

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

REPORT No.6



**PILOT STUDY
COASTAL MANAGEMENT & PLANNING
BARIA-VUNG TAU PROVINCE
March 1996**

Prepared by :

Marine Hydrometeorological Center, Hydrometeorological Services, Hanoi, S.R of Vietnam

Polish Academy of Sciences, Institute of Hydroengineering, Gdansk, Poland

Joint Venture : Frederic R Harris BV - Delft Hydraulics, The Hague, The Netherlands

and

National Institute for Coastal and Marine Management, Coastal Zone Management Center,
Ministry of Transport, Public Works and Water Management, The Hague, The Netherlands

H1742-6

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1 Introduction

1.1 VA framework and goal of Pilot Studies

At all stages of the formulation, inception and implementation of the Vietnam Vulnerability Assessment programme (titled notably as *Vietnam Coastal Zone Vulnerability Assessment and First Steps Towards Integrated Coastal Zone Management (ICZM)*), in line with the requests from Vietnam and the findings of the 1993 Identification Mission, the VA project has been formulated so as to address a few aims, of which the primary one has been to strengthen the capabilities for performance of ICZM activities in Vietnam.

Although the emphasis in VVA has been placed on specialist assistance to the Vietnamese Government by conducting together with Vietnamese counterparts in working out Vulnerability Assessment to accelerated sea level rise (along the lines of the IPCC Common Methodology), one of the three major outputs formulated in the project documents consists in strengthening the capability (staff and equipment), communication and inter-agency cooperation of Vietnamese counterpart organisations in the context of ICZM.

Throughout all project documents it has been stressed that the project must *not* aim, nor is it capable of doing so because of the time and financing constraints, to design and carry on a *full* programme for implementation of Integrated Coastal Zone Management (ICZM) in Vietnam. Instead, the programme of work and the outputs should be seen as providing important *first steps* towards this longer term objective.

Hence, in addition to the basic VA activities, in order to ensure effective interaction with Vietnamese counterparts on addressing short term problems and demonstrating techniques and benefits of integrated approaches and actions, the VA component has been supplemented by *3 short Pilot Studies* on selected local coastal zone problems.

The combination of the long term VA and the short term Pilot Studies should result in strengthening of the technical and management capabilities of the Vietnamese counterparts to deal with the coastal zone management demands imposed by increased development and climate change related impacts on the Vietnamese coastal zone.

There is a strong link between the Pilot Studies and the VA. This enhances the quality of the VA since the feasibility of local application of certain techniques, interactions and adaptive responses is tested in the Pilot Studies and thus not only helps one understand better the local and short-term problems but also sheds light on large-scale long-term processes tackled in VA proper. This will result in the formulation of realistic adaptive responses and recommendations in the VA based on the experiences of the Pilot Studies.

In the Inception Phase I, the Pilot Studies have been formulated as to the ToR, framework and planning. In the Implementation Phase III, aside from the full VA activities in Vietnam, two Pilot Studies have already been carried out --- Pilot Study 1 for the Nam Ha Province and Pilot Study 2 for the Thua Thien Hue Province (Figure 1.1). This report describes the third Pilot Study, which deals with the Ba Ria - Vung Tau Province (Figure 1.2).

1.2 Goal and limitation of this Pilot Study

The goal of this Pilot Study is both far-reaching and limited. This Pilot Study report just wants to indicate how a structured approach could be set up towards a better integrated planning and management of the coastal zone, specifically in relation to the area of Ba Ria - Vung Tau Province. This Province is located in the Southern Focal Economic Zone - one of the three national Focal Economic Zones - in the south of Vietnam. All ingredients are present here which make this area an interesting example to apply a set of coherent management principles which are together known as Integrated Coastal Zone Management (ICZM).

This goal does not ask for a very precise delineation of the study area. As an indication, we focus on the Vung Tau Bay area (Vinh Ganh Rai), its adjacent coastal sea, and the lower Saigon River branches with surrounding lowlands (Figure 1.3) where, according to the present plans, huge port, industrial, urban, transport and tourism developments will take place in the coming years.

In line with the goal so defined, this Pilot Study report is meant as a first, indicative guideline only, which could be the onset for a follow-up study.

1.3 Set up of this report

The present Pilot Study report aims to briefly put the enormous industrial development plans in the wider Vung Tau Bay area, with its associated environmental impacts, into the perspective of sustainable development. This report, instead of posing solutions, offers an approach towards solutions. After the summary and conclusions in Chapter 2, Chapter 3 summarizes the scope of the planned developments in the SFEZ. Chapter 4 points towards flooding risks, without and with ASLR. Chapter 5 introduces the perspective of Integrated Coastal Zone Management in general terms, and Chapter 6 points towards a structured approach using policy analysis and decision support systems. A number of small reports on meetings and site visit are presented as Appendices at the end of this report.

Some of the information used in this report is also available in digitized form.

1.4 Site visit and local meetings

On 19 and 20 March 1996 a site visit was carried out to Vung Tau. A report of this visit is presented in Appendix 1.

On 19 March 1996 a meeting was held with the People's Committee of Ba Ria Vung Tau Province, the Department Of Science, Technology and Environment (DOSTE) at Vung Tau. A report of this meeting is presented in Appendix 2.

On 21 March 1996 a Seminar was conducted in the South Center of Hydrometeorology, where a.o. the preliminary findings of this Pilot Study were presented and discussed.

On 23 March 1996 a meeting was held at the Institute for Economic Research of HCM. A report of this meeting is presented in Appendix 3.

On 23 March 1996 a meeting was held at the Transport Engineering Design Institute (TEDI-South), Consultants under the Ministry of Transport. A report of this meeting is presented in Appendix 4.

1.5 Acknowledgements

We gratefully acknowledge the kind and professional efforts of the Vietnamese contributors to the present report:

VA team in Hanoi and HCMC, all persons met during the various meetings, interviews, site visit, and during the Seminar on 21 March 1996:

- Institute for Economic Research (Dr Ton Si Kinh- Vice Director, Mrs To Thi Thuy Hang, Mrs Pham Thanh Binh);
- People's Committee of Ba Ria Vung Tau Province, Department of Science, Technology and Environment DOSTE (Mr Nguyen Van Hoang-Director and Mr Nguyen Quang Lich- Head of Environmental Section);
- Southern Institute of Water Resources Research (Prof. Dr Nguyen An Nien-Director);
- Research Institute for Aquaculture No. 2 (Mr Tran Thanh Xuan, Vice-Director);
- Institute of Forest Inventory and Planning FIPI (Mr Pham Trong Thinh-Ecologist);
- Hydro Meteorological Service HMS, South Center of Hydrometeorology (Mr Hoac-Director; Dr Nguyen Huu Nhan-Hydraulic Computer Modelling);
- Transport Engineering Design Inc. TEDI South (Mr Le Quang Trinh-Engineer, Chief of Technical Department).

2 Summary and conclusions

A summary of the present report can be given in the form of the following seven points.

- The wider Vung Tau Bay area is one of the main development zones in Vietnam. The area has a great potential for oil-based development and associated industrial development.
- A large part of the needed infrastructure is planned in the very low-lying coastal plain and along the lower branches of the Saigon River. As such, the entire development effectivity will in principle be susceptible to increased flooding risk due to accelerated sea level rise (ASLR).
- Impacts of the planned developments on important existing natural resources might jeopardize the long-term basis for sustainable development.
- The above mentioned large developments and far-reaching impacts ask for a sound review of the inherent risks and possibilities.
- This Pilot Study presents an introduction to a basic framework for optimization of sustainable economic usage of the coastal resources in the wider Vung Tau Bay area.
- A review of current development plans for the wider Vung Tau Bay area in a framework of Integrated Coastal Zone Management will point towards possibilities to enhance the overall long term effectivity of these plans.
- Vietnamese institutes for planning and research could be provided with specialised support to effectively carry out such review.

3 Southern Focal Economic Zone (SFEZ) of Vietnam

3.1 Overview of SFEZ

In Vietnam there are eight so-called Economic Regions. Among these eight, three are selected as so-called Focal Zones: Hanoi-Hai Phong-Quang Ninh in the North of Vietnam, Hue-Da Nang in the middle of Vietnam, and the SFEZ (HCMC-Vung Tau) in the South of Vietnam. Of these three, the SFEZ is the most dynamic economic zone in terms of foreign investments and GDP growth rate. The SFEZ comprises parts of four provinces: HCMC, Song Be, Dong Nai, and Ba Ria Vung Tau (see Figure 3.1).

Recently, in February 1996, the boundary of the SFEZ has been somewhat redefined, and the SFEZ is now said to completely comprise these four Provinces. However, at the time of the present Pilot Study the available written information was still related to the old SFEZ-definition.

According to the report "Preliminary orientation of the socio-economic Master Plan in the SFEZ" (Ref. report No. 32) the following presents a summary of the situation, the objectives, and the requirements for the SFEZ:

The population of the SFEZ was 7.044 million in 1993. The population density was 2193/km².

In 1991 - 1993, GDP increased 11 % to US\$ 731 per person.

Development objectives are: GDP increases 17 %/yr in the period 1993 - 2000, reaching a GDP of US\$ 1859 per person. For 2000, an export of US\$ 6.3 milliard is planned. GDP increases 14.5 %/yr in the period 2000 - 2010.

The development orientation includes constructing a refinery factory with a capacity of 5 to 6 million tonnes/yr, an LPG factory with a capacity of 1.2 milliard m³/yr, a fertilizer factory of 577,000 tonnes/yr, a tire and tube factory of 1 million/yr. The planned rate of development of electricity and water supply is 16.55 %/yr. The agriculture should develop together with industries and export.

Tourism targets are 3 million in 2000 and 6 to 7 million in 2010.

Prerequisites for these great ambitions are capital requirements, developing both domestic and international markets, promoting consumer credits, decreasing birth rate, immigration of experts and managers, and developing the educational system.

The following necessary future tasks have been formulated in Ref. No. 32 for the implementation of the developments:

- To construct regulations to implement development objectives according to the socio-economic plan of the SFEZ;

- To construct programs of investment and cooperation for the various regions, for the Mekong delta, and for the Highlands;
- To make detailed plans for cities, industrial zones, export production zones, rural zones, port systems, transport and communication;
- To study the formation of pre-implementing projects, with priority for projects with Government's capital;
- To study the combined goals of economy and defence.

3.2 Master Plan for Vung Tau area

Various versions and elements of the Master Plans for the Vung Tau area have been published, and some of the maps have been made available to us in the form of copied maps or photographs. Most of them are labeled as having a preliminary and indicative status.

Our main sources of information for the development plans were:

- The report "Preliminary orientation of the socio-economic Master Plan in the SFEZ". Text and Figures with captions from Reference Report No. 32, written by the National Committee of Planning and Investment; Project of Development Plan of SFEZ; HCMC, 1-9-1994.

A number of sketched plans, some of them still in a preliminary stage, for port and associated industrial development plans near Vung Tau, in the Ganh Rai Bay and along the upstream river branches, have been copied from the above mentioned report and are presented as Figures 3.2 to 3.6.

- The meeting with the Ba Ria - Vung Tau People's Committee (see Appendix 2);
- The meeting at the Institute of Economic Research (see Appendix 3);
- The meeting at TEDI (see Appendix 4);
- Vietnam News article of 25 March 1996.

This article in the Vietnam News of 25 March 1996 "Vung Tau's oil economy" contains a compact overview of most of the offshore-related development plans as have been presented by the above mentioned sources, and is therefore quoted in full below:

Vietnam's offshore oil and gas industry centres on the seaside resort town of Vung Tau, with at least a dozen companies exploring for oil in blocks on the continental shelf offshore. The first of these, the Russian-Vietnamese joint venture VietSovpetro, is pumping crude oil from the Bach Ho (White Tiger) and Rong (Dragon) oil fields employing a range of service centres both onshore and off. Australia's BHP meanwhile became the first western company to tap Vietnam's oil reserves in October 1994 at the Dai Hung (Big Bear) field. Together these fields produce a combined output of more than seven million tonnes of crude oil a year.

Natural gas is another important resource for the region, with several major fields already discovered by companies from France, India, Japan, Malaysia, Norway and the UK. Both associated and non-associated gas finds have been made in recent years,

which if properly exploited and brought ashore by pipeline could help fuel major thermal power stations in Ba Ria Vung Tau province. The three oil fields (Bach Ho, Rong and Dai Hung) yield 20,000 tonnes of crude oil and three million cu.m of associated gas a year.

One third of this gas is being channelled to gas turbines in Ba Ria, lowering operating costs 30 per cent from diesel. Work is underway to bring the gas to a thermal plant in Thu Duc outside HCMC and to a proposed liquefied petroleum gas plant in Long Hai. according to some forecasts oil and gas finds off Vung Tau could produce 20 million tonnes of oil and three billion cu.m of associated gas a year by the year 2000.

Several gas turbine plants are under construction in the province to supplement the existing plant in Ba Ria which will have a capacity of 215 MW. Phu My thermal power station No. 1 should have a capacity of 600 MW, while Phu My No. 2 should reach 320 MW. A 120 MW plant is to be built with investment from Wartsila Co. Together the planned facilities in Ba Ria could generate up to 2,400 MW for the southern provinces by the year 2000.

The Vietnam Petroleum Technical Service Company (PTSC), a subsidiary of PetroVietnam, is investing in a modern petroleum port for Vung Tau and is gearing up for the challenge of supplying materials, equipment, and services to oil companies in the area.

A number of port facilities are under development to accommodate both sea and river traffic, including vessels of 5,000 to 200,000 tonnes which could bring in some 150 million tonnes of merchandise a year. The Ben Dam port on Con Dao is moving ahead with investment from Seaprodex-Con Dao. The Phu My port along the Thi Vai River is shaping up under the guidance of the Ba Ria Serece Joint Venture, which groups four Vietnamese enterprises with three foreign firms from France and Norway. When phase one is completed in April 1996, the harbour will accommodate 40,000 tonne ships transporting loose, packed and container freight. Phu My will have a capacity of one million tonnes a year at this stage, increasing to 4.2 million tonnes later.

A number of other projects await approval from the central government, including a proposal to build Vietnam's largest deepwater seaport at Sao Mai-Ben Dinh for ships of 100,000 to 200,000 tonnes. The US\$ 640 million project is backed up by an international consortium of companies from Japan, Malaysia and Singapore together with Vietnam's National Maritime Department.

Another key project is the Phu My Industrial Park, which will eventually cover some 800 ha of land and include a port, several power plants, steel, chemical and fertiliser factories. Vinakyoei Steel Company, a joint venture between Vietnam Steel Corporation and Kyoei Steel, Mitsui and itochu of Japan, became one of the first factories in the park, opening its 240,000 tonne per year steel plant in January 1996. Meanwhile the first Phu My power plant and the ChinFong Cement plant are proceeding.

Singapore's Keppel Group has pledged US\$ 100 million to build the 170 ha Dong Xuyen industrial park in Vung Tau and companies from Australia, South Korea and Taiwan are eying large projects of shipbuilding, steel and bitumen, as well as further industrial parks at Phuoc Thang and Long Son.

With a total of 48 licensed foreign investment projects capitalised at US\$ 839 million, the province of Ba Ria Vung Tau is stepping up the pace of development. Sixteen projects capitalised at US\$ 515 million won licenses in 1995, a fivefold increase over the previous year. Thirty more projects are in the pipeline worth an estimated US\$ 3 billion.

End of quote from Vietnam News

For the purpose of the present Pilot Study report, the preliminary status of the plans poses not a big problem, since we are only dealing here with the basic principles of Integrated Coastal Zone Management. However, as soon as the various plans take a more definite form, it will be possible to apply and demonstrate these same principles in a more concrete way.

4 Present situation Ba Ria - Vung Tau and effect of SLR

4.1 Land use and land elevation

On the basis of the available information which was assembled and analysed in the main VA study, the land use in Ba Ria - Vung Tau can be shown in Figure 4.1, where the following ten land use classes have been distinguished:

- rice,
- other annual crop,
- perennial crop,
- indigenous forest,
- timber forest,
- mangrove,
- urban area,
- rural area,
- grass/barren,
- surface water.

The city of Vung Tau is indicated as the urban area in the southwest part of Figure 4.1, while the main mangrove area can be seen north of the city along the lower branches of the Saigon River. Figure 4.2 presents a quantitative breakdown of the various land use areas, showing for example that the total mangrove areas occupy about four times as much as the urban areas, (which balance will be drastically changed following the envisaged developments).

The large scale developments as foreseen in the wider Vung Tau area will mainly take place in the low lying area along the lower river branches and along the coast. Therefore in Figure 4.3 an elevation map is shown of this low area, i.e. lower than an elevation of 10 m above mean sea level (MSL). By combining the land use and the land elevation information, the cross-tabulation result of Figure 4.4 is produced. For example this shows for "mangrove" (land use class no. 8, see Figure 4.2), that more than half of the total mangrove area (71.75 km² out of a total of 137.44 km²) can be found on land with an elevation lower than 2 m above MSL.

4.2 Effect of floods and SLR

Flooding due to sometimes occurring high sea levels will now and then affect the lower land areas, especially those which are not protected by dykes. Based on the information prepared in the main VA study, Figure 4.5 shows the extent of flooded areas for a range of average frequencies of occurrence viz. once in 10 years, once in 100 years, and once in 1000 years. Figure 4.5 represents the current condition, i.e. with the present sea level conditions.

Also, the (hypothetical) flooding situation has been determined for the scenario of 1 m ASLR, and this result is shown in Figure 4.6. It is noted that this last result is in so far purely hypothetical, that no additional future protection works have been taken into consideration.

Although being partly of indicative value only, Figures 4.5 and 4.6 do illustrate the enormous potential threat to the lowlands north of Vung Tau, and thus to the need to carefully consider the current development plans in the light of flooding risks. In the technical sense, effective protection is well possible and feasible. However it is clear that these measures might be very costly. These costs may significantly be reduced by carefully selecting the development locations, taking the flooding risks into consideration.

5 Developments within the wider Vung Tau Bay area: need for integrated management

5.1 Developments within the wider Vung Tau Bay area

The wider Vung Tau Bay (Vinh Ganh Rai) area, including the lower reaches of the branched Saigon River, being a very important part of the SFEZ as was stipulated in Chapter 3, plays a central role in the economic development of the southern part of Vietnam. As a consequence, the area faces an increasing demand as a resource for food, transport and communication and as a site for industry, energy supply, urban development and recreation. The present rate of utilization of land and water resources in the area gives already rise to environmental problems.

Flooding will be an increasing problem in the region due to ASLR and possibly land subsidence. Due to increasing agricultural, domestic and especially industrial pollution and sedimentation, fisheries production in Vung Tau Bay will probably be negatively affected. The assimilative capacity of the Bay will probably gradually but strongly be compromised, due to increasing bacteriological concentrations, decreasing dissolved oxygen levels near the bottom, and increasing heavy metal concentration. Another very important factor in the near future is a sufficient and safe water supply for domestic and industrial use from various sources, including surface water (from a distant source) and perhaps also groundwater. To this should be added sewer systems and waste water treatment, as well as the collection, transportation and environmentally sound disposal of various types of waste.

The available area for expansion of urban areas, industrial sites and ports may seem no problem within the wider Vung Tau Bay area, but this will be largely at the expense of precious wetlands, especially mangrove areas. Land reclamation projects may provide land for the pursued industrial development and provide opportunities for urban expansion, including the necessary infrastructure. However, there are environmental concerns associated with reclamation. Alteration of drainage patterns and water circulation could lead to more flooding than now is anticipated. In cases where the free passage of estuarine waters into the open sea is hampered, there is a possibility of nutrient overload. Since reclaimed land reduces the tidal prism and its natural scouring effects, increased sedimentation may occur in areas which are planned to accommodate deep sea ports. One major and irreversible impact of land reclamation is the local destruction of benthic habitat.

The Vung Tau Bay and Saigon River branches serve as the natural breeding, nursery and feeding ground and sanctuary for several varieties of fish and other forms of marine life as well as for birds. The sustainable functioning of the Bay ecosystem, and especially the still extensive mangrove areas, may be subject to a number of threats. Industrial development and associated infrastructure including land reclamation may result in a reduction of the area for birds for breeding, feeding and rest and destruction of the benthic communities (loss of nearshore and coastal flora and fauna). The discharge of waste water, in particular the load with nutrients, in combination with sediment rich water, may result in low oxygen levels, causing fish-kills. The presence of heavy metals,

pesticides, accidental oil spills and persistent organic halogen compounds may aggravate the situation. Outflow of water and sediments from various contaminated rivers and waste water outlets into the bays can reduce the area for spawning leading to a drop in fish stock.

The issue of massive industrial development and associated land reclamation is a good example of the necessary trade-offs that have to be made within the wider Vung Tau Bay area with respect to development and conservation, as well as with respect to alternative development options. An integrated approach to the management and development of the wider Vung Tau Bay area may result in adjustments of the location, size and design of the necessary infrastructural works, as well as in mitigating measures to reduce or prevent negative impacts. Moreover, compensating measures may be defined resulting in a net increase of habitats or ecological values through the concept of 'building with nature'.

5.2 Need for integrated management

As demands on coastal resources in the wider Vung Tau Bay area continue to grow with increasing population and economic development, conflicts on resource use will become more common and apparent. A process is needed that can resolve these conflicts and that can implement decisions on the mix of uses that best serves the needs of society now and in the future. For coastal areas, the most appropriate process for addressing these challenges is integrated coastal zone management (ICZM). The World Coast Conference of 1993 (The Hague, The Netherlands) defined ICZM as follows:

Integrated coastal zone management involves the comprehensive assessment, setting of objectives, planning and management of coastal systems and resources, taking into account traditional, cultural and historical perspectives and conflicting interests and uses; it is a continuous and evolutionary process for achieving sustainable development.

ICZM can provide for coastal societies an opportunity to move towards sustainable development. Integrated management of conflicting uses and activities is essential for this goal, including the consideration of short-, medium and long-term interests in coastal areas and resources. Integration in coastal zone management is most appropriate in preventing the degradation of coastal ecosystems, which would reduce their economic value and increase their vulnerability to climate change.

Integration in coastal zone management is basically cooperation between all responsible actors. The incentives for cooperation are the common needs to achieve objectives related to the coastal zone, resulting in "win-win" situations. In this context ICZM involves the integration of:

- the responsibilities of agencies at different levels, from basic local stakeholders to the central government ('vertical integration'), and
- the responsibilities of different (non)government sectors ('horizontal integration').

5.3 Pre-requisites and obstacles for ICZM

Based on a world wide evaluation of experiences in the set-up and development of coastal zone management, some essential prerequisites can be identified for a successful implementation of ICZM:

- The first of these is the need for *initial leadership* for the planning process. For effective ICZM, institutional responsibility must be distributed intersectorally and hierarchically, both within the government, and between government and local groups.
- Thus, the second necessary element of ICZM is the provision of *institutional arrangements*. This may involve creating new institutions, but will more commonly involve improving horizontal and vertical linkages between existing ones.
- Third, *technical capacity* (both human and technological capacities) is necessary for compiling inventories in the planning phase, during the implementation of the programme, and for monitoring the changes. This may include simple methods for field surveying or resource conservation. At the other end of the spectrum, sophisticated technologies such as remote sensing, computerized databases, and model simulations may be used.
- The final necessary element of ICZM is *management instruments*. These include tools ranging from command-and-control to incentive-based, all with the aim of encouraging stakeholders to comply with the ICZM plan.

One of the most commonly found obstacles to successfully implement ICZM is the lack of adequate institutional arrangement. Generally there is a need for enhancing:

- (i) inter-agency integration;
- (ii) public participation and awareness, and
- (iii) the legal and financial bases for management.

Inter-agency coordination is needed both within and between government agencies. An enhanced legal framework is necessary in some cases to establish ICZM as a priority, and to set up the mechanisms for inter-agency coordination.

Another widely cited obstacle to ICZM is the lack of adequate resources, from human resources to investment capital. These include deficient monitoring of resource conditions, and the lack of feedback necessary for evaluation and programme revision. In developing programmes for ICZM, it is necessary to establish ongoing monitoring and evaluation programmes. Specifically flexible tools need to be developed for use in:

- (i) monitoring the quality and distribution of coastal resources;
- (ii) monitoring development activities and resource usage, and
- (iii) managing coastal data to facilitate meaningful policy analysis.

Within the limited framework of this Pilot Study, there clearly is no possibility to present detailed solutions to the problems of massive but sustainable development in the Vung Tau Bay area. But we believe that it is possible, in a condensed way, to indicate in

the next Chapter a structured approach of planning and analysis with the aim to deliberately look for better alternatives and more sustainable solutions.

6 Planning and analysis for integrated coastal zone management

6.1 General approach

ICZM deals with conflicting interests and competing demands for the use of coastal areas and resources. It involves the formulation and implementation of coastal zone management plans, not as a one-off exercise but as a continuous and cyclic process. In developing coastal zone management plans, trade-offs have to be made between conservation and development, as well as among various development options.

Developments in demographic and socio-economic conditions, including social preferences, result in changing demands on the coastal resources. Also natural conditions may change, e.g. due to global climate change. Hence, ICZM involves decision making under uncertain economic, ecological, social and technological conditions.

Decision making under uncertainty can be facilitated by formal and consistent evaluations, incorporating cost-benefit analyses, resource and land use inventories and environmental impact analyses. Such a framework of analysis can assist decision-makers to choose rationally and objectively among alternative courses of action.

This chapter discusses in some more detail the role and set-up of analysis to support planning for ICZM, including the development and use of information systems and decision support systems to enable a quantitative assessment of the impacts of different development options.

6.2 Policy analysis of coastal zone management

This section presents a brief overview of the steps involved in a policy analysis of coastal zone management based on a system's approach. Figure 6.1 gives a systems view of the coastal zone. The Natural Subsystem imposes natural boundary conditions, while development plans come from the Socio-Economic Subsystem. On a more detailed level, we may distinguish three systems. The *natural system* encompasses atmosphere, lithosphere and hydrosphere with their mutual interactions through physical, chemical and biotic processes. The total complex of human activities is split up into two entities. The *user-functions* represent the uses which are made of the natural resources. The *infrastructure* in a general sense represents technical and organisational means to materialise the user functions. Between these elements there are all kinds of interactions. The triangle in the centre represents ICZM, where information comes together and where strategies are prepared, based on a coherent knowledge of the coastal zone.

The steps involved in a policy analysis to support ICZM can be described as follows, see also Figure 6.1.

1 *Delineation of study area*

The limits of the area to be studied are determined, both geographically and socioeconomically. This is the outer circle in the systems diagram. The relevant factors from the subsystems are described from available *field* data and macroeconomic data.

2 *Delineation of system elements*

Databases for the elements within the area to be studied are described from available or newly derived material. These are the inner circles in the system diagram.

3 *Identification of development factors (scenarios)*

An inventory is made of relevant processes and plans, both from the natural and the socioeconomic subsystem. These are the arrows from the outer circle in the system diagram to the system elements. They can be seen as the agents of change in the system elements. These agents can both be demand driven (from the socioeconomic subsystem) or driven by natural processes.

4 *Assessment of system relations*

A model is made of the relations between the various elements of the system. In this model, the effect of changes in a system element on the other elements is described. This can be done in a matrix of possible conflicts between the interests, describing qualitatively the possible effects. These effects are used in the next step to design promising strategies.

5 *Formulation of possible strategies*

With the information gathered in the previous steps, it is now possible to design strategies, that look promising or are advocated by some interest group. This is where the "CZM control centre", the triangle in the centre of the system diagram, comes into the picture. This can be some administrative institution or a conference of involved interest groups. Anyway, it is above the level of a particular interest.

6 *Assessment of system responses*

In the system diagram these are the same arrows as in step 4, but now the effects are quantified for the particular strategies that were developed in step 5.

7 *Choice of actions*

In the final step, in the "CZM control centre", a decision is taken on the preferred actions.

The seven steps together form a policy analysis for a given problem. Policy analysis is often supported by quantitative analysis using predictive models. Such models describe cause-effect relationships and constitute an indispensable tool in assessing the consequences of certain developments or measures (step 6).

Models and databases are increasingly being equipped with user-friendly interfaces to promote an easier and wider use of these tools. Databases and models have evolved into information systems and decision support systems.

6.3 Decision support systems

From a functional point of view a decision support system consists of three subsystems or 'layers' (see Figure 6.2). The subsystems are:

- (1) the information system proper,
- (2) an integrated model system and
- (3) a policy analysis framework.

The objective and contents of each subsystem are briefly explained below. The user interacts with the system through a userfriendly interface. Presentation of information is mostly graphical.

Subsystem 1: Information system

The core of an information system is a database containing (monitoring) data from the study area. (This could be of type similar to that which has been used in the main VA study). The database consists in principle of two layers, the meta-information layer and the actual data themselves. The meta-information layer contains background information on the actual data, e.g. the source of the data, the measurement method used, etc.. The database should be based upon an open data structure which will facilitate future extension of the database. Moreover it should be possible to link the database to external databases through interfaces. The information system incorporates additional functionality, such as a geographical information system (GIS) for easy processing and presentation of spatial data. Furthermore the information system may include rule- and knowledge bases, containing circumstantial quantitative and qualitative information to be used for evaluation purposes. These databases may contain amongst others accepted criteria for water quality, remote sensing imagery and descriptive ecological information on local species, habitats and valuable resources.

The information system is used to describe the historic and present state of coastal resources. The scope of the system depends on the envisaged uses. The system will provide the necessary field data for calibration and validation of the models, which are included in the decision support system. In addition, the information system provides qualitative and quantitative data which can be used in a policy analysis.

Subsystem 2: Integrated model system

An integrated model system consists of a set of related models. Basically two types of models can be distinguished: user function models and natural system models.

- User function models describe the demands and impacts from user functions on the natural system (e.g. extraction of sand for coastal protection and land reclamation; waste loads from domestic and industrial sources). In addition there

are user function models which describe the impact of the state of the natural system on particular user functions (e.g the impact of water quality on fish productivity).

- Natural system models describe the physical, chemical and biological processes within a natural system. It includes phenomena such as hydrodynamics, eutrophication, coastal morphology, dispersion and accumulation of toxic substances, etc..

In developing an integrated model system it is important to match inputs and outputs of the different models. Differences in timescale (dynamics) and level of spatial aggregation often require conversion of model output before it can serve as input for a next model.

Subsystem 3: Policy analysis framework

A decision support system is used to analyse cases. A "case" comprises a completely specified situation to be analyzed, including a strategy (i.e. a combination of management measures), a scenario for external developments (including economic growth, population growth, climate change, etc.) as well as certain important boundary conditions. The socioeconomic, ecological and spatial consequences of a particular case are assessed using the integrated model system. Many different cases can be analysed to evaluate the attractiveness and feasibility of various alternative strategies.

As models tend to produce enormous amounts of output data, there is the need for an environment in which such output data can be aggregated and condensed, e.g. in the form of comprehensive score-cards and maps for evaluation.

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- 32 (Replaces Nos. 12, 13 and 14) Preliminary orientation of socio-economic Master Plan in SFEZ.

Appendix 1

Site visit Vung Tau, 19 and 20 March 1996

Site visit Vung Tau

On 19 and 20 March 1996 a site visit was carried out by the following team:

Mr Nguyen Ngoc Huan, MHC Hanoi
Mr Lam, MHC Hanoi
Mr Nguyen Huu Nhan, South Center of Hydrometeorology
Mr Boa Thanh, South Center of Hydrometeorology
Mr G. Toms, Fr H
Mr T. Okroj, IBW
Mr C.H. Hulsbergen, DELFT HYDRAULICS

On 19 March the team made a trip from HCMC to Vung Tau, using a small craft (see Figure 1.3). The busy HCMC Port and quays along the Saigon River and the industrial development sites (including the Tan Thuan special economic zone) along the upper river were inspected. Nautical activities observed include general cargo vessels, car carriers, LPG carriers, a fast hydrofoil passenger boat connecting HCMC with Vung Tau, local small scale dredging activities, mooring buoys in the river with seagoing ships being serviced by small lighters. At Cat Lai the relatively narrow Saigon River merges with the much wider branch of the Song Nha Be. At the southern end point of this wider part, heading for the narrower Song Long Tau, we checked at a riverside customs office.

Going further seaward through the winding branches of the lower river system we inspected the lush river bank mangroves, which were at some spots locally removed to make place for small villages and solitary houses, small scale private boat landing sites made of wooden poles, and small scale inlets and outlets for fish ponds and salt collecting sites. In this particular nearcoast area there is no rice cultivation, since only during the rainy season there is some fresh water supply.

During the trip the tide was falling, and gradually more of the steeply sloping muddy banks were exposed. Nowhere along the river banks during this trip there are any protection dikes. Especially the mangrove area south of HCMC, through which the second part of our trip went, has been seriously damaged (only 30% of the mangrove forest survived) during the American war using chemical means. Since 1975 massive reforestation efforts have recovered large portions of the mangrove stands in an artificial way, while a more diversified, natural mix of mangrove vegetation was seen bordering the river. Mr Pham Trong Thinh, Ecologist of FIPI, informed us about the current efforts at FIPI to draw up an ecologic Master Plan for the entire Mekong River Delta area, including the Saigon River area.

Finally we arrived in Vinh Ganh Rai (Ganh Rai Bay), where we passed along the low lying seaside town of Can Gio and an idle offshore platform (Viet-Sov) on our way to the Vung Tau peninsula with its three conspicuous hill tops rising to an elevation of some 200 m, with a lighthouse on the southernmost hill top.

During the trip, fishery techniques of various kinds and scales were seen. On the river (long stretches of nets parallel to the river banks; nets suspended by small boats half way across the stream); in Ganh Rai Bay (nets suspended between a row of half a dozen large

poles, one of them carrying a hut), and at sea (150 HP fishing boats heading for fishing grounds 100 miles offshore, making trips of 2 or 3 weeks at sea).

In Vung Tau we enjoyed a panoramic view from the lighthouse on the southernmost of the three mountains on the Vung Tau peninsula, and were shown various interesting landmarks, such as:

- Local town beach used for small craft fisheries landings;
- Fisheries village of Ben Dinh (some 20,000 families depend on fishing) full of dried fish in the streets and on top of the houses roofs;
- Fisheries wharf and small shipyard with heavy shoreline pollution;
- Offshore supply base a bit further to the east;
- Between the ocean and the Bay there are the remainings of the former elongated lagoon, now used as fish ponds and in the future to be incorporated in a new public park complex (FIPI);
- Ocean beach for weekend visitors from HCMC and for tourists, including 230 ha holiday resort set up by Taiwan;
- The magnificent complex of dunes which are backing the beach; there are plans (FIPI) for a public beach park of what is remaining of the dunes, which have been partly deforested and exploited for tourism.

Appendix 2

**Meeting with:
People's Committee of Ba Ria Vung Tau Province**

Meeting with: People's Committee of Ba Ria Vung Tau Province

Meeting on 19-3-1996 with the People's Committee of Ba Ria Vung Tau Province, the Department Of Science, Technology and Environment (DOSTE):

Mr Nguyen Van Hoang, Director

Mr Nguyen Quang Lich, Head of Environmental Section

After a brief presentation of the scope of the Pilot Study by Mr Toms, Mr Hoang gave us the following general information about the plans to develop the Ba Ria Vung Tau Province, thereby indicating the relevant locations on a 1:50,000 scale wall map.

Vung Tau population has grown from 140,000 in 1992 to 170,000 in 1995. Asked for a crude estimate for 2010, a number of 500,000 is mentioned. So, massive residential extensions will be needed.

Massive port extension planning is done in close cooperation with HCM, in view of large dredging efforts needed to improve existing access capacity to Port of HCM.

New road connections with HCM are already partly under construction.

Upgrading of water supply will be needed. Existing pipeline (diameter 0.5m) from reservoir in mountains some 50 km northeast of Vung Tau will be too small for future demand.

A power plant of 2400 MW (natural gas) is planned (BP has found promising natural gas fields).

There is much interest from abroad to lease land for various industrial and tourism development. Taiwan (has 230 ha for tourism resort on ocean beach), Mitsubishi, etc. Also interest for Con Dao island.

Although the central Government has decided to locate the main centre of the offshore-related petroleum industry in the Dun Quat area in the middle of Vietnam, local refinery development is foreseen to develop at Vung Tau as well.

Fisheries are encouraged to engage more in larger scale, deepsea activities instead of local activities in the river, bay and coastal waters.

On the land, agriculture will be developed. Also, hotwater springs and mineral water sources are interesting for tourism development

Asked about the implications of all these developments for the environment, the following information was provided.

There is a big concern about the impact all these changes will have on the environment. Now there are large mangrove areas, and one wishes to protect these, at least in part. The expected deterioration of the ambient water quality will form a threat. Sources of water pollution are diverse and will increase in number and intensity.

A recent oil spill occurred on the White Tiger platform, releasing 300 tons of oil about 9 miles offshore. On the Dai Hung platform 100 tons of oil were accidentally spilled. Also recently in HCMC a 5000 DWT vessel smashed a wharf causing an oil spill.

The following sources of water pollution were mentioned as threats for the Vung Tau area:

- offshore production platforms,
- onshore oil industry,
- shipping transport,
- industrial plants in general,
- domestic sewage (no treatment at all),
- fisheries.

At this moment a programme of water quality and environmental monitoring in 17 stations is going on (1996 - 1999), but the equipment and staff is hardly sufficient. For individual projects an Environmental Impact Assessment (EIA) is said to be needed before implementation is allowed. In connection with relatively small projects (under 3 million US\$) DOSTE may act on its own behalf to investigate the environmental impacts. For marine projects closer than 3 km from the shore, the Province has its own responsibility; beyond that line it is up to the central Government. Many aspects of development and especially the environment are typically trans-provincial. More coordination is much needed in order to gain a better, more effective grip on the environmental impacts of coming large scale developments in this area. There is no sufficiently powerful and coherent, high-level environmental authority to date, which is a great concern to the local (provincial) DOSTE.

Finally, it was verified and confirmed that at present in the Vung Tau area there are no serious coastal erosion problems, and no flooding problems.

Appendix 3

**Meeting at:
The Institute for Economic Research of HCM**

Meeting at: The Institute for Economic Research of HCM

Meeting on 23-3-1996 with:

Dr Ton Si Kinh, Vice Director
Mrs To Thi Thuy Hang, Researcher

After a brief presentation of the scope of the Pilot Study by Mr Hulsbergen, Dr Kinh and Msr Hang informed us as follows.

The Institute for Economic Research (IER) of HCMC plays an important role in preparing and coordinating the socio-economic development plans in Vietnam. In a cyclic process the IER is involved in preparing, planning and coordinating on National, Provincial and District level. For example under the general planning guidelines of the socio-economic goals for the SFEZ (encompassing the four Provinces HCMC, Song Be, Dong Nai, and Ba Ria Vung Tau), the actual implementation activities belong to the competence of the Provinces, which on their turn take care of coordinated implementation on District level.

In accordance with this, during the meeting it was emphasized that the various maps and plans as presented in the various SFEZ-reports do not pretend to solve problems in detail, but rather give a framework for subsequent detailed planning. But, although this framework is not very detailed, it does form an assessment reference for example to allocate (or to reject) foreign investment proposals by comparing those proposals with the intended land use as laid out in the plans.

To illustrate the consecutive steps in the planning process it was said that the final version of the overall development report of HCMC (including scenarios for three different quantitative development options) will be ready by the end of March 1996. By mid 1996, the HCMC People's Committee will have seen and commented the priorities of the plan. Then the plan will go to the Prime Minister's Office and to relevant Ministries. Subsequently, on the basis of this approved plan, Master Plans will be drawn up via the IER, and post-planning projects will be worked out in more detail. Finally, depending on the size of the individual projects, decisions will be taken to implement the detailed plans on Central, Provincial or on District level.

Within the Southern Focal Economic Zone (SFEZ), HCMC as the main centre will have to further expand in the near future. Among other considerations, one reason for horizontal expansion of HCMC is that the Central Government regards the present number of inhabitants of the inner center of the city (about 3.4 million) already unacceptably high, and rather opts for a maximum of about 2.5 million. Discussions are currently going on about the best geographical direction of this necessary lateral expansion. Until recently, an expansion in NE direction (in the direction of Bien Hoa) was thought to be preferable for various reasons, but not long ago a number of arguments indicated that an expansion towards the SE could be favourable. This would mean an expansion roughly in the direction of Vung Tau.

A number of possibly very important implications of this SE expansion direction should however be carefully investigated prior to finally taking such a far reaching decision.

A first implication is related to the given direction of river flow, with all associated aspects of upstream water pollution effects (industrial and domestic) on downstream water quality (the river water being used both for sewage disposal and drinking water intakes, the local ground water capacity not being an option for massive drinking water retrieval).

A second implication is that a SE expansion might sooner or later interfere with harbour-related developments, which will take place in the same direction (see also the meeting with TEDI, Appendix 4).

Thirdly, expanding residential areas towards the lower lying parts of the delta automatically means moving towards areas which are more exposed to the impacts of Sea Level Rise. In this respect the IER expressed keen interest in the results of the main VA study, realizing that this might be of great importance in the basic decision-making process for the further expansion of HCMC.

At the end of the meeting, some remarks were made highlighting the views and tasks which the IER finds very important with respect to planning and implementation:

- Environmental factors should be taken into consideration more seriously than in the past.
- HCMC will consider the implementation of own pricing mechanisms (e.g. for power and water) as a means of management.
- The actual rate of development for HCMC in 1995 was significantly higher than anticipated. This is one of the reasons that an updated version of the SFEZ-planning report has been made (February 1996).
- In terms of foreign investments the ranking of the first six Provinces is as follows:
 - 1 HCMC,
 - 2 Ha Noi,
 - 3 Dong Nai,
 - 4 Ba Ria Vung Tau,
 - 5 Hai Phong,
 - 6 Song Be.
- A major problem in view of the implementation of the development plans, is to maintain a sound and safe balance concerning important population aspects. Main concerns are:
 - 1 the rate of internal migration,
 - 2 to supply sufficient infrastructure,
 - 3 education development,
 - 4 conflict of industrial development with tourism and environment.

Appendix 4

**Meeting at: The Transport Engineering Design Institute
(TEDI-South), Consultants under the Ministry of Transport**

Meeting at: The Transport Engineering Design Institute (TEDI-South), Consultants under the Ministry of Transport

Meeting on 23-3-1996 with:

Mr Nguyen Van Loc, Vice Director
Mr Le Quang Trinh, Chief of Technical Department
Mr Ha Ngoc Truong, Bridge & Road Specialist
Mrs Tran Thi Bich Phuong, Secretary to the Director

After a brief presentation of the scope of the Pilot Study by Mr Hulsbergen, Mr Loc and Mr Truong informed us as follows about the status of port planning and development in the HCMC area and the Vung Tau area, referring to a 1:50,000 scale wall map showing various planned port extension stages. There are two main port development areas: the HCMC area and the Vung Tau area.

The port of HCMC (along the Saigon River and its confluence with the Dong Nai River) currently has a capacity of 15 Mtonnes/yr for ships up to 15,000 to max. 20,000 DWT. This port needs to be extended before the year 2000. Therefore two river port areas are planned south of HCMC for 15,000 - 50,000 DWT ships, adding a capacity of 40 to 50 Mtonnes/yr. Access to these ports from the sea needs to be improved, since the Nha Be River and Soai Rap River Mouth, although wide enough, are too shallow. Large scale capital and maintenance dredging is currently investigated as to its cost and feasibility, along with a study of the overall river bed dynamics. Recently, the Ministry of Transport has assigned TEDI-South to prepare a Master Plan for the entire port development along the Saigon River South of HCMC.

The other option for major port developments in the area is along the river system north of Vung Tau, i.e. the Thi Vai River and the Cai Mep River, which discharge in the Ganh Rai Bay near Vung Tau. This area near Vung Tau certainly has a better natural deep water port development potential than HCMC. The ongoing planning and development for this area is subsequently discussed, going from north to south on the map where about half a dozen riverbound port and industrial zones are indicated along the Thi Vai River and the Cai Mep River, named Go Dau, Thi Vai, Phu My, Go Gia, Cai Mei, Long Son, and Ben Dinh (the last one near Vung Tau). These new industrial sites are now in development. Some jetties and terrains have already been finished and others are in various stages of construction, preparation and (pre-)feasibility planning. These industrial sites accommodate plants for among others superphosphate, soda, ureum, bauxite, and various services for the petroleum industry. The 670 million US\$ Ben Dinh port complex near Vung Tau has passed the prefeasibility stage, has been OKayed on Government level, and awaits now a feasibility study. The preliminarily sketched SW breakwater is a very long term development, waiting for further interested parties to be focused on. From Australian side a broad interest has been shown for the entire Ganh Rai Bay area, but is waiting for next moves. TEDI regards a thorough investigation and analysis of currents, sediment movement and seabed stability in the Bay area as absolutely necessary in the framework of further feasibility studies.

Connected with these various large scale port development plans, a Japanese project looks into the establishment of a new fishing port some 8 km east of the present fishery

wharf at Vung Tau (which must make place for the Ben Dinh port development). Also, large areas of mangrove must make way for new bridges and roads. From Vung Tau along the ocean to the northeast a 115 km long coastal road, partly newly designed, will be necessary to open up these shores for industrial and tourism development. Contruction of this National Highway 55 project has just started on 15 March.

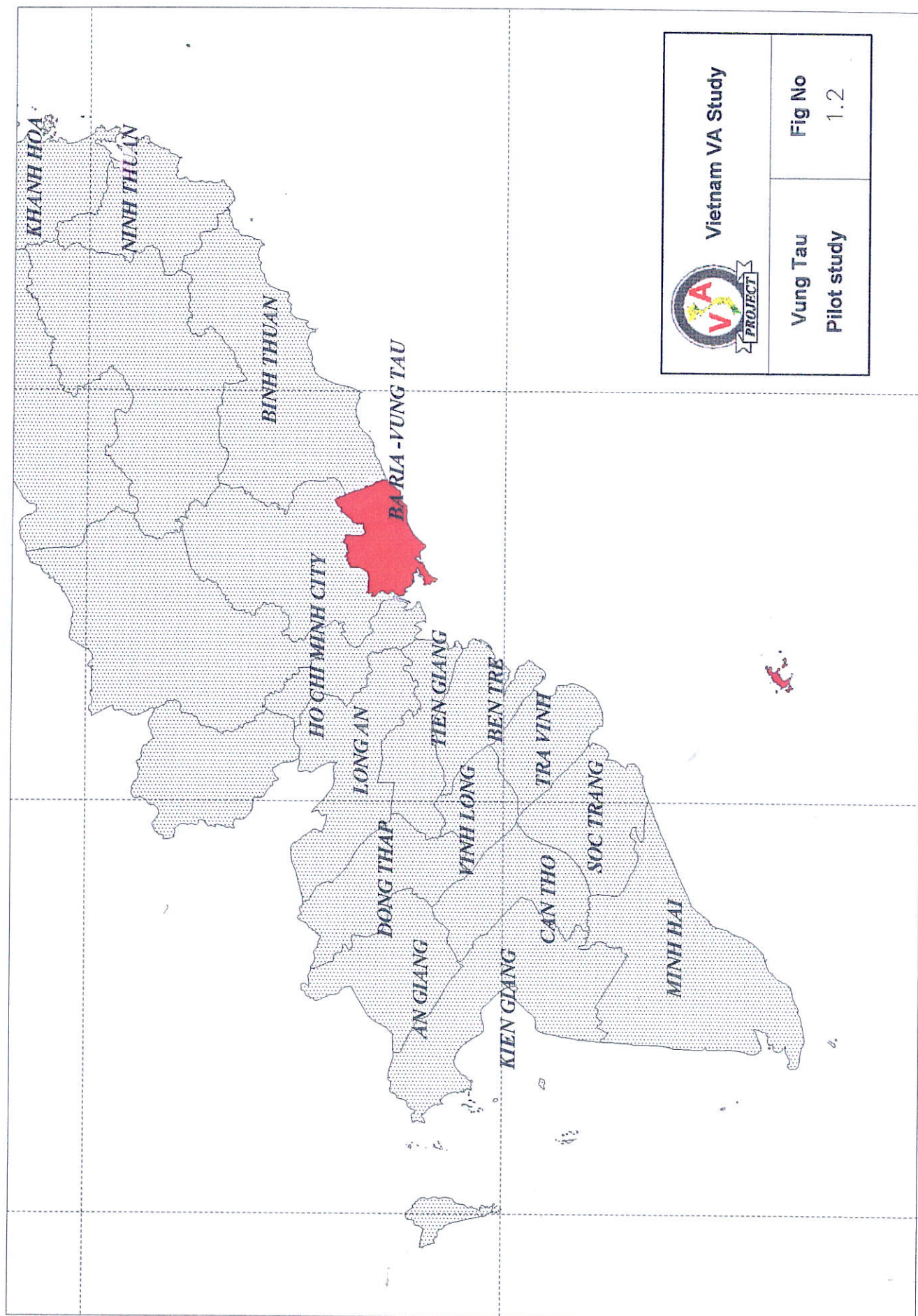
In general, potential conflicts between industrial and tourism development interests increasingly form a concern to the planners and designers of this potentially rich area.




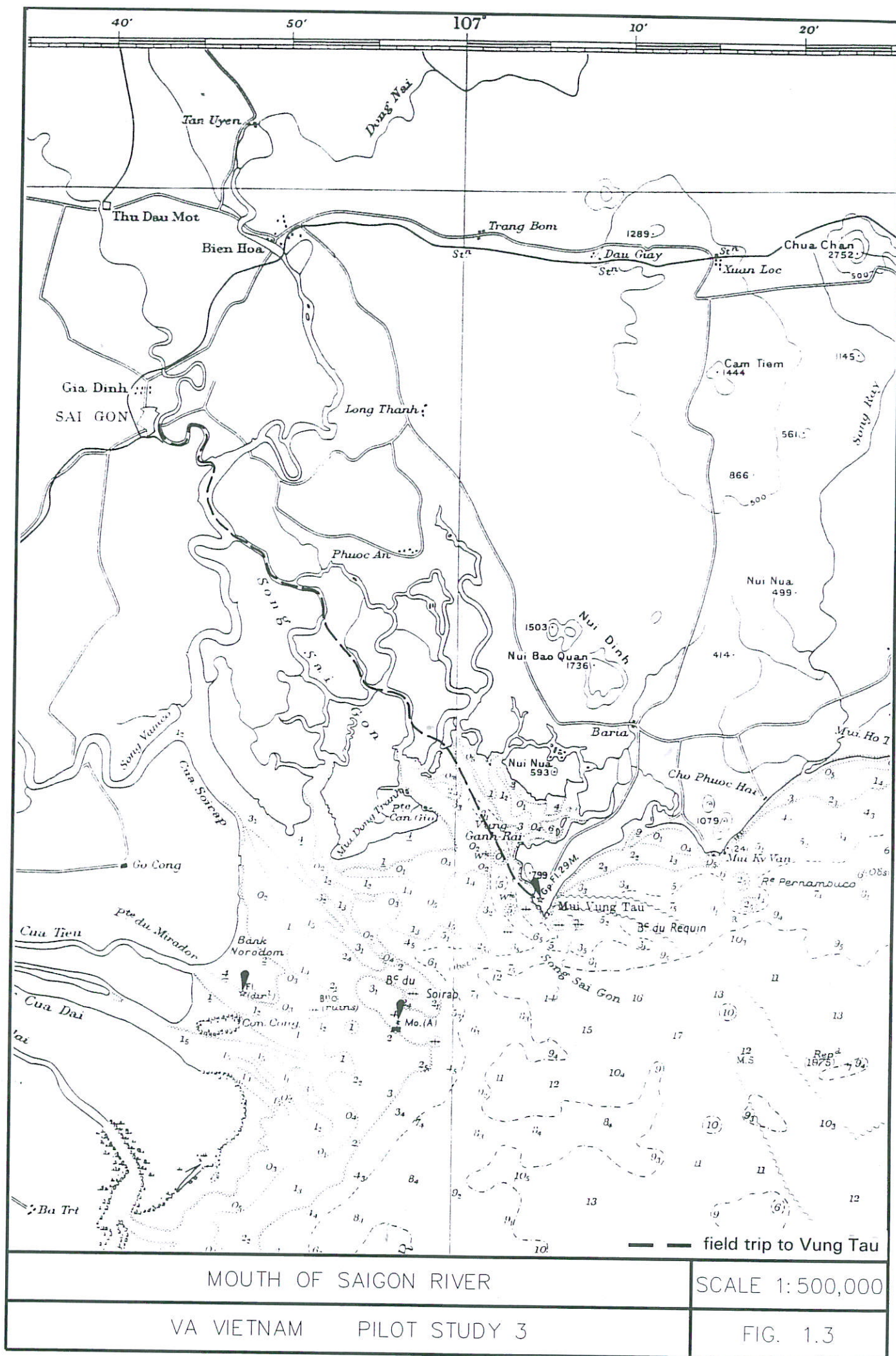
Vietnam VA Study

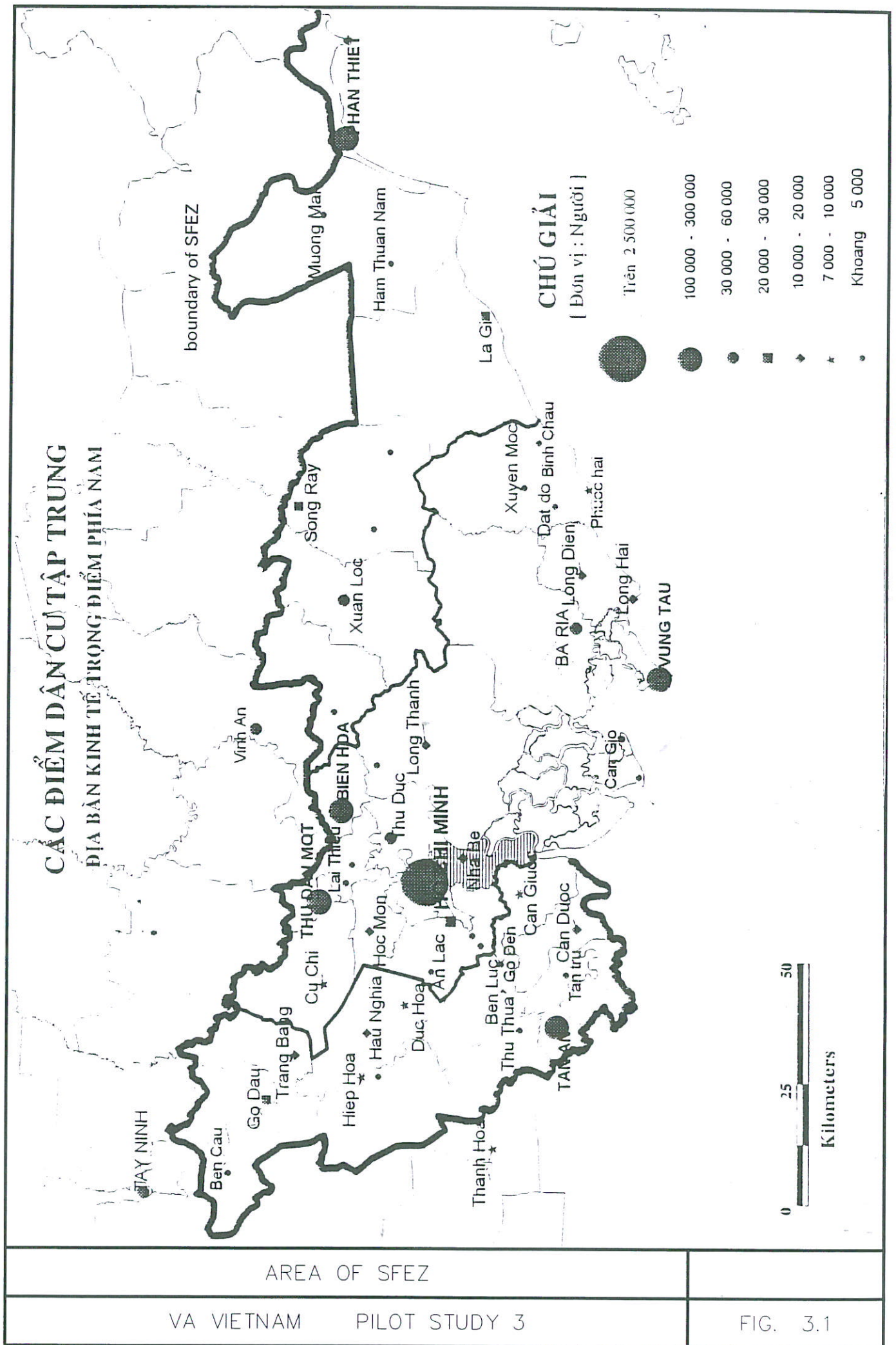
Sites of
3 Pilot Studies

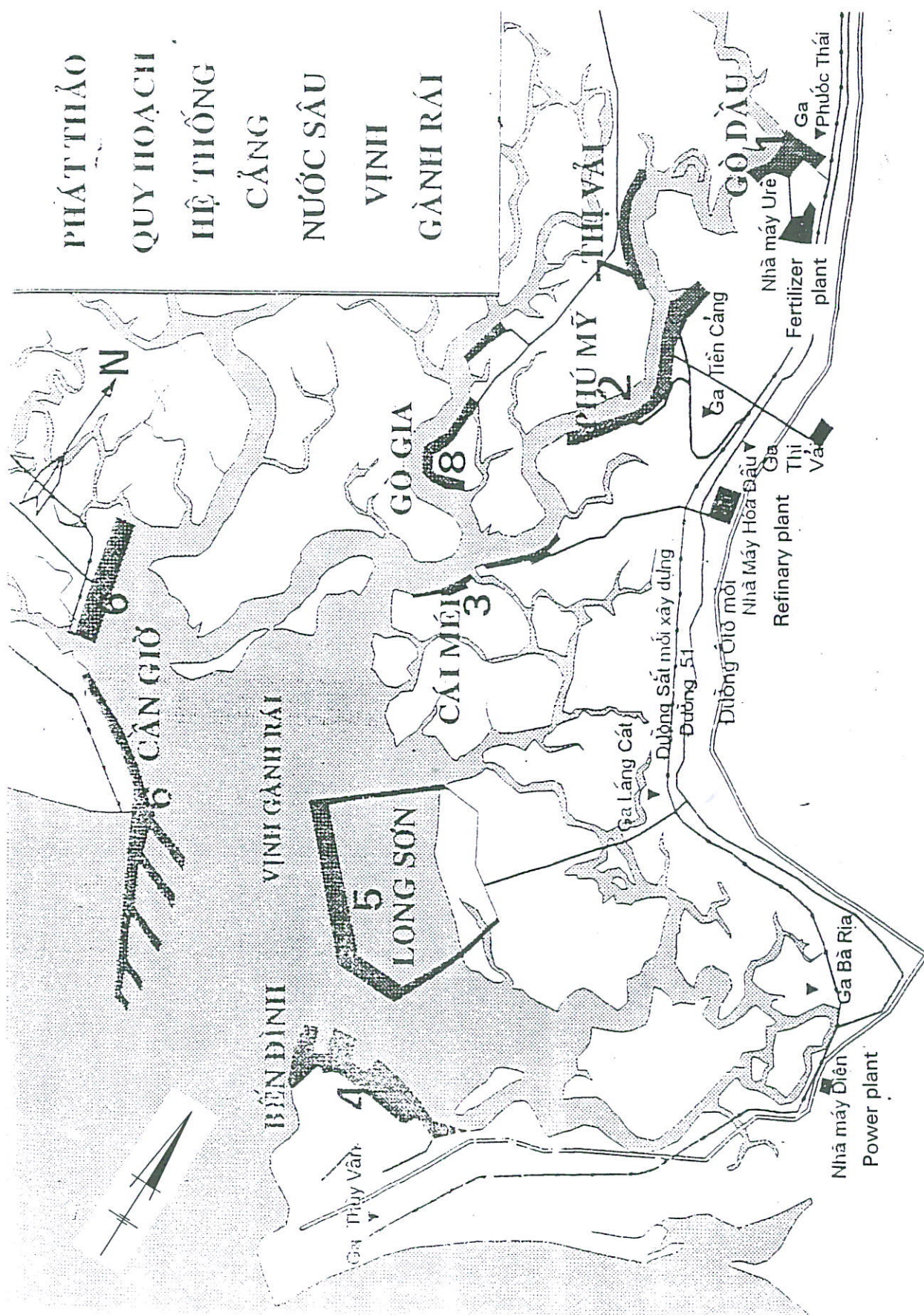
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1.1



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|--|-------------------------|---------------|
|  Vietnam VA Study | Vung Tau Pilot study | Fig No 1.2 |
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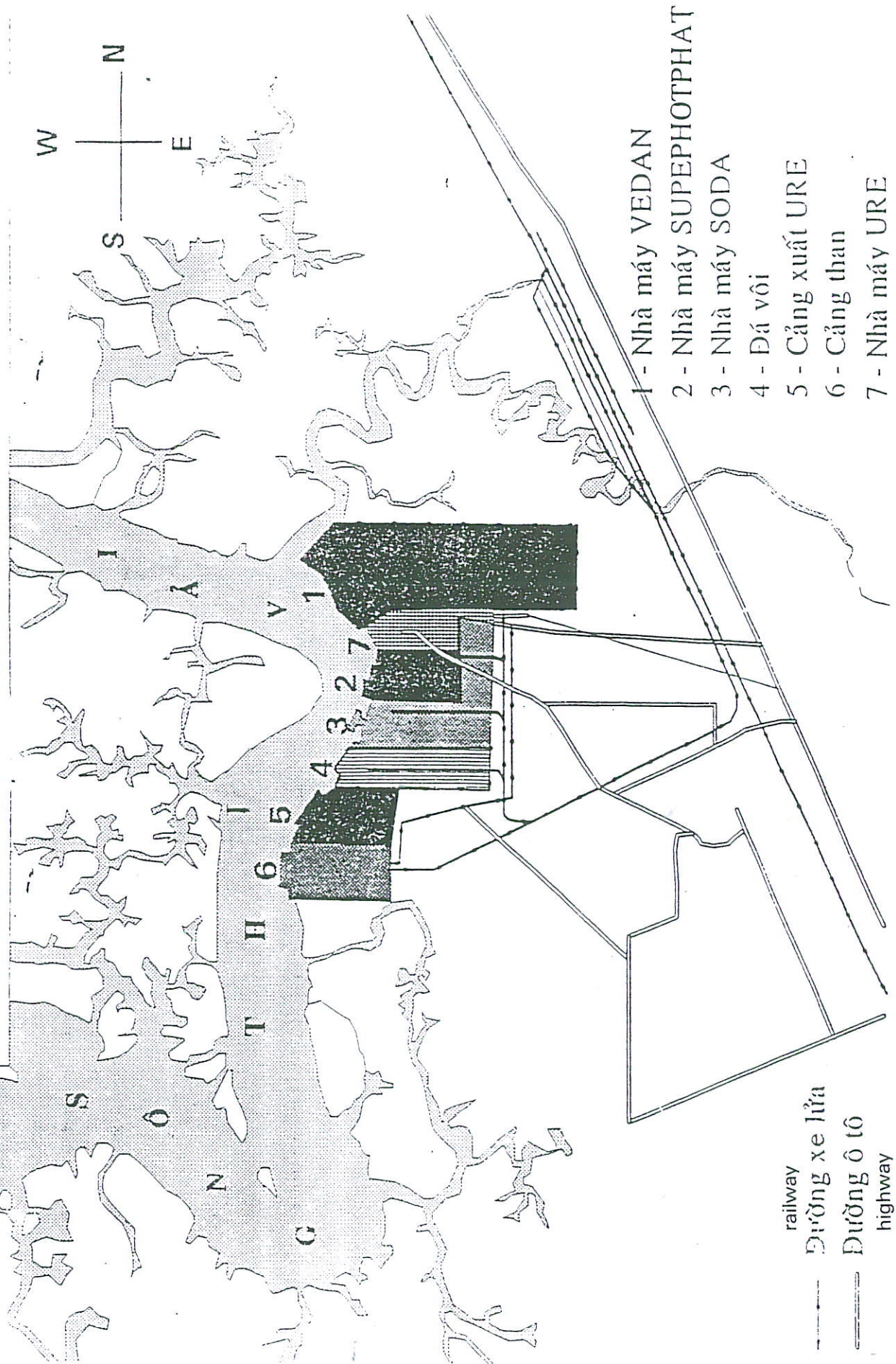




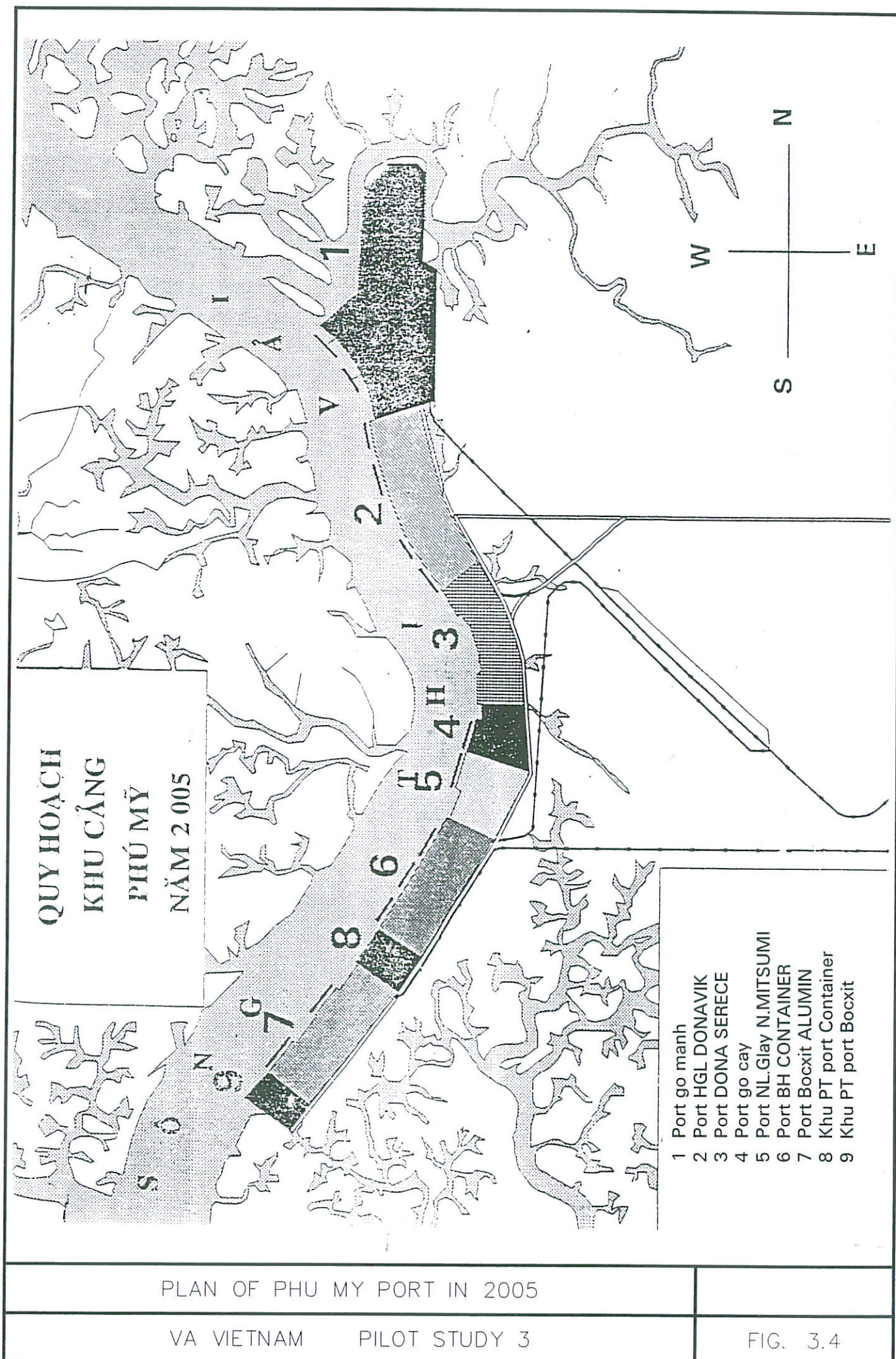


DRAFT PLAN OF DEEP-SEA PORTS SYSTEM
IN GANH RAI BAY

QUY HOACH CẢNG GỒ DẦU NĂM 2 005

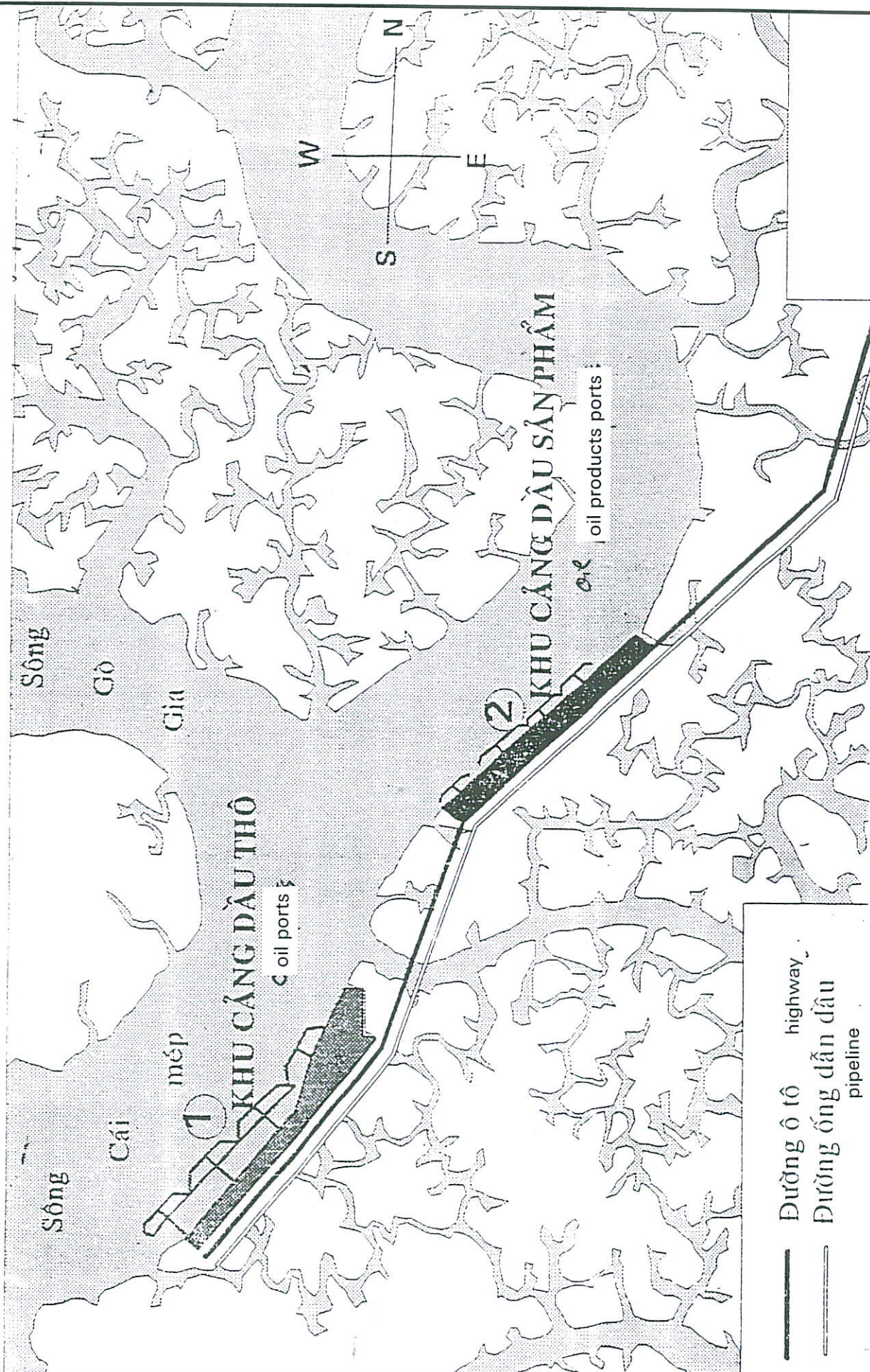


PLAN OF GO DAU PORT IN 2005



PLAN OF PHU MY PORT IN 2005

DỰ THẢO SƠ BỘ VỀ QUY HOẠCH CẢNG DẦU KHÍ NĂM 2005



DRAFT PLAN OF PETROLEUM PORT IN 2005

DỰ THẢO SƠ BỘ VỀ
 QUY HOẠCH KHU CẢNG BẾN ĐÌNH NĂM 2005



Cảng chuyển tải
 transition port

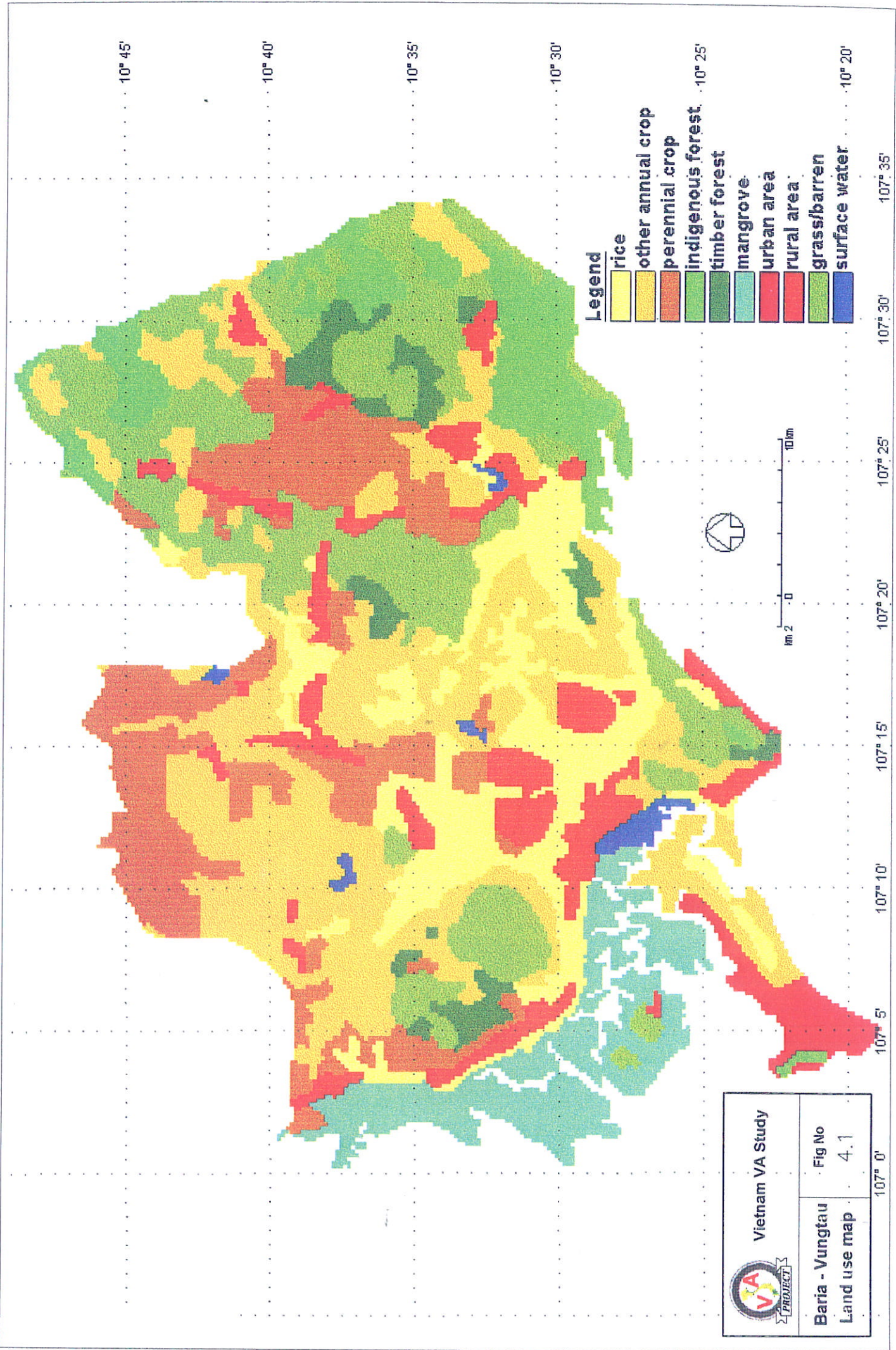
Khu cảng Container
 container port


Cảng dịch vụ dầu khí hiện hữu
 present petroleum services port

| STT | BT30000T | CHIEU DÀI | DIỆN TÍCH | area |
|-----------|----------|-----------|-----------------------|------|
| 1 | 6 | 1400 | 378000 | |
| 2 | 2 | 500 | 150000 | |
| 3 | 10 | 2300 | 907200 | |
| Tổng cộng | | 4200 m | 1435200m ² | |

→ μm

DRAFT PLAN OF BEN DINH PORT IN 2005

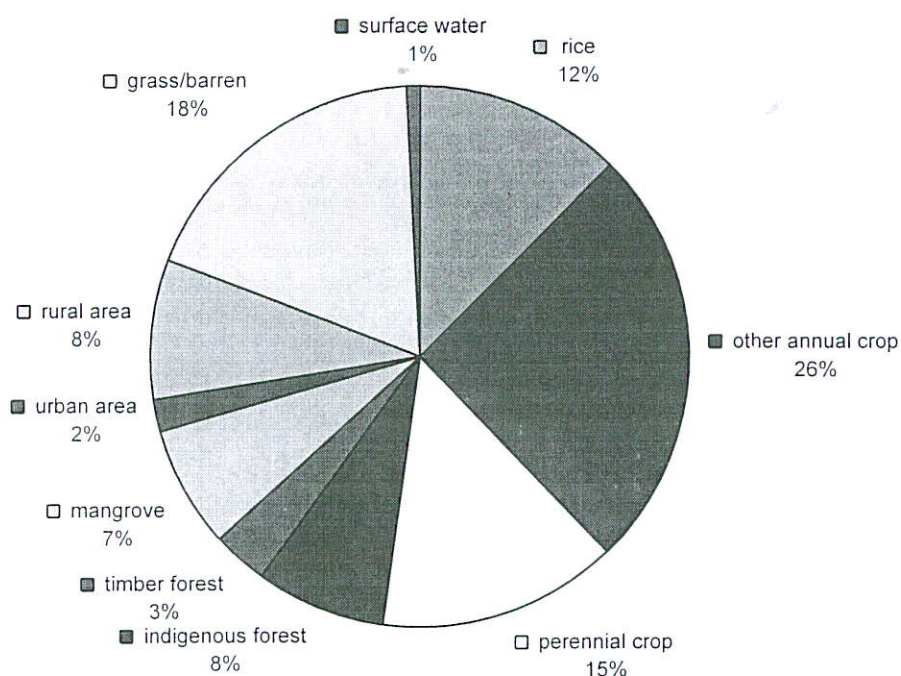



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|  Vietnam VA Study | |
| Baria - Vungtau | Fig No |
| Land use map | 4.1 |

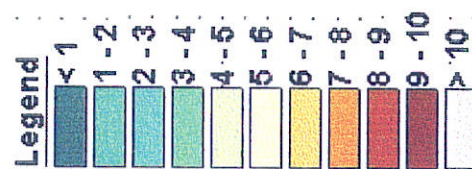
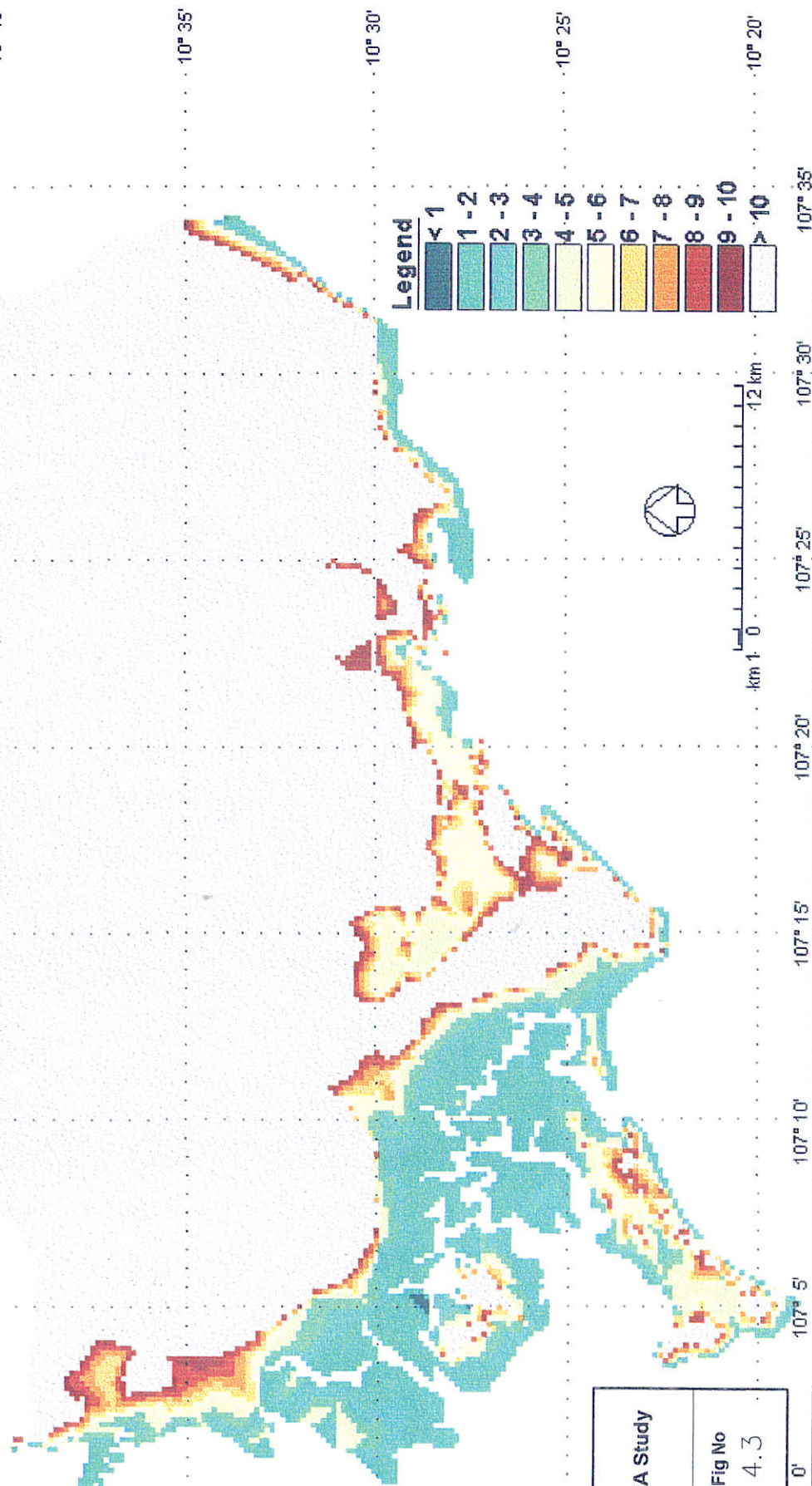
SINGLE MAP ANALYSIS

Map : landuse - landuse South Vietnam

| Class | Legend | Area(%) | Cumm Area | Area(km ²) |
|----------------------------|-------------------|------------|-----------|------------------------|
| 1 | rice | 12.41 | 12.41 | 230.5 |
| 2 | other annual crop | 25.33 | 37.75 | 470.38 |
| 3 | perennial crop | 14.56 | 52.31 | 270.44 |
| 6 | indigenous forest | 7.59 | 59.9 | 140.88 |
| 7 | timber forest | 3.34 | 63.24 | 62 |
| 8 | mangrove | 7.4 | 70.64 | 137.44 |
| 10 | urban area | 1.84 | 72.48 | 34.19 |
| 11 | rural area | 8.42 | 80.9 | 156.38 |
| 12 | grass/barren | 18.28 | 99.18 | 339.38 |
| 13 | surface water | 0.82 | 100 | 15.25 |
| Total of 10 classes | | 100 | | 1856.81 |



| | |
|---|-----------------------|
|  Vietnam VA Study | |
| Baria - Vungtau Elevation map | Fig No 4.3 |



AREA CROSS TABULATION FOR BA RIA - VUNG TAU PROVINCE

Row landuse - landuse South Vietnam

Col elev_m - elevation contours per meter

Area (km²)

Total [%]

Row [%]

Col [%]

| | < 1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 | 8-9 | 9-10 | >10 | Total |
|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 1 | 0 | 5.63 | 7 | 5.81 | 9.38 | 15.38 | 7.44 | 7.44 | 6.88 | 6.75 | 158.8 | 230.5 |
| | 0 | 0.3 | 0.38 | 0.31 | 0.5 | 0.83 | 0.4 | 0.4 | 0.37 | 0.36 | 8.55 | 12.41 |
| | 0 | 2.44 | 3.04 | 2.52 | 4.07 | 6.67 | 3.23 | 3.23 | 2.98 | 2.93 | 68.9 | |
| | 0 | 5.06 | 14.36 | 14.62 | 23.04 | 29.43 | 28 | 31.65 | 30.56 | 36 | 10.79 | |
| 2 | 0 | 13.44 | 4.88 | 4.19 | 6.31 | 11.44 | 3.69 | 2.56 | 2.19 | 2.25 | 419.4 | 470.38 |
| | 0 | 0.72 | 0.26 | 0.23 | 0.34 | 0.62 | 0.2 | 0.14 | 0.12 | 0.12 | 22.59 | 25.33 |
| | 0 | 2.86 | 1.04 | 0.89 | 1.34 | 2.43 | 0.78 | 0.54 | 0.47 | 0.48 | 89.17 | |
| | 0 | 12.09 | 10 | 10.53 | 15.51 | 21.89 | 13.88 | 10.9 | 9.72 | 12 | 28.49 | |
| 3 | 0 | 0 | 0 | 0 | 0 | 0.13 | 0.31 | 0.44 | 0.69 | 1.44 | 267.4 | 270.44 |
| | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.02 | 0.02 | 0.04 | 0.08 | 14.4 | 14.56 |
| | 0 | 0 | 0 | 0 | 0 | 0.05 | 0.12 | 0.16 | 0.25 | 0.53 | 98.89 | |
| | 0 | 0 | 0 | 0 | 0 | 0.24 | 1.18 | 1.86 | 3.06 | 7.67 | 18.16 | |
| 6 | 0 | 4.69 | 1.69 | 1.5 | 1.38 | 1.69 | 1.69 | 1.19 | 2.25 | 1.69 | 123.1 | 140.88 |
| | 0 | 0.25 | 0.09 | 0.08 | 0.07 | 0.09 | 0.09 | 0.06 | 0.12 | 0.09 | 6.63 | 7.59 |
| | 0 | 3.33 | 1.2 | 1.06 | 0.98 | 1.2 | 1.2 | 0.84 | 1.6 | 1.2 | 87.4 | |
| | 0 | 4.22 | 3.46 | 3.77 | 3.38 | 3.23 | 6.35 | 5.05 | 10 | 9 | 8.36 | |
| 7 | 0 | 0.13 | 0.19 | 0.19 | 0.13 | 1.63 | 0.63 | 0.94 | 0.81 | 0.44 | 56.94 | 62 |
| | 0 | 0.01 | 0.01 | 0.01 | 0.01 | 0.09 | 0.03 | 0.05 | 0.04 | 0.02 | 3.07 | 3.34 |
| | 0 | 0.2 | 0.3 | 0.3 | 0.2 | 2.62 | 1.01 | 1.51 | 1.31 | 0.71 | 91.83 | |
| | 0 | 0.11 | 0.38 | 0.47 | 0.31 | 3.11 | 2.35 | 3.99 | 3.61 | 2.33 | 3.87 | |
| 8 | 0.63 | 71.75 | 22.06 | 12.56 | 7.88 | 6.38 | 4.44 | 2.63 | 2.31 | 1.44 | 5.38 | 137.44 |
| | 0.03 | 3.86 | 1.19 | 0.68 | 0.42 | 0.34 | 0.24 | 0.14 | 0.12 | 0.08 | 0.29 | 7.4 |
| | 0.45 | 52.21 | 16.05 | 9.14 | 5.73 | 4.64 | 3.23 | 1.91 | 1.68 | 1.05 | 3.91 | |
| | 100 | 64.57 | 45.26 | 31.6 | 19.35 | 12.2 | 16.71 | 11.17 | 10.28 | 7.67 | 0.37 | |
| 10 | 0 | 4.25 | 2.56 | 4.38 | 7 | 5.13 | 2.5 | 1.88 | 0.94 | 0.5 | 5.06 | 34.19 |
| | 0 | 0.23 | 0.14 | 0.24 | 0.38 | 0.28 | 0.13 | 0.1 | 0.05 | 0.03 | 0.27 | 1.84 |
| | 0 | 12.43 | 7.5 | 12.8 | 20.48 | 14.99 | 7.31 | 5.48 | 2.74 | 1.46 | 14.81 | |
| | 0 | 3.82 | 5.26 | 11.01 | 17.2 | 9.81 | 9.41 | 7.98 | 4.17 | 2.67 | 0.34 | |
| 11 | 0 | 2.38 | 6.69 | 8.63 | 6 | 6.69 | 3.94 | 4.25 | 3.81 | 2.69 | 111.3 | 156.38 |
| | 0 | 0.13 | 0.36 | 0.46 | 0.32 | 0.36 | 0.21 | 0.23 | 0.21 | 0.14 | 5.99 | 8.42 |
| | 0 | 1.52 | 4.28 | 5.52 | 3.84 | 4.28 | 2.52 | 2.72 | 2.44 | 1.72 | 71.18 | |
| | 0 | 2.14 | 13.72 | 21.7 | 14.75 | 12.8 | 14.82 | 18.09 | 16.94 | 14.33 | 7.56 | |
| 12 | 0 | 3.13 | 1.44 | 1.88 | 2.56 | 3.81 | 1.94 | 2.19 | 2.63 | 1.56 | 318.3 | 339.38 |
| | 0 | 0.17 | 0.08 | 0.1 | 0.14 | 0.21 | 0.1 | 0.12 | 0.14 | 0.08 | 17.14 | 18.28 |
| | 0 | 0.92 | 0.42 | 0.55 | 0.76 | 1.12 | 0.57 | 0.64 | 0.77 | 0.46 | 93.78 | |
| | 0 | 2.81 | 2.95 | 4.72 | 6.3 | 7.3 | 7.29 | 9.31 | 11.67 | 8.33 | 21.62 | |
| 13 | 0 | 5.75 | 2.25 | 0.63 | 0.06 | 0 | 0 | 0 | 0 | 0 | 6.56 | 15.25 |
| | 0 | 0.31 | 0.12 | 0.03 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0.82 |
| | 0 | 37.7 | 14.75 | 4.1 | 0.41 | 0 | 0 | 0 | 0 | 0 | 43.03 | |
| | 0 | 5.17 | 4.62 | 1.57 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0.45 | |
| Total | 0.63 | 111.1 | 48.75 | 39.75 | 40.69 | 52.25 | 26.56 | 23.5 | 22.5 | 18.75 | 1472 | 1856.81 |
| | 0.03 | 5.98 | 2.63 | 2.14 | 2.19 | 2.81 | 1.43 | 1.27 | 1.21 | 1.01 | 79.29 | |

BA RIA – VUNG TAU LAND USE VS ELEVATION

VA VIETNAM PILOT STUDY 3

FIG. 4.4

Legend

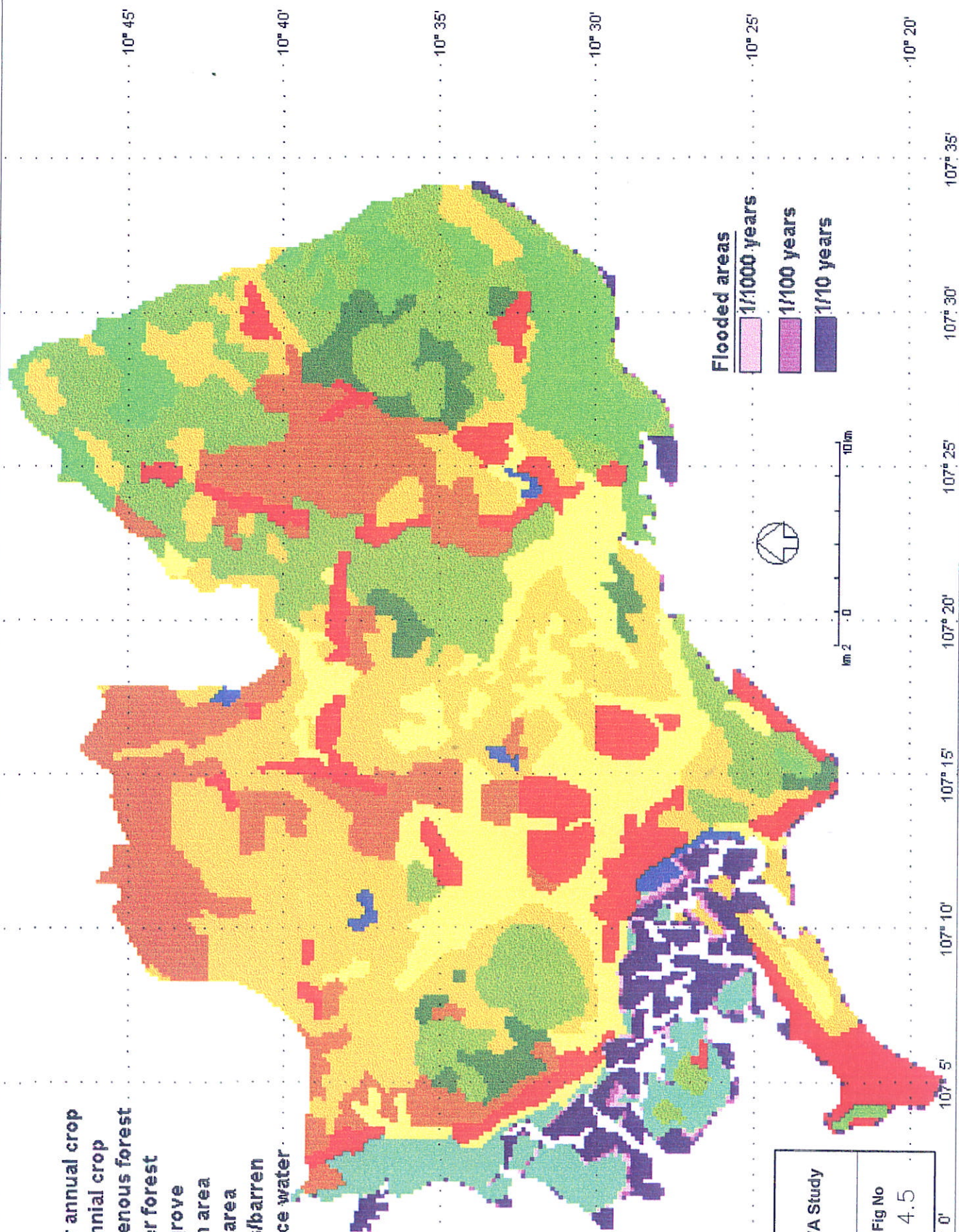
- rice
- other annual crop
- perennial crop
- indigenous forest
- timber forest
- mangrove
- urban area
- rural area
- grass/barren
- surface water

- Flooded areas**
- 1/1000 years
 - 1/100 years
 - 1/10 years



km 2 0 10 km

| | |
|---|----------------------|
| | |
| Baria - Vungtau Flooded areas without ASLR | Fig No 4.5 |



Legend

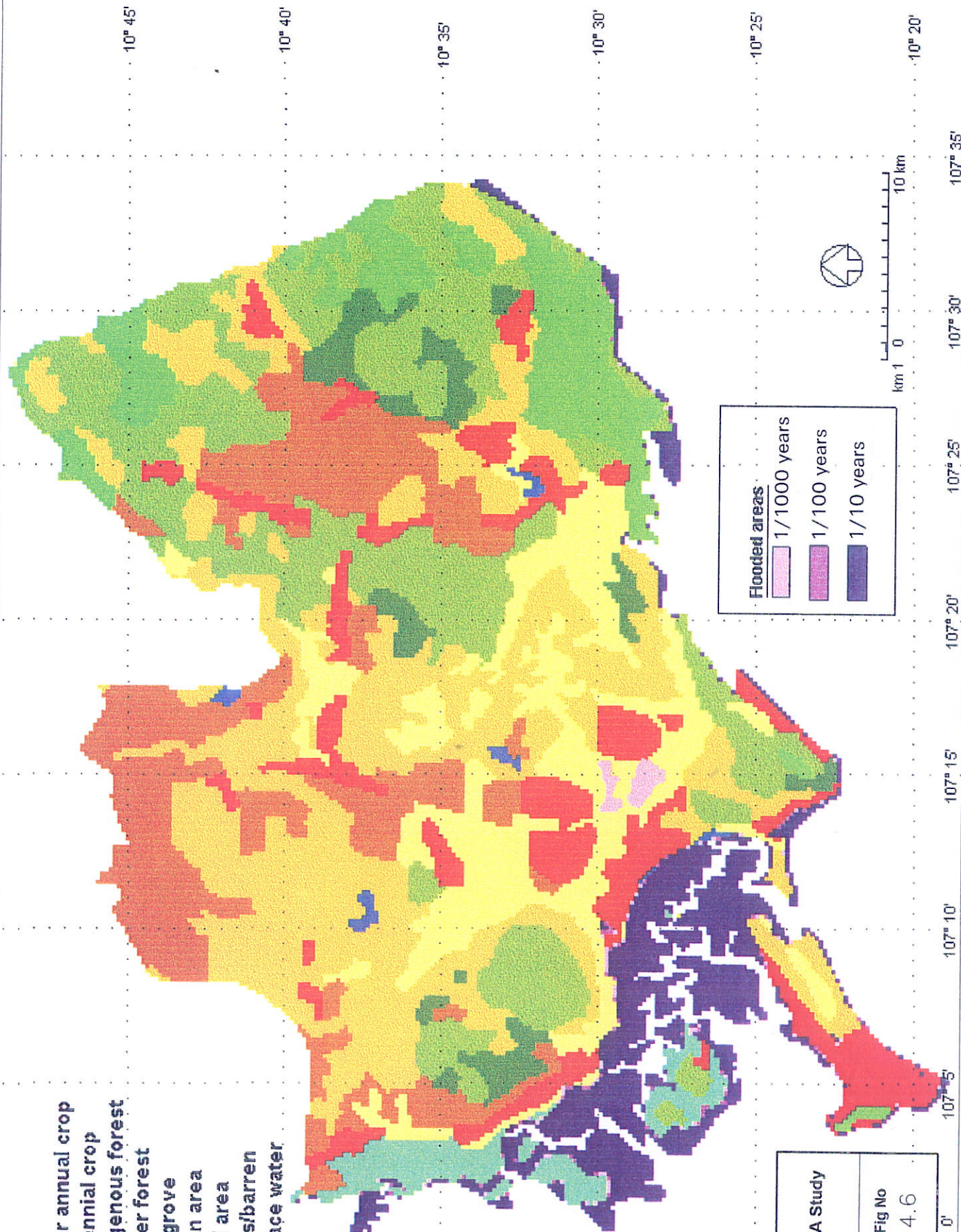
- rice
- other annual crop
- perennial crop
- indigenous forest
- timber forest
- mangrove
- urban area
- rural area
- grass/barren
- surface water

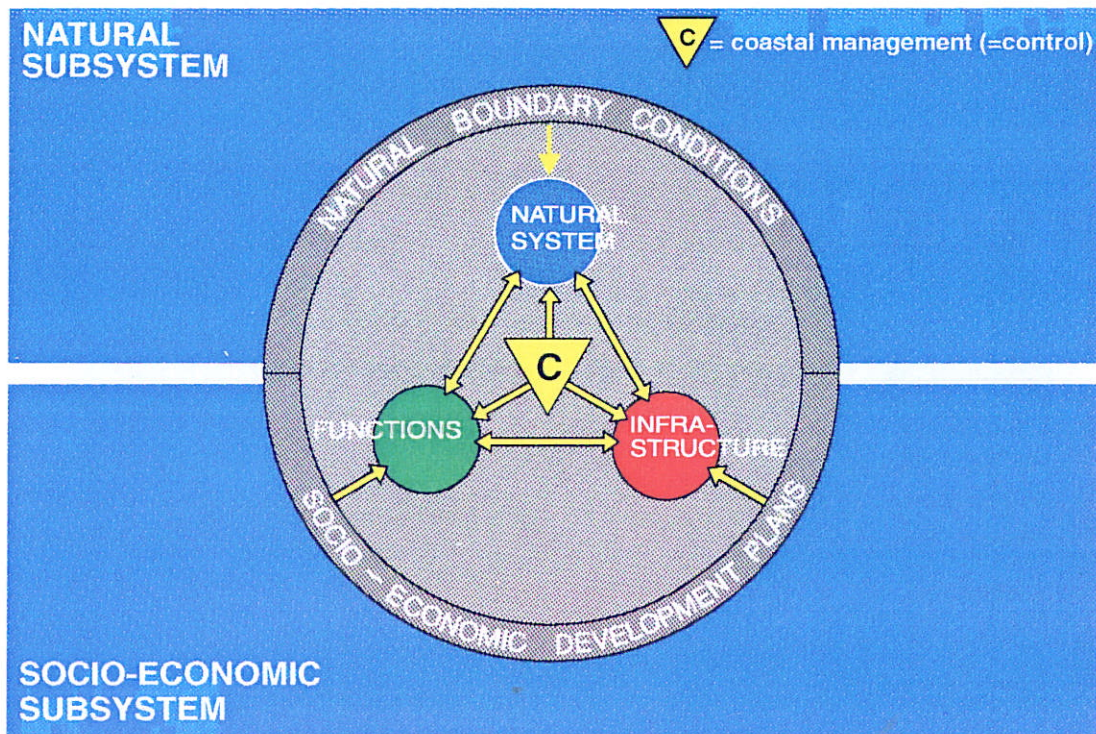


Vietnam VA Study

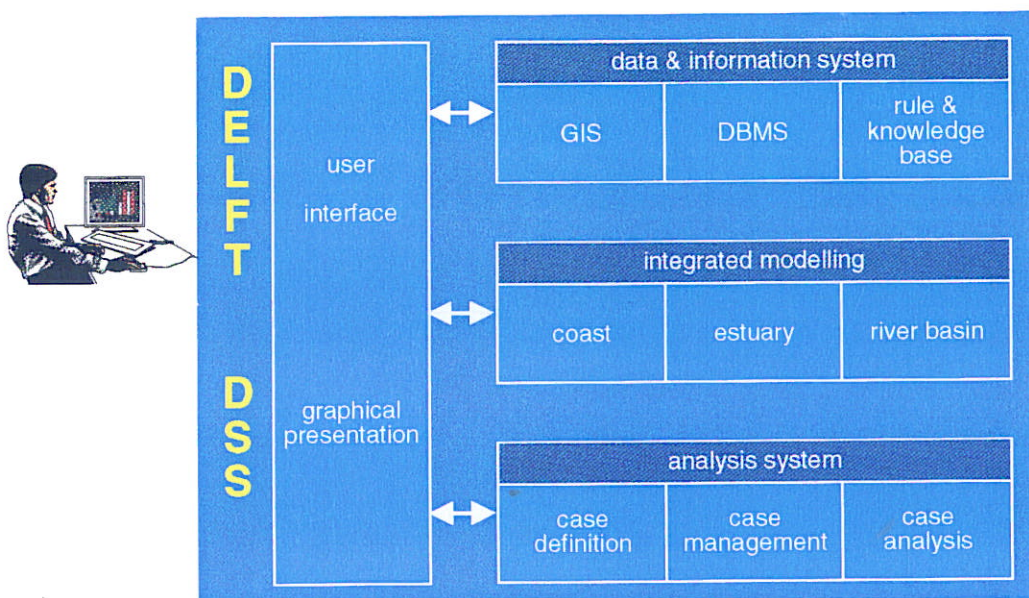
Baria - Vungtau
Flooded areas
with 1m ASLR

Fig No
4.6





COASTAL MANAGEMENT SYSTEM WITH ITS SUBSYSTEMS



GENERAL SET-UP OF DECISION SUPPORT SYSTEMS
FOR RESOURCES MANAGEMENT

