104	51	1629
Total area of province	km2	11100	5010	4438	6443	4632	3419	7964	1852	1861	46719
% of province below +10m HD	km2	24	10	10	5	11	6	3	25	16	12
Area below +10m HD	km2	2719	524	424	294	488	195	246	456	294	5640
Area below +5m HD	km2	213	168	183	61	260	58	70	312	61	1386
Area below +2.5m HD	km2	57	38	76	16	128	21	24	209	16	585
Area below 0m HD	km2	0	0	0	0	0.5	0.1	0.3	0	0	0.9
Sea dyke with no revetment	km	30	0	0	20	17.5	0	8	0	0	75.5
Sea dyke with stone or concrete revetment	km	0	5	0	40	2	0	4	0	1	52
Sea dyke plus seawall	km	0	0	0	0	2	0	0	0	0	2
Ports, quays etc.	km	6	0	2	0	6	0	0	0	0.5	14.5
Total protected coastline	km	36	5	2	60	27.5	0	12	0	1.5	144
Total protected coastline	%	19	4	1	29	7	0	6	0	3	9
Sea dyke crest height (ave.) above MSL	m	2	3	–	0.7	2	–	3	–	2	1 to 3
Sea dyke crest width (ave)	m	1.2	3	–	1.5	2	–	3	–	4.5	1 to 4.5
Mangroves in front of shoreline type	km	0	0	0	0	3	0	0	20	10	33
Coast with groynes	km	0	0	0	0	0	0	3	0	1	4
Coastline length of islands within 100 km only	km	36	14	4	22	36	0	0	91	0	203
Natural (geological) subsidence	mm/yr	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	1 to 3	2 to 3	0 to 3
Man induced subsidence	mm/yr	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
RIVER CHARACTERISTICS											
Name of major river entering the sea		Thu Bon	Tra Khuc	An Lao	Ky Lo	Cai (N.H.)	Cai (Ph.R)	Luy		Dong Nai	
Name of major river entering the sea			Ve	Con	Ba	Cai (N.T.)		Cai (Ph.T)		Saigon	
Number of major rivers entering the sea	#	1	2	2	2	2	1	2	0	2	14
Total average annual discharge to sea (combined)	m3	19	8.5	4.2	11	3	2	1		31	79.7
Average discharge rate to sea	m3/s	603	221	134	346	90	55	41		970	2460
Peak discharge rate to sea	m3/s	25000	8540	4936	36000	616	153	279		15000	90524
Total annual sediment load discharged to sea	mill.t	1.2	1.3	0.4	3	0.3	0.2	0.1		2.1	8.6
Measuring station		Hoi An	no data	no data	Weir	no data	no data	no data	no data	Bien Hoa	
Distance from coast (along the river)	Km	10			40					100	
1 per 10 years maximum water level	m	2.2			4.9					2.1	
1 per 50 years maximum water level	m	2.8			5.7					2.3	
1 per 100 years maximum water level	m	3.0			6.1					2.4	
Number of major lagoons	#	1	3	2	2	1	1	0	0	0	10
Total length of river and estuary dykes	km	200	78	124	104	27	6	12	31	1	583
Salinity (0=no problem to 5 = severe)	index	4	4	3	3	3	3	2	1	5	ave. 3
Drainage (0=no problem to 5 = severe)	index	2	1	2	2	1	1	2	1	4	ave. 2
Sluice gates in operation in dyke systems	#	207	53	44	74	0	0	0	17	1	396
Annual flooding (0=no problem to 5 = severe)	index	2	0	1	0	1	1	0	3	1	ave. 1
MARINE HYDRAULICS & METEOROLOGY											
High high water of spring tide (HHWS)	m	0.5	0.6	0.7	0.8	0.8	0.9	1.2	1.6	1.5	0.5 to 1.6
Low low water of spring tide (LLWS)	m	−0.6	−0.6	−0.7	−0.8	−0.8	−0.9	−1.2	−2.2	−1.9	−.6 to −2.2
Tidal range (HHWS−LLWS)	m	1.1	1.2	1.4	1.6	1.6	1.8	2.4	3.8	3.4	1.1 to 3.8
approx. extreme storm surge range at the coast	m	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1.0 to 1.5	1 to 1.5
1 per 10 years maximum water level at the coast	m	1.3	1.2	1.1	1.1	1.1	1.1	1.4	1.6	1.6	1.1 to 1.6
1 per 50 years maximum water level at the coast	m	1.5	1.4	1.2	1.2	1.2	1.2	1.5	1.6	1.6	1.2 to 1.6
1 per 100 years maximum water level at the coast	m	1.6	1.5	1.3	1.3	1.3	1.3	1.5	1.7	1.7	1.3 to 1.7
1 per 10 yrs max. significant deepwater wave hgt.	m	12 to 13	12 to 13	12 to 13	12 to 13	11 to 12	10 to 11	10 to 11	9 to 10	9 to 10	9 to 13
Ave. number of typhoons crossing coast per year	#										1 to 2
Average annual rainfall	mm/yr	2300	2400	1800	1600	1400	1000	1000	1600	1400	1000–2400
Wettest month		Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.
Average rainfall in wettest month	mm/m	800–900	700–800	600–700	500–600	400–500	300–400	300–400	300–400	300–400	300–900
Driest month		March	March	March	March	March	March	January	January	January	Jan – Mar
Average rainfall in driest month	mm/m	all at 150 to 250 mm/month						all at 100 to 200 mm/month			100 – 250
Winter months (January)	deg.C	22	22	23	23	24	25	26	26	26	22–26
Summer months (July)	deg.C	30	30	30	30	28	28	28	28	28	28–30

NATURAL SYSTEM DATA: PHYSICAL CHARACTERISTICS	MEKONG DELTA PROVINCES												
	Unit	DONG THAP	LONG AN	AN GIANG	CAN THO	VINH LONG	T.GIANG	BEN TRE	TRA VINH	S.TRANG	MINH HAI	K.GIANG	TOTAL
COASTAL CHARACTERISTICS													
Total overall coastline length (incl. small bays)	km	0		0	0	0	40	103	68	75	435	154	**875**
High rock cliff, no beach	km						0	0	0	0	0	18	**18**
High rock cliff with beach	km						0	0	0	0	0	0	**0**
Low rocky coast with beach	km						0	0	0	0	0	0	**0**
Low sand/mud coast and beach	km						36	95	60	55	335	126	**707**
Low coast with sand/mudflats, river mouths etc.	km						4	8	8	20	100	10	**150**
Sand dunes with beach	km						0	0	0	0	0	0	**0**
Total coastline length	km	0		0	0	0	40	103	68	75	435	154	**875**
Total area of province	km2	3261		3048	2942	1437	2264	2066	2136	3152	7676	6170	34152
% of province below +10m HD	km2	100		100	100	100	100	100	100	100	100	100	100
Area below +10m HD	km2	3261		3048	2942	1437	2264	2064	2136	3152	7694	6164	34162
Area below +5m HD	km2	3207		2840	2937	1437	2259	2060	2114	3134	7670	5983	33641
Area below +2.5m HD	km2	2125		1845	2659	1312	2020	1952	1891	2810	6315	5099	28028
Area below 0m HD	km2	1		1	1	0	0	2	0	2	4	0	11
Sea dyke with no revetment	km						33	34	20	24	239	126	**476**
Sea dyke with stone or concrete revetment	km						2	0	0	0	0	0	**2**
Sea dyke plus seawall	km						0	0	0	0	0	0	**0**
Ports, quays etc.	km						0	0	0	0	0	0	**0**
Total protected coastline	km						35	34	20	24	239	126	**478**
Total protected coastline	%						88	33	29	32	55	82	**55**
Sea dyke crest height (ave.) above MSL	m						4	2.5	3	2	1.8	1.5	**14.8**
Sea dyke crest width (ave)	m						3	7	4	3.5	3	4	**24.5**
Mangroves in front of shoreline type	km						5	50	20	30	300	115	**520**
Coast with groynes	km						1	0	0	0	0	0	**1**
Coastline length of islands within 100 km only	km						0	0	0	0	18	222	**240**
Natural (geological) subsidence	mm/yr						3	3	3	3	3	3	
Man induced subsidence	mm/yr												
RIVER CHARACTERISTICS													
Name of major river entering the sea									Mekong	Bassac			
Name of major river entering the sea													
Number of major rivers entering the sea	#								1	1			2
Total average annual discharge to sea (combined)	m3								399	87			486
Average discharge rate to sea	m3/s								16840	2770			19610
Peak discharge rate to sea	m3/s								50000	22300			72300
Total annual sediment load discharged to sea	mill.t								156	14			170
Measuring station		Cao Lanh		Chau Doc	Can Tho	Lg. Xuyen	My Thuan		Dai Ngai				
Distance from coast (along the river)	Km	135		200	88	150	112		43				
1 per 10 years maximum water level	m	2.2		3.8	1.9	1.9	1.7		1.9				
1 per 50 years maximum water level	m	2.5		4.2	1.95	2.0	1.8		1.9				
1 per 100 years maximum water level	m	2.6		4.4	2	2.0	1.8		2.0				
Number of major lagoons	#	0		0	0	0	0	0	0	0	0	0	0
Total length of river and estuary dykes	km	848		60	40	90	786	110	200	190	140	80	2544
Salinity (0=no problem to 5 = severe)	index	0		0	1	1	5	5	5	5	5	5	0 to 5
Drainage (0=no problem to 5 = severe)	index	5		5	5	3	5	4	4	5	4	3	ave.4
Sluice gates in operation in dyke systems	#						3	1			11	3	18
Annual flooding (0=no problem to 5 = severe)	index	5		5	5	5	5	3	3	3	3	5	ave.5
MARINE HYDRAULICS & METEOROLOGY													
High high water of spring tide (HHWS)	m									−0.8	0.8	0.8	
Low low water of spring tide (LLWS)	m									0.8	−0.8	−0.7	
Tidal range (HHWS−LLWS) − approx.	m	1.5		1.3	2.4	1.6	2.1	2.5	3.3	1.6	1.6	1.5	
approx. extreme storm surge range at the coast	m												
1 per 10 years maximum water level at the coast	m												
1 per 50 years maximum water level at the coast	m												
1 per 100 years maximum water level at the coast	m												
1 per 10 yrs max. significant deepwater wave hgt.	m						8 to 9	8 to 9	8 to 9	8 to 9	8 to 9	8 to 9	8 to 9
Ave. number of typhoons crossing coast per year	#												<<1/year
Average annual rainfall	mm/yr	1400		1400	1400	1400	1400	1400	1400	1600	2200	2000	1400−2000
Wettest month		Oct.		Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.
Average rainfall in wettest month	mm/m	300−400		300−400	300−400	300−400	300−400	300−400	400−500	400−500	400−500	500−600	300−600
Driest month		January		January	January	January	January	January	January	January	January	January	January
Average rainfall in driest month	mm/m	100−200		100−200	100−200	100−200	100−200	100−200	100−200	100−200	100−200	100−200	100−200
Winter months (January)	deg.C	26		26	26	26	26	25	25	25	25	26	25 to 26
Summer months (July)	deg.C	28		28	28	28	28	27	27	27	27	28	26 to 28

APPENDIX B

Summary of the Vietnam Country Programme to Implement the UNFCCC (Draft May 1995)

Summary of Vietnam's Country Programme to Implement the UN Framework Convention on Climate Change: (as based on the 3rd Draft, May 1995)

The Vietnam Country Programme lists the following ***objectives : :***

1 To fully implement the UNFCCC commitments
2 Make efficient use of foreign aid and funds
3 Conduct a clear step by step plan to respond to climate change

To meet these objectives the Country Programme describes four ***Principal Policies :*** (see Table I)

1 Greenhouse gas mitigation
2 Adapting to climate change
3 Legislation and policy formulation
4 International networking

In accordance with these Principal Policies the Country Programme proposes the ***Action Plan :*** (see Table II)

1 Organise a mechanism for implementation of the Convention
2 Formulate legislation and regulations
3 Inventorize greenhouse gas emissions, sinks
4 Mitigate greenhouse gas emissions
5 Prevention and mitigation of natural disasters
6 Observing measuring and studying climate change
7 Enhance public awareness
8 Develop and implement projects

To accomplish the Action Plan the Country Programme outlines the following ***Principal tasks :***

1 Carry out inventory of greenhouse gas emission
2 Carry out national programme for mitigation of greenhouse gas emissions
3 Apply and publicize checking, control and mitigation measures for greenhouse gases
4 Develop and complete plans for management of coastal regions, water and agriculture
5 Include climate change in economic policies (provide funds for climate change response)
6 Develop systematic observations and storage of climatic data
7 Promote the exchange of information about climatic change and the climatic system
8 Notify other parties of the UNFCCC of data and progress
9 Participate in approval of the suitability of measures used for greenhouse gas mitigation
10 Support and develop international programmes on technical issues, data collection etc.
11 Publicize to the population the importance of climate change issues and raise awareness
12 Propose projects to request financial aid for equipment, technology and compensation

To develop its strengths and abilities to accomplish the principal tasks the Country programme states that ***Vietnam undertakes*** :

1 To make effective use of international funds to cover implementation commitments
2 To make effective use of international funds to cover adaptation expenses
3 To provide favourable conditions for the reception of healthy environmental technologies
4 To use international aid for programs relating to climate change impacts such as :
  - sea level rise impacts to islands, coastal lowlands, coastal developments
  - increased floods and erosion in areas of increased rainfall
  - water quality impacts on agriculture yields and forestry (higher salinity)
  - worsening living conditions of people and spreading of diseases

Table I : ***Principal Policies*** of the Vietnam Country programme on the Implementation of the UN Framework Convention on Climate Change :

1 Policy on greenhouse gas mitigation

1.1 Use cleaner energy
- a develop hydroelectric power
- b experiment and apply wind, solar, geothermal and wave energy
- c study the use of biological gas

1.2 Mitigate energy consumption and save energy
- a mitigate losses in transport and distribution of energy
- b improve and increase efficiency of energy use in industry
- c improve processes and reduce fuel losses in thermoelectric power stations
- d improve domestic stoves in rural areas and efficiency of domestic fuel use
- e upgrade and repair rural transportation and its management
- f plan and improve urban transportation and associated energy savings

1.3 Re-forestation and forest protection
- a Manage exploitation, more planting, subsidies, credit funds etc.
- b Forbid rash mangrove exploitation, control aquaculture, plant salt marshes
- c publicise/encourage combined farming (includes planting) in mountainous regions

2 Policy on adaptation to climate changes

2.1 Increase adaptability of agriculture
- a rebuild the agricultural plans for every region taking account of climate trends
- b research/implement new practices (drought, saline and cold resistant plants etc.)
- c develop water resource management and irrigation methods
- d research climate change mitigation methods, production technologies
- e apply international experience and technologies as appropriate

2.2 Promote the management of water supplies, flood prevention and mitigation
- a build new reservoirs with hydroelectric plants
- b rearrange crop planting patterns and transfer water to drier areas
- c improve drainage of low lying areas (more pumps)
- d improve quality and protection of dykes, sea defences, estuary dykes etc.
- e improve coastal protection by mangroves, beach defences etc.

2.3 Prevention and mitigation of natural disasters
- a expand the hydrometeorological station network
- b improve forecasting and warnings (eg typhoon, flood warnings etc.)
- c strengthen ability of flood and drought committees to cope with emergencies

3 Policy on compiling and implementing laws

3.1 Promulgate decrees and guidelines for climate change response
3.2 Enforce measures to deal with violations of climate change related provisions
3.3 Promulgate law on the exploitation and protection of water sources in Vietnam
3.4 Promulgate guidelines on protection and exploitation of forests, mangroves etc.

4 Policy on strengthening international cooperation

4.1 Develop a detailed programme to comply with UNFCCC
4.2 Join international and regional community activities related to climate change
4.3 Promote multilateral/bilateral cooperation for financial aid and technology transfer
4.4 Promote cooperation in exchange and receipt of scientific information, research etc.

Table II : ***Action Plan*** of the Vietnam Country programme on the Implementation of the UN Framework Convention on Climate Change :

1 Organize a mechanism for the implementation of the Convention
- 1 Identify the institution and organise the implementation
- 2 Establish the "Secretariat of the Climate Change Convention in Vietnam"
- 3 Organise a committee of climate change experts in Vietnam
- 4 Establish a climate change office
- 5 Establish a Center of Climate Change Information and Greenhouse Gas Inventory

2 Compile laws and regulations
- 1 Develop state regulations on forest exploitation
- 2 Develop state regulations on protection and development of mangroves
- 3 Develop state regulations on import of fossil fuel technologies and equipment
- 4 Identify taxes for transport modes that emit excessive gases
- 5 Subsidize expenses of research projects for cleaner energy use
- 6 Subsidize expenses of research projects for lower energy use

3 Inventorize greenhouse gas emissions
- 1 Prepare plans for greenhouse gas inventory in Vietnam
- 2 Study and give guidance on reports of greenhouse gas inventory
- 3 Identify emission sources and main removal sinks in Vietnam
- 4 Apply recommended methods for calculating greenhouse gas emissions
- 5 Systemise inventory results, storage, reporting to Climate Change Secretariat

4 Mitigate greenhouse gases and encourage sinks
- 1 Prepare plans for reforestation of barren lands
- 2 Prepare plans for increasing use of hydroelectric power
- 3 Prepare plans for implementation of cleaner generation (wind, solar, etc.)
- 4 Prepare plans for reuse of energy in all sectors where possible

5 Prevent and mitigate natural disasters
- 1 Build more reservoirs to increase dry season flow and provide hydroelectricity
- 2 Improve and strengthen irrigation networks
- 3 Plant more and protect at source (forests) and for protection (eg mangroves)
- 4 Repair and upgrade the sea dykes, build new dykes in central and south Vietnam

6 Observe, measure and study climate change
- 1 Expand climate change observation and measurement network
- 2 Measurement and mapping of coastal areas to assess sea level rise impacts
- 3 Assess the climate change reality and forecast trends
- 4 Study improved manufacturing for less energy use and cleaner energy

7 Enhance public awareness
- 1 Publicize climate change characteristics, causes, impacts and responses
- 2 Organise national conferences to share information and discuss actions
- 3 Participate in appropriate international and regional conferences
- 4 Assist and support the preparation of projects relating to climate change

8 Develop and implement projects
- 1 Projects to strengthen the capability to implement the Convention
- 2 Projects on mitigation of greenhouse gases
- 3 Projects on increased efficiency and clean energy usage (industrial and domestic)
- 4 Projects on technical research to reduce the price of modern energy generation
- 5 Project on replacement of energy consuming equipment for energy savings etc.
- 6 Project on planning to replace transport means to save energy and fuel use