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Bach Ma National Park
Lam Dong Provincial Forest Protection Department
Ha Tinh Provincial Forest Department
People's Committee of Lao Cai Province
People's Committee of Cao Bang Province
People's Committee of Lai Chau Province
People's Committee of Bac Thai Province
People's Committee of Nghe An Province
People's Committee of Ha Tinh Province
People's Committee of Thanh Hoa Province
People's Committee of Khanh Hoa Province
People's Committee of Lam Dong Province
People's Committee of Song Be Province
People's Committee of Minh Hai Province
People's Committee of Kien Giang Province

The BAP broadly reflects the needs and wishes of the Vietnamese people as well as the international community. The BAP Planning Team wishes to thank all of these institutions and the numerous dedicated individuals associated with each for countless hours of assistance and guidance provided.

BAP Planning Team
Hanoi - November 1994

LIST OF ACRONYMS

ABC	Asian Bureau for Conservation
AWB	Asian Wetland Bureau
BAP	Biodiversity Action Plan
COE	Center of Ecology
CBD	International Convention on Biological Diversity
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
ECIP	European Community International Programme
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organisation of the United Nation
FIPI	Forest Inventory and Planning Institute
GEF	Global Environment Facility
HCM	Ho Chi Minh City
HIO	Hai Phong Institute of Oceanography
HKU	University of Hong Kong
ICBP	International Council for Bird Preservation (now BirdLife International)
IEBR	Institute of Ecology and Biological Research
ICZM	Intergrated Castal Zone Management
IOC	International Oceangraphic Commission
IOOC	Institute of Oceangraphy
IUCN	The World Conservation Union
MAFI	Ministry of Agriculture and Food Industries
MOE	Ministry of Energy
MOSTE	Ministry of Science, Technology and Environment
MOF	Ministry of Forestry
NPESD	National Plan for Environment and Sustainable Development (1991-2000)
NCS	Vietnam National Conservation Strategy
RAMSAR	The Convention on Wetlands of International Importance
SIDA	Swedish International Development Authority
SCS	State Committee for Sciences (now the Ministry of Science, Technology and Environment)
SPC	State Planning Committee
TFAP	Tropical Forestry Action Plan
UNDP	United Nation Development Programme
WWF	World Wide Fund for Nature (also known as World Wildlife Fund in North America)

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INTRODUCTION TO BIODIVERSITY IN VIETNAM

The Biodiversity Action Plan comes at a crucial time in the history of biodiversity conservation in the world and in Vietnam. Ten years ago worldwide understanding of the subject was too limited to warrant the comprehensive, integrated approach adopted by the BAP. Ten years from now, if no action is taken, it is likely to be too late for Vietnam - the majority of the remaining biological reserves could be extinct.

Vietnam is undergoing profound transformation. Planned and spontaneous reforms are occurring in all sectors. The rapid transition to a market economy is uniting with legal, social, and public administration reforms to foster strong economic growth. The result is more personal wealth and a nation more integrated into regional and global economies.

It is not known how the developing market economy will affect biodiversity, but indications are that trade liberalisation, increasing production and growing resource extraction are posing a serious threat. However, legal and public administration reforms open the possibility for the introduction of appropriate environmental protection measures. If well managed, increased investment and promotion of individual responsibilities should combine to promote a sound environmental management, including the conservation of biodiversity. The conserved natural resource base would be the basis for continued economic growth. The Biodiversity Action Plan represents a national strategy to meet new challenges and to encourage sustainable growth.

The Value of Biodiversity

Biodiversity is the sum total of living resources on the planet and includes all plants and animals: It is the diversity and variety within the world's numerous species and the differing ecosystems they inhabit. The overall objective of the Plan is to conserve biodiversity in Vietnam within the context of sustainable development. All future domesticable species will be drawn from the pool of available wild species, each bringing its own unique characteristic features and values. Equally important are the wild relatives of tamed species because they have the genes necessary to allow development, through artificial methods, of new varieties and special forms. These new forms will be resistant to disease and be able to adapt to global changes. At present many wild species are used for food, medicine, timber, fibre, fuel and other functional uses, or are needed by domestic animals.

Even more valuable is the ecological function served by biodiversity in protecting soil by creating fertility, in regulating the flow and cycle of water, oxygen and minerals in the atmosphere, the earth and in the rivers, lakes and seas. It is green plants and ocean systems that control the climate and atmosphere of the world.

The value of this diversity is massive in scale and gives indispensable benefits to life on earth. Vietnam has a very valuable biodiversity resource base which was underlined by the recent identification of two new mammal species, out of a total of only seven in the world this century. However extinction rates (the measure of the loss of biodiversity resources) in Vietnam are estimated to be higher than the worldwide average at about 1,000 times more than natural extinction rates. A species lost is a species lost forever.

For thousands of years people have taken nature for granted, used whatever was needed and then expected it to take care of itself. Those days are over because human impact on the environment is so extensive that nature can no longer mend itself. Only with peoples' partnership and stewardship can efforts to conserve biodiversity be successful.

Recent History of Biodiversity Conservation in Vietnam

During the 1960s the Vietnamese government took the first official steps towards nature conservation by promulgating decrees for protection of some forests and several rare and valuable species such as tigers and elephants, as well as banning destructive methods of hunting. Some local authorities issued their own protective regulations and the first national park was declared in 1962.

In 1972 a decree on forest protection was issued which led to the recruitment of 10,000 special forest guards who were posted throughout the country at all levels. In addition various regulations were issued to control the catching of fish.

During the 1980s a concerted effort was made to put conservation on a more scientific basis. A national programme was started to research into a variety of topics relating to conservation and the rational use of resources. Two international conferences were held in 1983 to review the environmental situation in the country. In 1985 the Vietnam National Conservation Strategy (NCS) was published - one of the first to be completed by a developing country. The NCS was well received both by the government and the international community.

The NCS was the forerunner of the *National Plan for Environment and Sustainable Development 1991-2000* (NPESD). Developed by the State Committee for Sciences, the NPESD incorporated the main recommendations of the NCS and the TFAP as well as a number of broader environmental issues.

The NPESD stressed the need for a clear law on the environment, laid out government policy for conservation and listed and prioritised action areas. The development of a law on the environment (passed in 1994) was a major activity of the State Committee for Sciences (which by National Assembly decree became the Ministry of Science, Technology and Environment in 1992).

In 1993 Vietnam signed the Convention on Biological Diversity, pledging its support to the global movement of conservation. The Convention was ratified in October 1994, and Vietnam must now act accordingly. The development of a Biodiversity Action Plan is therefore very opportune.

What is new in the Biodiversity Action Plan?

Vietnam had already identified the major problems facing its natural environment and biodiversity resources in the NCS, the National Plan for Environment and Sustainable Development, and the Tropical Forestry Action Plan.

So what is different about this Biodiversity Action Plan? The Plan advocates a comprehensive and integrated approach. Several features characterise the Plan's approach:

The first is that the BAP builds on partnerships with local people to protect nature. In effect, the high population density in Vietnam means that almost all natural resources are being exploited. There is simply no option for creating vast protected areas with no human intrusion. Hence nature reserves are no longer seen as islands of natural habitat protected by armed guards from human development. Instead the reserves are centres in broader biodiversity landscapes where these small, protected zones are part of a land-use mosaic with buffer zones, corridors, plantations, regeneration zones and agricultural lands all managed in ways that help to protect the diversity of biological resources.

A second partnership promoted is with provincial level administration. As Vietnam restructures the linkages between central, provincial and lower level systems of regional government there is a need to identify provincial level responsibilities for biodiversity conservation and funding. Considerable effort has been made to canvas provincial government opinion and in this sense the BAP is a more bottom up approach to solving biodiversity problems than its predecessors.

Next, the BAP draws attention to three new elements of biodiversity conservation in Vietnam, namely marine conservation, wetlands conservation and conservation of agricultural biodiversity.

Fourth, the BAP places more emphasis on international aspects of biodiversity protection and clarifies Vietnam's responsibilities with its immediate neighbours. Areas

pinpointed here are transfrontier reserves, data sharing, expertise sharing, management of migrating species, spread of fire, trade and other issues. Broader issues such as global warming, marine pollution, international wildlife trade and global programmes and conventions are also taken into account.

And, the BAP focuses more attention on the values and uses of biological resources. Matters of access to and sovereignty over biodiversity resources are discussed to safeguard the country's long-term economic potential.

Finally, the BAP goes into the details of planning a protected area system by reviewing up-to-date information and by examining the country on remote sensed satellite images. Twelve priority areas are identified where attention should be focused during the next 10 years.

Relationship of Biodiversity Action Plan with Other Sectoral Programmes

The BAP is the result of extensive consultations with government representatives from all levels, with Vietnamese and international scientists and academics, with planners and managers, and with common village people and resource users. It therefore reflects the needs and wishes of the people of Vietnam, as well as the concerns of the international community. There is a sincere recognition that biodiversity conservation requires integrated measures, and is not simply a technical or financial challenge. Hence biodiversity conservation is integrally linked to the general development process. The BAP does not attempt to address these related but wide-ranging development issues, but it does note their influence and does acknowledge the dependence of biodiversity conservation on success in these sectors.

The most important developmental sectors linked to biodiversity conservation are:

a) Population

Vietnam already has a high population density, and this will most likely increase in the coming years. There are two ways to reduce the resulting population pressure on the biodiversity. Firstly by providing the rural populations with real alternatives to biodiversity destruction in the form of productive employment, new technologies etc. and secondly by combining with family planning programmes, which should be concentrated in areas lying close to valuable biodiversity reserves.

b) Agricultural Development

Agricultural development is relevant in three ways. Firstly it is important to shift planned new large-scale developments away from environmentally sensitive areas. Secondly various agricultural development programmes and

agro-forestry programmes could be of great value for development of buffer zones around important nature reserves and national parks. Thirdly the development of new agricultural areas can be used as a way to stop agricultural encroachment in environmentally sensitive areas.

c) Fisheries Development

Fisheries development and policy will have major impacts on the biodiversity of aquatic fauna and flora. It is important to ensure that these impacts are considered at all stages. It is in the interests of the fishery sector to ensure that commercially used species are properly conserved to maximise sustained yields. It is particularly important to safeguard breeding areas of important species and to take control measures to ban the use of selfish and destructive fishing methods such as poisons, bombs and fine gill nets.

d) Forestry Sector Plans

A large part of the BAP is already included in the Forestry Sector Planning. However the use of forests should be viewed from a broader perspective than the mere production of forest products. It is hoped that the State Planning Committee will use the BAP as a blueprint against which forestry and other sector plans are screened when decisions concerning funding priorities are made.

e) Programme for Regreening and Restoration of Bare Hills

The Vietnamese government has undertaken a large-scale regreening and barren land restoration programme. This programme is important in restoring the productivity of the country especially in the hills and midland areas. The success of this programme will take the pressure off remaining natural forests (mostly around Protected Areas in buffer zones), extend the habitat available to wildlife and add greatly to the welfare of local people living in remote and forested areas.

f) Promoting Protection of Indigenous Culture

Several programmes relating to indigenous ethnic minorities will have major impacts on biodiversity. It is hoped that the stated policy of protecting indigenous culture will prove successful. Protecting indigenous culture will at the same time preserve many indigenous varieties of domesticated and semi-domesticated fauna and flora as well as safeguarding a great and valuable pool of knowledge about the native species of Vietnam and their particular uses.

Resettlement of indigenous people into unfamiliar regions or areas where they must practice quite different methods of agriculture and life-style have met with limited success, particularly in terms of environmental protection. Where changes in life-style are to be encouraged such as the conversion from shifting cultivation to more intensive forms of land-use, those changes should be introduced in-situ, gradually and through spontaneous experiments and adoption rather than by order.

g) Mekong Development

Vietnam is a party to the UN Commission on the Mekong Development and signatory to the November 1994 Mekong River Agreement. This covers the development and wise and fair harnessing of the shared Mekong River resources. The Mekong Committee runs several programmes including environmental conservation programmes and monitoring programmes. These can be adapted to form some parts of the Biodiversity Action Plan of Vietnam especially with regards to stabilising land-use, establishing reserves and preserving Melaleuca and mangrove cover in the Mekong delta area.

h) Alternate Power Generation Plans

Vietnam should try to reduce the use of wood and charcoal as fuel by the developing and promoting alternative energy technologies. These should cover more efficient ways to use wood and charcoal, and alternative sources. The vast potential for hydropower resources are the most obvious alternative.

However, large hydropower schemes may have a major impact on local biodiversity, flooding important lowland habitats, displacing local people who then resettle with added impact in new sites, breaking the traditional migration pathways of large mammals, changing water flow patterns and the life cycles of local fish. However, there are some positive aspects. The reservoirs created constitute new habitats for fish and wetland birds and the importance of protecting the forested catchment becomes a higher priority for funding.

Oil and gas fields in the South China Sea will become an increasingly important source of energy. Their development also carries major threats in the form of oil spills and pollution that could destroy the mangrove ecosystem and other coastal and marine ecosystem.

In addition, the BAP is related to those programmes which impact indirectly on patterns of use of living resources such as education, tourism, research and public awareness as well as governmental measures such as laws, regulations, enforcement mechanisms, trade controls and international agreements.

BIODIVERSITY ACTION PLAN FOR VIETNAM

1. THE STATUS OF BIODIVERSITY CONSERVATION IN VIETNAM

1.1 Physical Geography of Vietnam

Vietnam has a total land area of 330,541 km² and extends along the south-eastern coastline of Asia for 3,260 km between 8°30'N to 23°N in the north. Three quarters of the country is composed of hills and mountains with the highest peaks reaching over 3,000 metres above sea level (*Figure 1*).

The country is S-shaped with wide deltas in the south (Mekong River) and north (Red River) joined by a narrow, coastal, mountainous, central portion. At the narrowest point the country is only 50 km across. Vietnam has a long land boundary (3,700 km) in proportion to its area. Most of the country drains directly into the sea but the western parts of the central highlands drain west into the Mekong basin of Cambodia.

Climate varies with latitude. Mean temperature in the south is 27°C while in the north it is only 21°C. There is a drop of about 0.5°C with every 100 m rise in altitude. Most of the country receives about 2,000 mm of rain annually with over 3,000 mm in some central areas, going as low as 500 mm on the south-east coast. Rainfall is affected by three main monsoons. The winter monsoon is rather cool and dry from the north-east and only affects the country as far south as 16°N. The south-east monsoon and western monsoon blow in the summer months bringing rain in from the sea. Solar radiation is high averaging 130 kcal/cm²/yr, giving the country high agricultural productivity.

Most of the hilly country is lateritic, high mountains have humisols, and river valleys and deltas have fertile alluvial fluvisols. Limestone areas have rendsina soils and in some coastal areas the soils are very sandy. Some deltaic areas are acid sulphate soils.

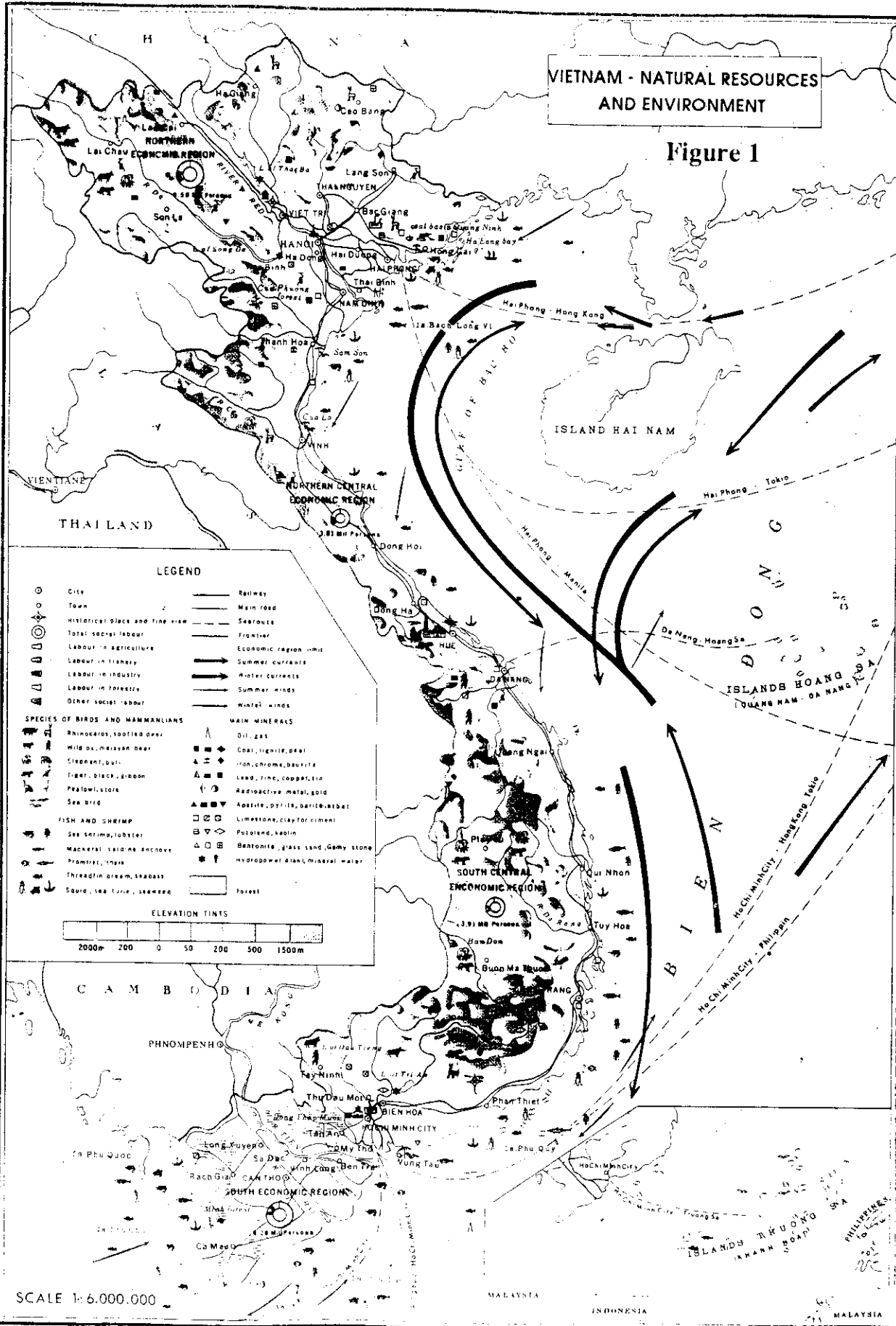
This wide range of latitude and altitude and wide variety of landform from swampy deltas, limestone karst and high mountains has given the country a great diversity of natural environments and a high level of biodiversity.

1.2 Terrestrial Vegetation Types

Vietnam has a wide range of natural vegetation types, which in some cases have

VIETNAM - NATURAL RESOURCES AND ENVIRONMENT

Figure 1



Department of Natural Resources and Environment, Vietnam Committee for Scientific and Technical Cooperation

Map Printing Enterprise, State Department of Geodesy and Cartography

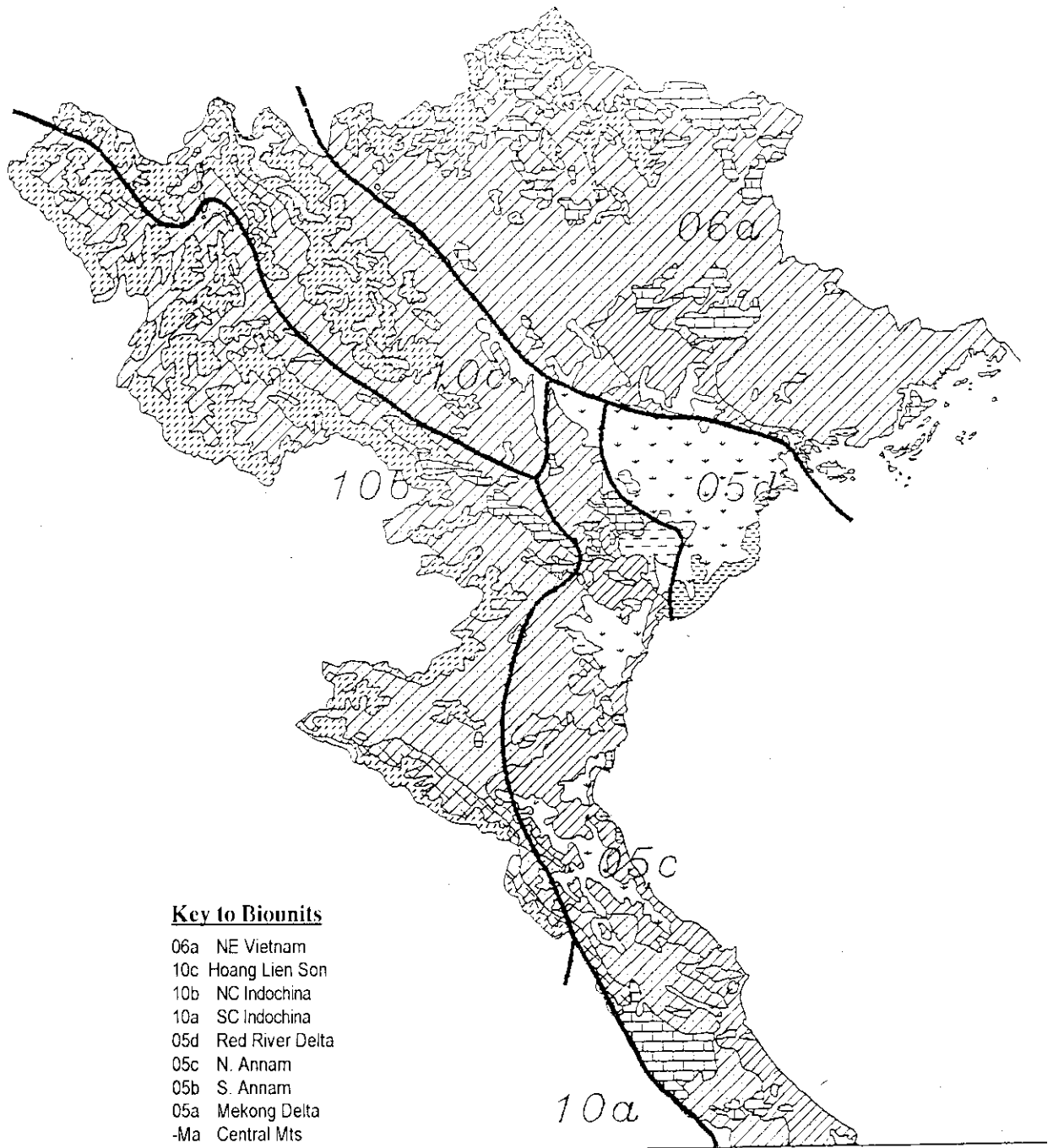















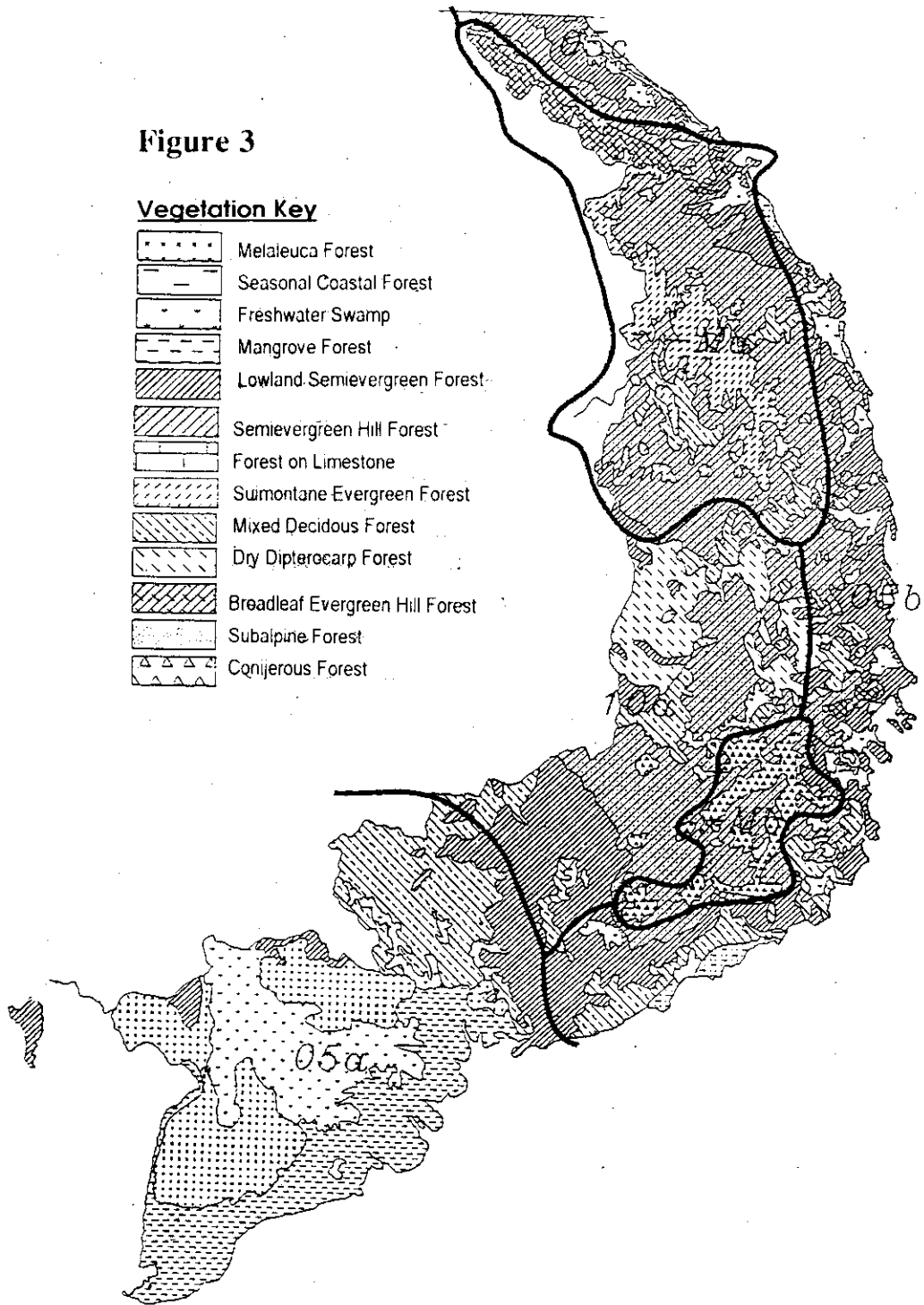
Figure 2

Maps of Original Vegetation Cover and Biounits

Figure 3

Vegetation Key

-  Melaleuca Forest
-  Seasonal Coastal Forest
-  Freshwater Swamp
-  Mangrove Forest
-  Lowland Semievergreen Forest
-  Semievergreen Hill Forest
-  Forest on Limestone
-  Sumontane Evergreen Forest
-  Mixed Deciduous Forest
-  Dry Dipterocarp Forest
-  Broadleaf Evergreen Hill Forest
-  Subalpine Forest
-  Coniferous Forest



been almost totally transformed by human activities. *Figures 2 and 3* on the previous pages show the distribution of original vegetation types. These comprise:

Mangrove forests: Originally tall complex systems in the south and rather stunted simple systems in the north.

Melaleuca forests: Growing on peaty acid soils of the Mekong delta. Possibly formerly found in Red River delta. These forests were themselves secondary and the original peat swamp forests were richer as evidenced by massive tree stumps of the older forest.

Fresh-water swamp forests: Periodically flooded forests in low lying areas of southern Vietnam and small localities in the north.

Monsoon forests: Include the dry dipterocarp forests of the central highlands as well as some coastal dry forests in the south-east of the country.

Lowland evergreen/semi-evergreen broadleaf forests: Tropical in the south, subtropical in the north. Few remaining areas are still in original condition.

Hill evergreen/semi-evergreen broadleaf forests: Still found in scattered localities in several provinces.

Forest on limestone: distinct forest type associated with karst limestone landform. Most of this survives as these rocky areas are unsuitable for agriculture, but in many areas these forests are being degraded by fire, wood collecting and mining.

Montane evergreen and mixed coniferous forests: mainly distributed in Dalat Plateau, central mountains and northern Hoang Lien Son ranges with marked regional variations and a high level of regional endemism.

Sub-alpine vegetation: confined to the peaks of the highest mountains, especially the Hoang Lien Son range in northwest Vietnam. On the higher slopes of Hoang Lien Son where mountain ridges receive high levels of insolation and are largely above the cloud layer, the vegetation exhibits a special xerophytic vegetation type.

1.3 Biogeographical Units

The country can be conveniently divided into a number of different terrestrial biogeographical units (biounits) on the basis of differences in species composition and

the limits of distribution of indicative forms (*Figures 2 and 3*).

The main Truong Son range acts as a barrier between the generally wetter forests on the east and the drier forests to the west which fall into the Mekong Basin biounit. The higher parts of the mountain chain contain a number of endemic species and sub-species and can be regarded as a biounit in its own right which can be further subdivided into the Dalat Plateau and the Central Highlands.

In the south, the Mekong delta remains biologically very distinct from the hilly and mountain areas further east. Another natural division is seen at the Bach Ma-Hai Van pass which separates the tropical south-central part of Vietnam from the sub-tropical north - central portion. This pass forms a climatic and faunal division which is reflected in species distributions.

The north of Vietnam shows several levels of division where it is cut by a number of large rivers. The distribution of endemic forms of primates and some birds show the importance of these rivers as faunal boundaries.

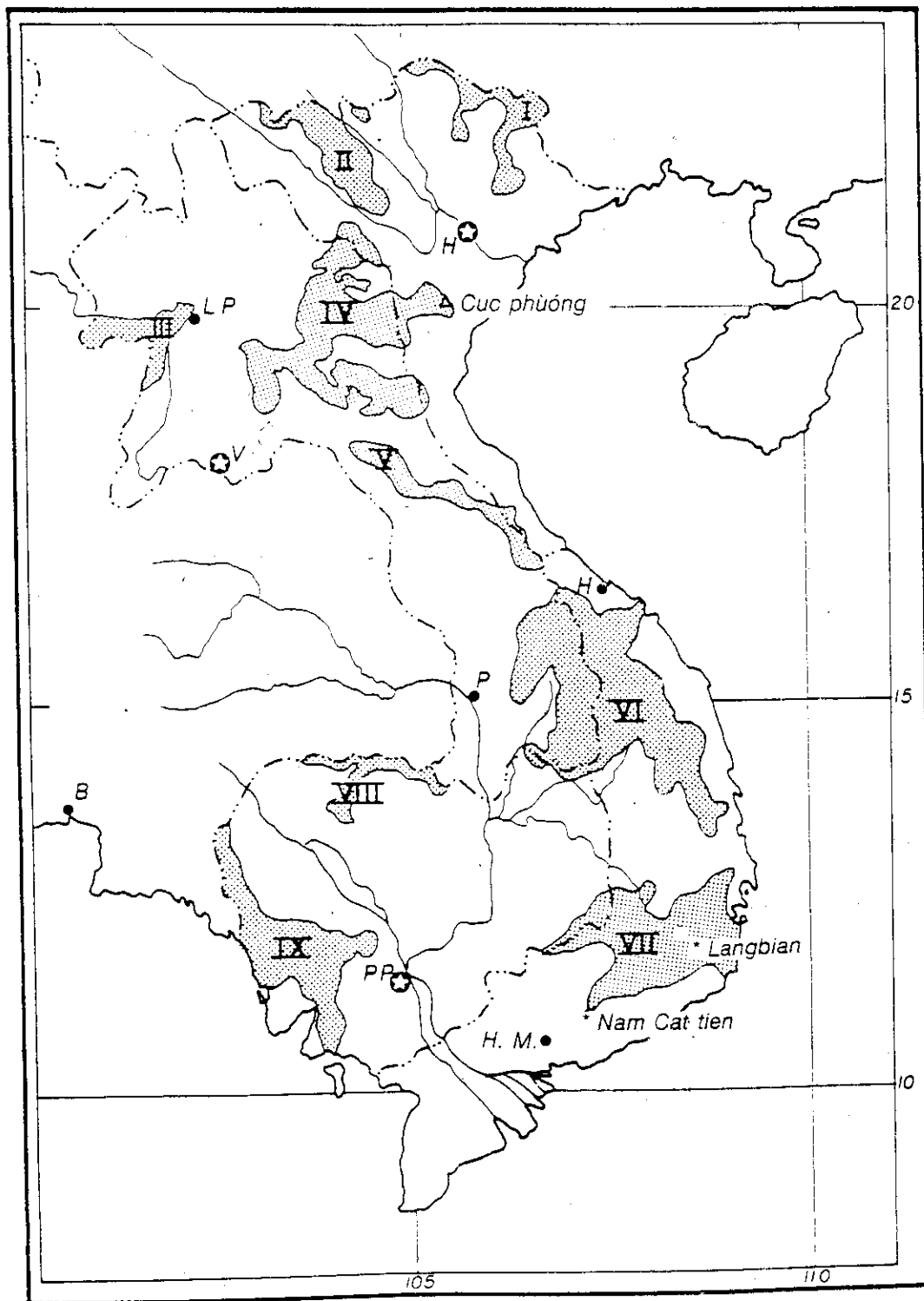
Finally the Hoang Lien Son range of hills in the north-west is a distinct unit connected by the Chinese Hengduan mountains to the eastern Himalayas. These mountains are much higher than the rest of Vietnam and show a quite distinct vegetation and fauna.

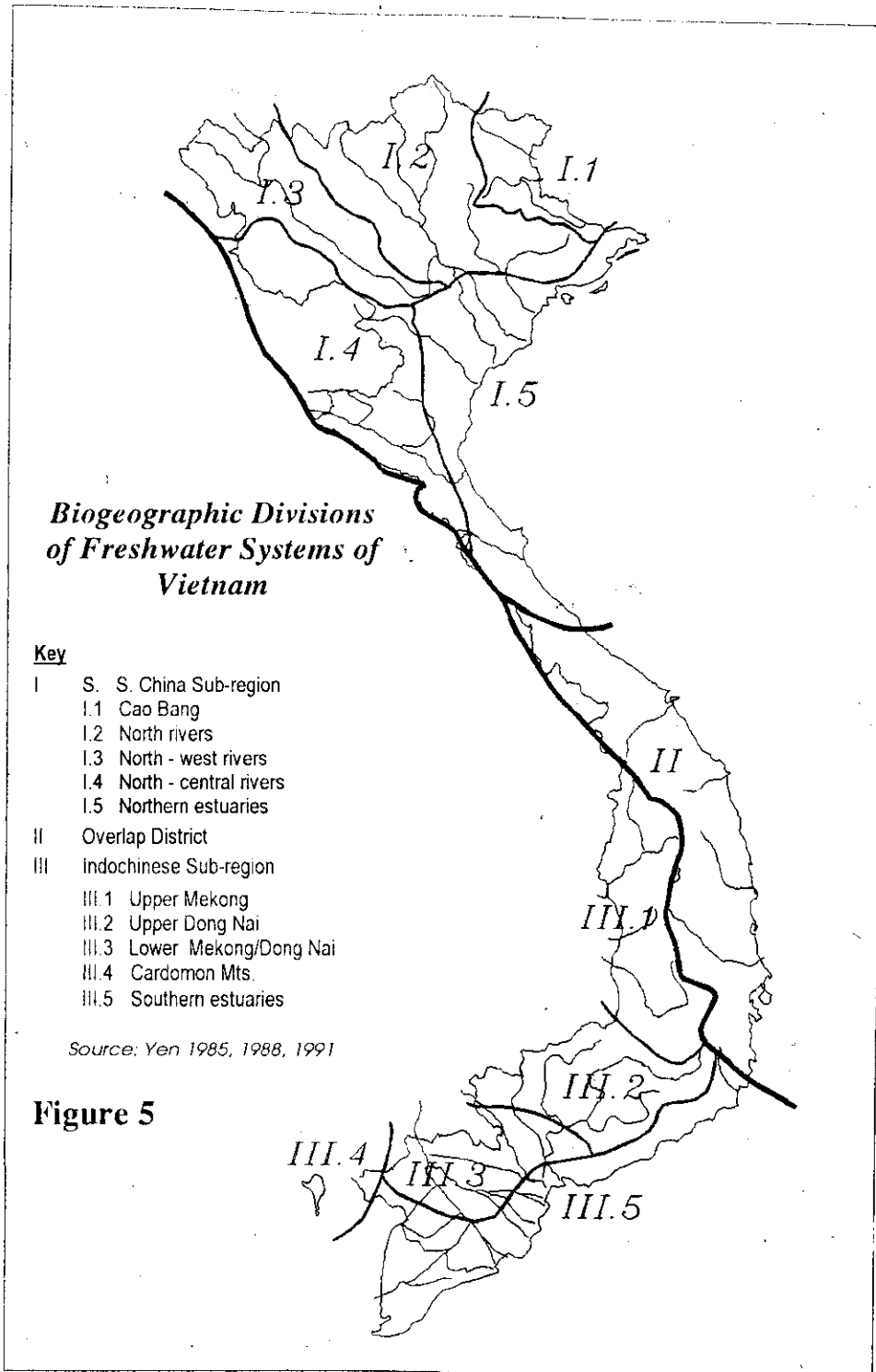
Figures 2 and 3 show these biounits as well as the natural vegetation types across the whole country. In considering the completeness of the protected area system, attention must be paid to ensure adequate coverage within each biounit as well as adequate inclusion of all major vegetation types. The internationally recognised centres of botanical biodiversity (Schmid, 1993) fit into these biounits (see *Figure 4* on the next page).

Freshwater habitats have also been classified into a number of distinct biogeographical units (Mai D.Y. 1985, 1988, 1991). There are two major sub-regions of the Oriental region - namely South China Sub-region which includes all of the rivers of northern Vietnam as far south as Hue, and the Indo-China or Mekong Sub-region including the Mekong delta, south coast and Dac Lac Province plateau rivers which drain into the Mekong. Rivers on the east coast south of Hue show a fauna that is a mixture or overlap of these two main sub-regions and can be treated as a district of overlap. Slight differences are apparent on different river systems within these major divisions, with the greatest contrast being seen in north-east Vietnam where the Ki Cung River drains into China and not into the Red River system. *Figure 5* on page 14 shows these freshwater divisions.

Figure 4

*Map of Floristic Biodiversity Centres
in Vietnam, Laos and Cambodia (Schmid, 1993)*





1.4 Coastal and Marine Environment

Relief and Hydrology

The marine environment of Vietnam is characterised by a wide range of geomorphological, climatic, hydrological, economic and geopolitical conditions.

Over 3,000 inshore and offshore islands are scattered over Vietnamese territory, including claims to the archipelagos of Spratly (Truong Sa) and Paracel (Hoang Sa). The total exclusive economic zone (EEZ) covers about one million km².

The continental shelf mirrors the shape of the land, wide and shallow in the north and south, but narrow and deep in the middle between Danang and Mui Dinh (*Figure 6*). Both northern and southern shelves are shallow with sandy-mud beds. The northern section records depths of less than 90 m, while the south has a 50 m isobath as far as 360 km from the coast. Numerous limestone islands are scattered in both regions, especially in the north of the Gulf of Tonkin. The coastline from north to central Vietnam is pre-dominantly sandy, extending into complex lagoon systems in the Hue area. Southwards from Danang the coastline is rugged.

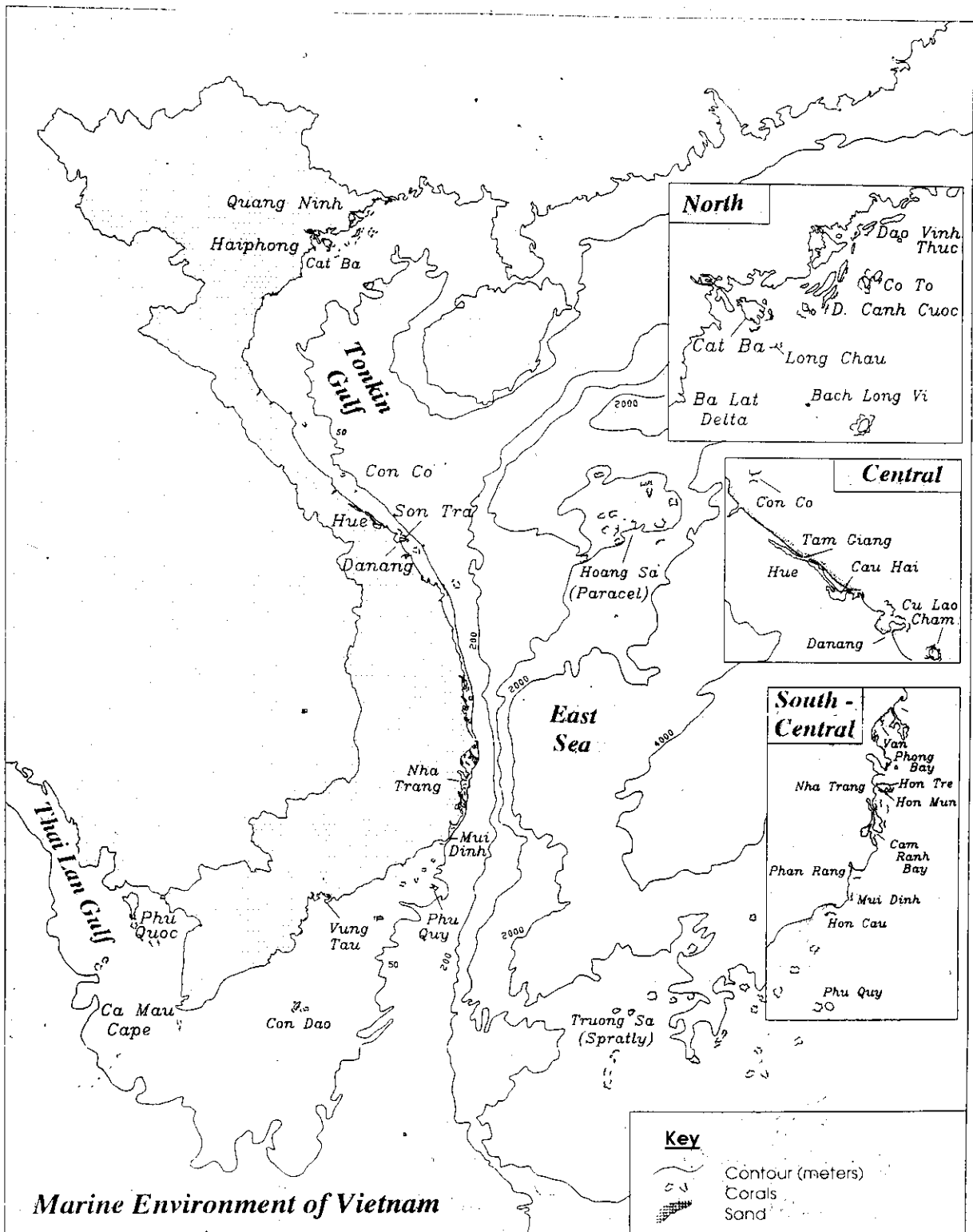
Three distinct regions can be identified according to different hydrological conditions; The Gulf of Tonkin, Central and Southern Vietnam.

Central and southern Vietnam are characterised by only two seasons - the south-west monsoon (summer) and the north-east monsoon (winter). The Gulf of Tonkin has four distinct seasons. Sea surface temperature in winter (January-March) ranges from 18-24°C and in summer (July-September) varies around 30°C. Spring and autumn have intermediate surface temperatures. The Red River has a strong seasonal effect on the salinity and turbidity of the Gulf of Tonkin with surface salinity in summer dropping to 12 ppt near river mouths. Major current direction runs SE-NW in summer and NE-SW in winter but is modified and diverged in local areas.

During the south-west monsoon, wind-driven upwelling moves surface waters offshore and brings cold nutrient-rich bottom water to the surface, causing surface temperatures to drop to as low as 22-23°C. This occurs from June to September at the nearshore areas of the south central region, mainly around Phu Quy Islands and along the coast of Binh Thuan Province. The coastal region of southern Vietnam from Vung Tau to Ca Mau is strongly influenced by the Mekong River.

In addition, the north and central regions experience six to eight typhoons from the east every year, mostly from June to October, each lasting three to five days with wind speeds of up to 40-50 m/s.

Figure 6



Ecosystem Types

i) Coral Reefs

Coral reefs are the richest of all marine habitats in terms of numbers of species, orders and phylla represented. Other important functions of coral reefs include fisheries, coastline protection and marine tourism. In Vietnam, coral reefs are distributed intermittently over the whole range of latitudes (*Figure 6*), with increasing extensiveness and structural and species diversity from north to south.

- a) The Northern Coral Reefs Although northern Vietnam is located in the tropical Indo-Pacific, continental anticyclones in winter lower the sea surface temperature to 16°C, limiting the development of tropical hermatypic scleractinian communities. In addition, the combined actions of salinity fluctuations during the monsoon season, wide temperature ranges between tides, and terrestrial sediment, impose heavy stress on corals in shallow inshore bays.

All coral reefs in northern Vietnam are of the fringing type. Most reefs are short and narrow or in the form of coral patches. This is due to the shallow depths of the sea, small islands of rugged topography and silty-muddy seabed. Maximum depth is limited to a mere ten metres.

- b) The Southern Coral Reefs Natural conditions in the south are favourable for coral reef development. Reefs are found along the coast between Danang and Binh Thuan Province, around islands and submerged banks in the south-east and around most islands in Gulf of Thailand in the south-west (*Figure 6*). Islands and submerged banks of the Paracel and Spratly Archipelagos have the most extensive coral reefs in Vietnamese waters.

In south-eastern Vietnam the shoreline is complex and the effects from rivers are insignificant. Hence, coral reef structure is diverse, consisting of fringing, barrier and platform reefs. Fringing reefs are the most common and widespread and are characterised by narrow width, high coral diversity, relatively low coral cover, peak development at four to eight metres and a maximum depth of about 15 m (Vo Si Tuan, 1993a; Vo Si Tuan and Dao Tan Ho, 1991). Unlike fringing reefs, studies on barrier and platform reefs are scarce. Barrier reefs are distributed on the coast of Phu Yen and Khanh Hoa Provinces and achieve both high diversity and

cover. Platform reefs are more restricted to submerged banks in Nha Trang Bay and near the Cam Ranh peninsula.

The Spratly Archipelago, administered by Khanh Hoa Province is situated over 400 km south-east of the main coast and extends over 5° of latitude. The two forms of coral reef - atoll and platform - reach a maximum depth of 40 m with peak growth at 5-15 m. Atolls with perimeters of up to 50 km enclose reefs hundreds of metres long which have a high coral diversity and cover. Platform reefs are less extensive and occur around single islands or submerged banks with small, shallow lagoons.

ii) Estuaries, Delta and Lagoonal River Mouths

There are three kinds of river mouths along the Vietnamese coast - estuaries, deltas and lagoonal river mouths. They are most numerous in the north (from Mong Cai to Thanh Hoa) and in the south (from Vung Tau to Ha Tien), occurring on average every 20 km along the coastline (*Figure 7* on the next page).

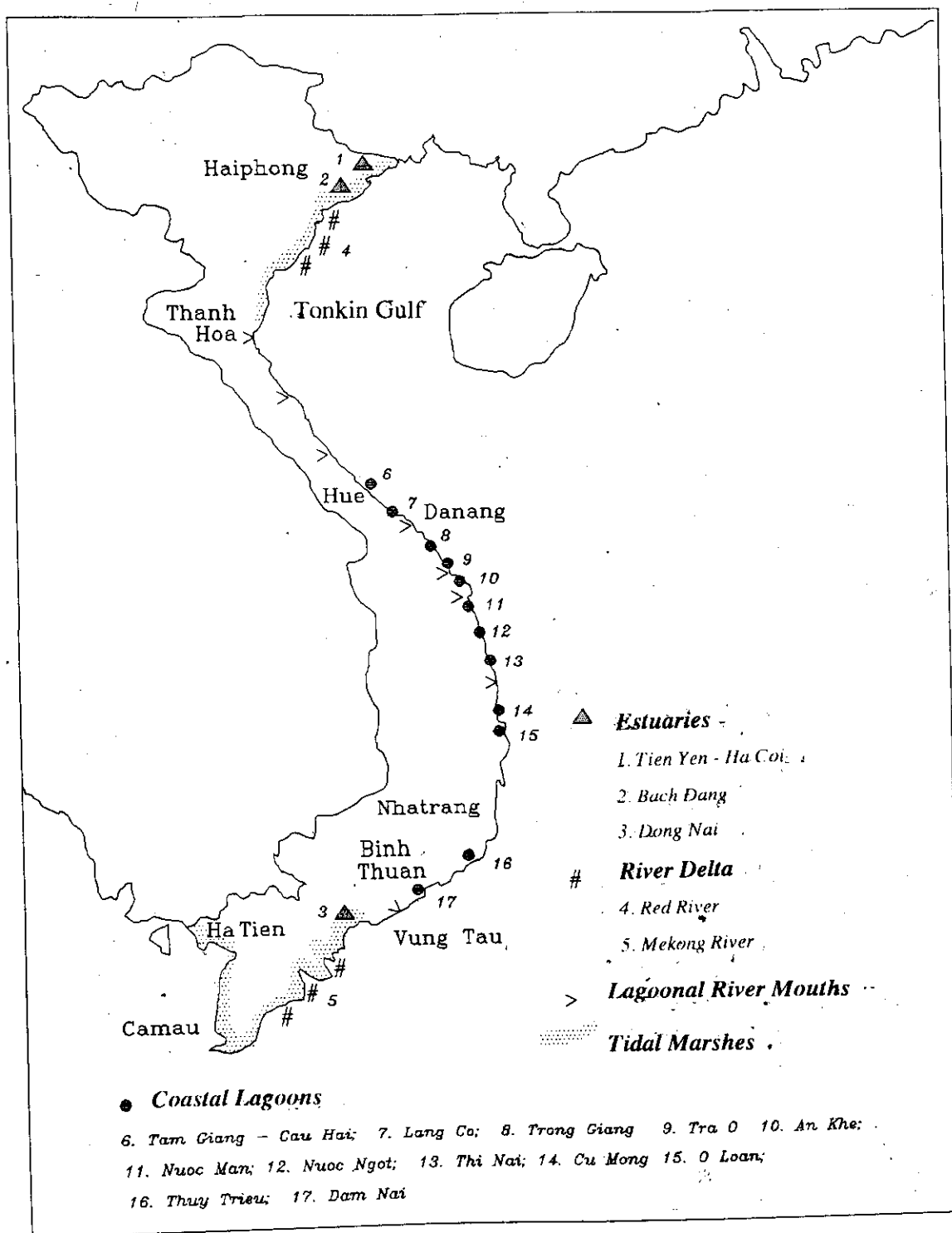
- a) Estuaries Estuaries are characterised by sedimentation rates below the rate of seafloor submergence and are strongly influenced by tides. Erosion is a common phenomenon, especially in areas of high tidal range such as 4.5-5.0 m at Tien Yen - Ha Coi (Quang Ninh), 4.2-4.3 m in Bach Dang (Haiphong) and 3-4 m at Dong Nai, Ho Chi Minh City (*Figure 7* on the next page). As tidal marshes erode away and more tidal channels fill with mud, tidal effects and salt penetration upland become more significant. Average salinity of the water and top sediment ranges from 5-10 ppt and suspension concentration in the rainy season varies from 20-100 g/m³.

In estuarine tidal marshes, mangroves, dominated by Rhizophoraceae, develop well. Algae, seagrass, invertebrates, plankton, and shrimp larvae in particular, are also abundant. In addition to being an important reservoir of aquatic resources, estuaries also support important waterway traffic and serve as pollution filters.

- b) River Deltas River deltas are characterised by the development of flood plains and shoreline advancement, typically at speeds of 3-6 cm/year vertically and dozens of metres horizontally. Unlike estuaries which are governed by tides, the dynamic conditions of deltas are largely shaped by rivers. The brackish

Figure 7

Costal Ecosystem of Vietnam



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.

- c) Lagoonal River Mouths Lagoonal river mouths are characterised by frontal sand barriers, often in the process of reaching a dynamic balance between the actions of rivers and the sea to form typical lagoons. These are found only along the coast in the central region from Thanh Hoa to Binh Thuan (*Figure 7*). In the dry season, water influx from rivers is small, turbidity and nutrient levels are low. In the rainy season, water levels at lagoonal river mouths are high due to flooding from rivers which widen the river mouth and may even break the sand barrier. Vegetation cover at lagoonal river mouths is thin and mainly consists of the water palm *Nippa fruticans* at high tidal flats and the seagrass *Phyllospadix* spp. at low tidal flats.

Aquatic resources at lagoonal river mouths are poor and vary with seasons. Fish, shrimps and crabs are the main products. Production of *Gracilaria* is low.

iii) Coastal Lagoons

Typical coastal lagoons occupy 5% of Vietnam's coastline and occur only in the central region from Hue to Phan Rang (Ninh Thuan), where sand supply is abundant and tidal range is small (0.5-2.5 m). These lagoons, 280-21,600 ha in area, are enclosed by 2-25 m high sand barriers or dunes, and are connected to the sea through narrow inlets which often vary in width and position according to seasons.

Hydrological conditions, biotic characteristics and patterns of resource utilisation of these lagoons vary widely depending on freshwater influx and exchange with the sea. Seasonal fluctuations in salinity are greatest in lagoons O Loan, Thuy Trieu and Dam Nai between Phu Yen and Ninh Thuan where annual rainfall is low (700 mm). While these three lagoons harbour biotic communities similar to those in the sea, An Khe and Tra O lagoons are characterised by freshwater in the rainy season when the inlet barriers are often flooded and by brackish water in the dry season. Other lagoons also 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.

Coastal lagoons are productive ecosystems due to their high nutrient levels

which exceed those of the sea, even in dry season. Fish, shrimps, crabs, molluscs and *Gracilaria* are exploited.

iv) Tidal Marshes

Tidal marshes are mainly distributed along the northern coast from Mong Cai in Quang Ninh to Thanh Hoa Province, and in the south from Vung Tau to Kien Giang (Figure 7 and Table 2). In the central region, few tidal marshes occur. The total area of tidal marsh amounts to about 300,000 ha, 70 percent of which possess mangroves (nearly 100 species) and seagrass. Non-vegetated tidal marshes are mainly found in the Red River and Mekong Deltas, extending seawards from large mangrove stands.

TABLE 2: National Distribution of Tidal Marshes and Mangroves

Region	Area (Ha)		
	Tidal Marsh	Natural Mangrove	Replanted Mangrove
Mong Cai-Thanh Hoa	74,520	46,400	4,200
Thanh Hoa-Vung Tau	18,000	14,300	
Vung Tau-Kien Giang	207,480	191,800	42,450

Over 60 species of fish, 146 molluscs, 107 crustacea and many waterbirds and mammals inhabit tidal marshes. These areas are also economically vital as they provide the spawning and nursery grounds for numerous fish, prawns, and mollusc species.

TABLE 3: Biodiversity Comparisons of Six Important Tidal Marsh Areas

No. of Species	Duyen Hai	Ca Mau	Xuan Thuy	Tien Lang	Yen Hung	Tien Yen-Ha Coi
Mangrove	105	46	8	6-7	45	23
Mollusc	55	52	38	26	30	24
Crustacea	19	30	30	28	32	30

No. of Species	Duyen Hai	Ca Mau	Xuan Thuy	Tien Lang	Yen Hung	Tien Yen-Ha Coi
Birds	33	50	40	23	32	36

TABLE 4: Mangrove Cover and Land Use of Six Important Tidal Marsh Areas

Area (ha)	Duyen Hai	Ca Mau	Xuan Thuy	Tien Lang	Yen Hung	Tien Yen-Ha Coi
Natural Mangrove	12,339	100,000	1,960	600	30,860	10,608
Planted Mangrove	26,598	38,000	8,200	132	0	0
Mud Flat	22,742	60,000	60,000	2,729	33,870	6,608
Water Surface	25,338	42,600	60,000	3,965	33,870	10,600
Agriculture	6,260	24,000	13,000	1,322	4,656	0
Aquaculture	677	21,505	402	140	8,173	840
Settlement & Others	41,426	0	0	0	0	0

1.5 Species Richness

Distribution and Levels of Endemism

Vietnam has a higher proportion of endemic species that are regional or national than any of its neighbouring countries. Different taxa vary in their distribution of endemism but all are far from uniform. Endemism in coniferous plants is concentrated in the main mountainous areas of the country (*Figure 8*). BirdLife International have evaluated the global distribution of concentrations of restricted range (endemic) birds. Three such areas have been identified in Vietnam: Dalat Plateau, Annamese (Truong Son)

lowlands, and Cochinchina (southern Vietnamese) lowlands (ICBP, 1992). The Hoang Lien Son range should be added to these three when looking at the sub-specific level.

The entire flora is characterised by a high proportion of endemic forms estimated at between 33% (Pocs Tamas, 1965) in northern Vietnam and over 40% (Thai Van Trung, 1970) over the whole country. The highest numbers of endemic forms are found in the three main mountain blocks namely - Hoang Lien Son range, Dalat Plateau and Central Highlands.

TABLE: 5: Details and Status of Major Centres of Plant Biodiversity

Centre	Type	Size sq.km	Altitude m	Flora spp.	Economic Plants	Vegetation	Protected Areas	Threats	Saassessment
Hoang Lien Son	S	2,000	1000-3142	3,000	timber trees, valuable medicinal plants essential oil plants	Tropical montane deciduous forest. Subtropical montane forest	200 sq.km. as proposed reserve	- shifting cultivation - collecting nonwood products - clearing forest for agriculture	At risk. No management plan
Cuc Phuong	S	300	100-637	1,800	timber trees medicinal plants, 4 rattans, 9 bamboos, ornamental plants	Forest on limestone. Low land evergreen forest	22 sq km as Cuc Phuong N. P	Poaching and valuable trees.	Reasonably secure.
Bach Ma	S	600	0-1450	2,500	200 timber trees, 108 medicinal plants, 50 ornamental plants, 30 fibre and rattans, 40 edible fruits	Lowland evergreen forest. Tropical monsoon evergreen forest	220 sq.km as Bach Ma N. P.	Stealing of valuable trees, fuel wood, nonwood products and wildlife. high human density.	Threatened.
Yok Don	V	650	200-482	1,500	150 timber trees, 10 oleoresins, 20 tannin trees, 40 ornamental plants	Dry dipterocarp forest. Lowland semievergreen forest. Riverine evergreen forest.	582 sq.km as Yok Don N. P.	Shifting cultivation, stealing of trees, non-wood products and animals. Fire.	Threatened

Table 5 page 2

Cat Tien	S	1,376	60-754	2,500	200 timber trees, 120 medicinal plants, 10 rattans, 59 orchids, 7 bamboos	Lowland evergreen forest. Lowland semievergreen forest. Freshwater swamp.	379 sq.km. as Nam Cat Tien N. P. and as Cat Loc rhino reserve.	- illegal logging - stealing of timber, rattan, resins, animals and fishes.	Reasonably secure.
Lang-bian Plateau	S	400	1400 - 2167	2,000	100 medicinal plants, 70 orchids, 4 resin trees, timber trees.	Pine forest, tropical montane evergreen forest.	46 sq.km. as Natruere Reserve. Others planned.	illegal collection of charcoal, timber, resins and medicinal plants.	Severely threatened.