7. Natural Environment

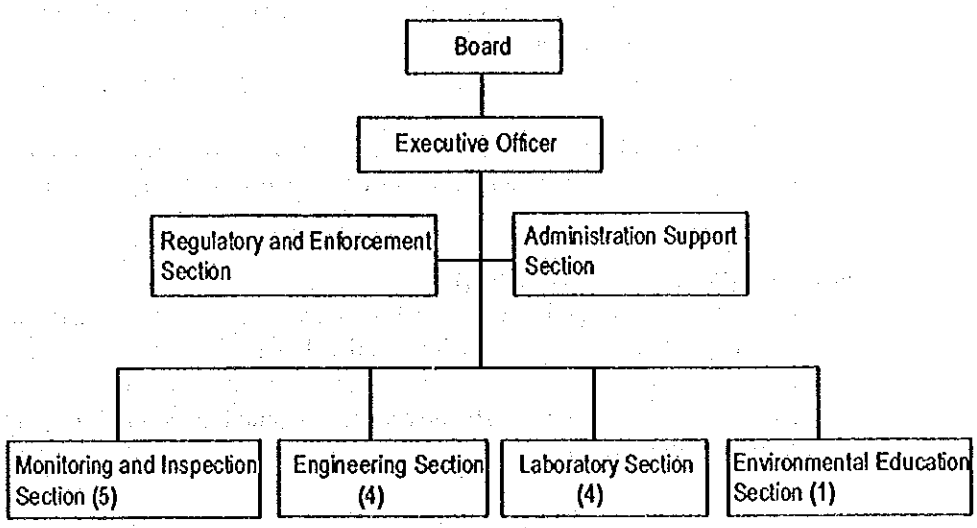
7.1 Environmental Administration and Policies

7.1.1 Environmental Administration and Related Organization

(1) Environmental Quality Protection Board (EQPB)

The EQPB is the regulatory and enforcement agency in terms of environmental protection in Palau. Figure 7.1.1 shows the latest EQPB organization chart in June 2000.

Figure 7.1.1 Present EQPB Organization



Source: EQPB
Note: ( ) shows the numbers of the present full time staffs

At present, the EQPB has the following six sections:

Administrative Support Section
This Section manages the annual budget and other grant funds assigned to the operation of the EQPB office.

Regulatory and Enforcement Section
This Section is charged with providing legal advise to the EQPB as well as assist in the enforcement of environmental laws and regulations.

Monitoring and Inspection Section
This Section is responsible for inspection all of the development projects throughout Palau in order to ensure the development activities in environmental conservation manners.

Engineering Section
This Section is responsible for advice in terms of environmental engineering related to development projects such as Compacts Road Development. There are two senior environmental engineers coming from the United States in this Section.

Laboratory Section
This Section is responsible for collection of data and information on the existing

conditions or the changes to the environment throughout Palau. EQPB actually only tests the water quality of the marine and fresh water on a regular base.

Environmental Education Section
This Section is charged with the responsibility of educating the Palau's peoples to be more aware of the need to protect the environment in Palau.

(2) Bureau of Natural Resources and Development (BNRD)

As the primary governmental agency, the BNRD is responsible for planning, coordination relating to development and management of natural resources of Palau.

At present, the BNRD has the following three divisions and an office, which has each own task in terms of natural resources conservation and management:

Division of Conservation and Entomology (DCE)

- Prepare plans for a nationwide conservation program for soil and water resources, flora, and fauna;
- Prepare the plans for a nationwide entomological management and control program; and,
- Advise national and state governmental agencies regarding the enforcement of the nationwide conservation regulations such as establishment of a conservations area.

Division of Marine Resources (DMS)

- Formulate and establish conservation measures in order to safeguard against over exploitation of inshore fish and other fish resources;
- Implement and enforcement the above conservation measures; and,
- Advise and inform the state governments and the peoples regarding marine resource conservation.

Forestry Branch under the Division of Agricultures and Mineral Resources (DAM)

- Promote forestry management practices such as reforestation and distribution of seedling; and,
- Promote reforestation efforts in Palau through information dissemination
-

Conservation Area Support Office (CASO)

- Formulate conservation area management project in Palau such Ngaremeduu Conservation Management Project; and,
- Advise state government regarding conservation area management in Palau.

(3) Ministry of Health (MOH)

The MOH has the following division, which has some tasks regarding environmental health:

Division of Environmental Health and Sanitation (DEHS)

- Implement vector control;
- Promote food safety in whole Palau region; and,
- Pollution control through surveillance of communicable diseases.

7.1.2 Environmental Policies

(1) EQPB Five Year Work Plan

In 1997, EQPB prepared a five-year (1998-2002) work plan in terms of environmental

protection in Palau. The five-year work plan translates the following general objectives into specific activities and their associated resource implications.

- Continue to monitor drinking water and near shore water quality and point source discharges;
- Increase environmental education and community participation efforts; and,
- Maintain, establish and/or enhance working relationships with other governmental agencies to coordinate environmental protection activities.

The specific technical activities are as follows:

Permitting, Inspections, Enforcement

- Review, permitting and inspection of the Compact Road
- Environmental Assessment/Impact Statement Review & Approval
- Permitting of Construction/Modification to Public Water Systems
- Permitting of Construction/Modification to Stationary Sources of Air Pollution
- Regulation of Point Source Discharges to Water of Palau
- Continue to Issue Permits and Monitoring Compliance of Earthmoving activities
- Individual On-Site Wastewater Facility Permitting
- Emergency Response
- Implement Solid Waste Regulations and Refine Litter Control Program

Program Development and Planning

- Revision of the Environmental Quality Protection Act
- Revision of Drinking Water Regulations
- Groundwater Management Regulations
- Regulation of Hazardous Wastes
- Revising Palau's Oil and Hazardous Substance Response Contingency Plan
- Regulation of Cutting and Filling of Mangroves and Other Special Aquatic Sites
- Organize and implement program to manage commercial vessels

Environmental Monitoring

- Regulation of Public Water Supply System
- Regulation of Near Shore and Recreational Marine Water
- Special Environmental Studies
- Monitoring of Malakal Wastewater Treatment Plant

Public Awareness and Education

- Annual Report
- Development and distribution of a permitting guide to EQPB
- EQPB Media Release/Public Services Announcement (PSA)
- Summer Volunteer Program
- Earth Day
- Outreach/Workshops Programs
- Publications-Head Start Coloring Book
- Development of Environmental Library
- Public Schools-Environmental Education Curriculum
- Publications-EQPB Quarterly Newsletter
- Palau Youth Conservation Corp (PYCC)

Although these activities needs a multi-year process and are implemented at present, the Plan need to be reviewed on an annual basis based on the present human resources of

the EQPB. It is too much tasks for present capability of the EQPB.

7.1.3 Legislative Framework

In Palau, environmental regulations include those enacted by the National Legislature (*OEK*), state legislature and traditional authorities. Main environmental regulations are as follows:

(1) Environmental Act, Regulations

Environmental Quality Protection Act
Environmental Quality Protection Act as Title 24, PNC created the Environmental Quality Protection Board (EQPB) to require the following regulations:

- Earthmoving
- Marine and Fresh Water Quality
- Toilet Facilities
- Solid Waste Management
- Pesticides
- Public Water Supply Systems
- Environmental Impact Systems
- Air Pollution Control

Although the above detailed regulations were revised in 1996, the regulations still have not covered the whole environmental fields. For example, there is no specific forestry and watershed management regulations regarding the protection of the vulnerable natural resources.

Marine Protection Act
This Act regulates the taking, use and exploitation of various marine resources. It also sets the framework for regulating marine habitats collected for research and aquarium trade and bans exploitation of corals.

Natural Heritage Reserve System (NHRS) Act
This Act established a mechanism for designating, recording and managing conservation areas in 1991. The designations of Natural Heritage Reserve System are based on nominations by the BNRD. The following four categories are proposed by the Act:

- Category 1: Natural Heritage Area
- Category 2: Natural Heritage Preserve
- Category 3: Natural Heritage Reserve
- Category 4: Special Management Area

However, this Act allows for the making and amending of rules and regulations affecting the conservation areas.

In the state level, several state governments regulate conservation acts recently. For example, Koror State has the following regulations:

- Rock Islands Use Act: (regulates tourist visits within Koror State)
- The Fishing Act of Koror State: (set fishing regulations and prohibits fishing within major dive sites)

(2) Bills

Recent important bills concerning environmental management are as follows:

Palau National Park System Bill

In 1999, it is proposed a comprehensive bill, which has the following objectives:

- To preserve the natural environment for the use and enjoyment of the Palauan peoples;
- To preserve the Palau's cultural and historical sites;
- To collaborate the state and national government for environmental conservation as mandated by the Constitution;
- To fulfill international environmental treaty obligations; and
- To develop eco-tourism as an industry of growing importance.

Mangrove and Wetlands Protection Bill of Koror State

It is approved in 2000 as a bill in order to protect mangroves and wetlands from the cutting and harvesting of trees in Koror State.

(3) International Environmental Treaties

Important international environmental conservation treaties, which Palau already ratified, are as follows:

The Convention on Biological Diversity

It requires countries to take appropriate action through regulations and management to control the destruction of biological species, habitats, and ecosystems within their jurisdiction.

South Pacific Regional Environmental Program (SPREP) Convention

It provide for the establishment of protected areas where activities, which are likely to have an adverse effect on species, ecosystems in the South Pacific Region.

7.2 Present Environmental Conditions

7.2.1 Terrestrial Environment

(1) Soil

According to the USDA Soil Conservation Services, there are basically 18 different soil types. Laterites, which are the main soil type, are widely observed in Babeldaob Island. Lithosols, bog soils, alluviums, and coralline sands are the other main soil types. Soils of Palau are also categorized 42 units based on soil types and slope degree. (See Table 7.2.1).

It is categorized the soils in terms of agriculture/forestry potential and preservation needs. According to the category, suitable land for agriculture is 6.8 %, and for timber harvest is 6.4% of the total land of Palau respectively.

(2) Water Resources and Watersheds

Babeldaob Island is the biggest island, which occupies an approximately 70 % of the total land of Palau. It is estimated that an average of almost 2,000 million liter of freshwater flow out of Babeldaob stream everyday.

Babeldaob Island could be divided into 16 watersheds. Within the 16 watersheds, there are five main watersheds in Babeldaob based on the coverage areas and the importance of the water sources for the peoples, as well as the ecological integrity (see Figure 7.2.1).

(3) Slope

Although it is very difficult to identify erosion prone area in Palau due to the lack of present data and survey, it could be estimated that main erosion prone areas according to hearing to USDA and PCS. Figure 7.2.2 shows the slope range and the main erosion prone areas in Babeldaob Island. Relatively flat areas, which is slope range less than 3% is the only 5% of the Whole Babeldaob Island.

On the other hand, Peleliu Island and Angaur Island have some relatively flat areas. For example, approximately a half of Peleliu Island is relatively flat, which may use for development activities such as tourism development.

(4) Forest

There are three main types of forest in Palau: upland, swamp, and mangrove. It is reported that the upland forests of Palau are the most species diverse in Micronesia, and including a number of endemic species. Swamp forests occur where soils are inundated with fresh or slightly brackish water, usually in low-lying areas just inland from mangrove forests or along streams in the interior hills. Mangrove forest occurs along the lower portion of rivers and their mouths and on coastal mud flats.

The remaining forest types in Palau are Rock Island forest, limestone forest, atoll forest, a small area of forest plantation, and a tiny area of palm forest (see Table 7.2.2).

However, no whole Palau's forest and vegetation survey has been conducted since 1979. The present detailed vegetation cover could not be described.

(5) Terrestrial Flora and Fauna

Palau has rich biological diversity for terrestrial environment as well as marine environment. According to Bureau of Natural Resource and Development of Palau in 1992, approximately 1,258 species and varieties of plants, which include 839 natives, are found in Palau. Also, more than 5,000 species of insects, 141 species of birds (including 8 are endemic), and 3 species of native terrestrial animals (including one is endemic) inhabit in Palau.

Table 7.2.3 shows the protected species and a selected endangered species. In terms of endangered species, the selection is based on the recommendations of the Rapid Ecological Assessment Synthesis Report and the hearings by JICA Study Team.

Table 7.2.1 Soil Units for Potentials and Preservation Needs in Palau

Soil Unit Number	Soil Name	Slopes	Soil Deepness(cm)		Drainage	Vegetation	Constraints for Agriculture
		(%)	surface	rooting			
400	Aimelik-Palau complex	6 to 12	10	150	fair	forest & savannah	low fertility
401	Aimelik-Palau complex	12 to 30	10	150	good	tropical forest	low fertility, degragation
402	Aimelik-Palau complex	30 to 50	10	150	good	tropical forest	slope, erosion
403	Aimelik-Palau complex	50 to 75	10	150	good	tropcal forest	sharp slope, erosion
404	Babelthuap-Ngardmau complex	2 to 6	10	150	fair	deteriorated savannah	low fertility, too much gravel
405	Babelthuap-Ngardmau complex	6 to 12	10	150	fair	deteriorated savannah	too much gravel, droughtness
406	Babelthuap-Ngardmau complex	12 to 30	10	150	fair	deteriorated savannah	too much gravel, droughtness
407	Chia-Insak complex	0 to 2	20	150	poor	mangrove forest	content of salts & sulfur, flooding
408	Dechel-Mesei complex	0 to 1	90	170	poor	swamp forest	flooding, very poorly drained
409	Iachetomel peat	0 to 1	20	150	poor	mangrove forest	surface peat, salts & sulfur
410	Nekken-Ollei complex	12 to 30	20	50	fair	tropical forest	shallow rooting, droutness
411	Ngardmau-Babelthuap complex	30 to 50	50	150	fair	deteriorated savannah	slop, erosion, low fertility
412	Ngardmau-Babelthuap complex	50 to 70	10	150	good	deteriorated savannah	slope, erosion
413	Ngardok silt loam	2 to 6	70	150	fair	tropical forest	low fertility
414	Ngardok silt loam	6 to 12	70	150	fair	tropcal forest	low fertility, degragation
415	Ngardok silt loam	12 to 30	70	150	fair	tropical forest	low fertility, degragation, erosion
416	Ngardok silt loam	30 to 50	70	150	fair	tropical forest	slop, erosion
417	Ngardok silt loam	50 to 75	70	150	fair	tropical forest	slop, erosion, lateral seepage
418	Ngatpang gravelly clay loam	2 to 12	20	150	fair	savannah, severe erosion	low fertility, strengthen, permeability
419	Ngatpang gravelly clay loam	12 to 50	70	150	fair	savannah, severe erosion	low fertility, high acidity
420	Ngatpang silty-clay loam	2 to 6	100	150	good	tropical forest	degradation
421	Ngatpang silty clay loam	6 to 12	100	150	good	tropical forest	degradadation
422	Ngatpang silty clay loam	12 to 30	100	150	good	tropical forest	deradation, erosion
423	Ngatpang silty clay loam	30 to 50	100	150	good	tropical forest	slop, erosion, low strength
424	Ngrdebus sand	0 to 3	50	150	good	coconut tree, atoll forest	coral sand, low fertility, droughtnese
425	Ngrdebus Variant cobbly loamy sand	2 to 6	20	150	good	atoll forest	coral sand, low fertility, droughiness
426	Ngersuul silt loam	0 to 2	60	190	poor	tropical forest	high water table, flooding,
427	Ngerungor Variant-Ngerungor complex	0 to 1	50	150	poor	fresh water marsh	poor drainage, water erosion
428	Ollei-Nekken complex	30 to 50	20	50	fair	tropical forest	shallow rooting, droutness, erosion
429	Ollei-Nekken complex	50 to 75	20	50	fair	tropical forest	shallow rooting, slope, erosion
430	Ollei-Rock outcrop complex	12 to 75	20	50	good	tropical forest	steepness of slope, runoff, erosion
431	Peleliu-Aimelik complex	2 to 6	100	150	good	tropical forest	degradation
432	Peleliu-Rock outcrop complex	0 to 4	20	50	good	forest & woody shrub	shallow rooting, coarse sand
433	Peleliu-Rock outcrop complex	6 to 20	10	30	fair	coral limestone	root depth, coarse fragments
434	Rock outcrop-Peleliu complex	80 to 150	10	30	good	coral limestone	sharp slope, shallow soil, drained
435	Tabecheding silty clay loam	2 to 6	60	160	poor	savannah	wetness, high acidity, aluminum
436	Tabecheding silty clay loam	6 to 12	80	160	poor	savannah	wetness, erosion, high acidity
437	Tabecheding silty clay loam	2 to 12	20	180	poor	deteriorated savannah	low fertility, wetness
438	Tabecheding silty clay loam	12 to 30	60	150	poor	savannah, pandanus	wetness, high acidity, aluminum
439	Tabecheding silty clay loam	12 to 30	80	180	poor	deteriorated savannah	very low fertility, slope, erosion
440	Typic Troporthents	12 to 30	30	150	good	snp of bauxite mine	to much gravel, high acidity
441	Typic Troporthents-Urban land complex	30 to 75			good	coral and basal gravell	rapid permeability, low soil strength
	Total						

Soil Unit Number	Agriculture (root & veget)	Agroforestry (fruit)	Forestry (timber)	Hydric soils (wetland taro)	Mangrove Preservation	Forestry Rehabilitation	Watershed Preservation	Hectares	Percent
400		○						1,222	2.8
401		○						4,701	10.7
402		○						8,129	18.5
403							○	5,521	12.6
404								170	0.4
405						○		1,046	2.4
406			○					1,744	4.0
407					○			316	0.7
408				○				2,161	4.9
409					○			4,130	9.4
410								299	0.7
411						○		1,489	3.4
412							○	560	1.3
413		○						103	0.2
414		○						469	1.1
415								959	2.2
416		○						1,269	2.9
417							○	575	1.3
418						○		229	0.5
419						○		89	0.2
420	○							152	0.3
421	○							233	0.5
422								202	0.5
423								107	0.2
424								577	1.3
425							○	89	0.2
426				○				991	2.3
427				○				214	0.5
428			○					455	1.0
429							○	1,078	2.5
430							○	391	0.9
431	○							332	0.8
432							○	811	1.9
433							○		0.4
434							○	1,392	3.2
435		○						312	0.7
436		○						198	0.5
437			○					322	0.7
438			○					217	0.5
439			○					93	0.2
440							○	107	0.2
441								198	0.5
Total								43,830	100.0

Source:"Soil Survey of island of ROP", 1983, USDA

Figure 7.2.1 Watersheds In Babeldaob

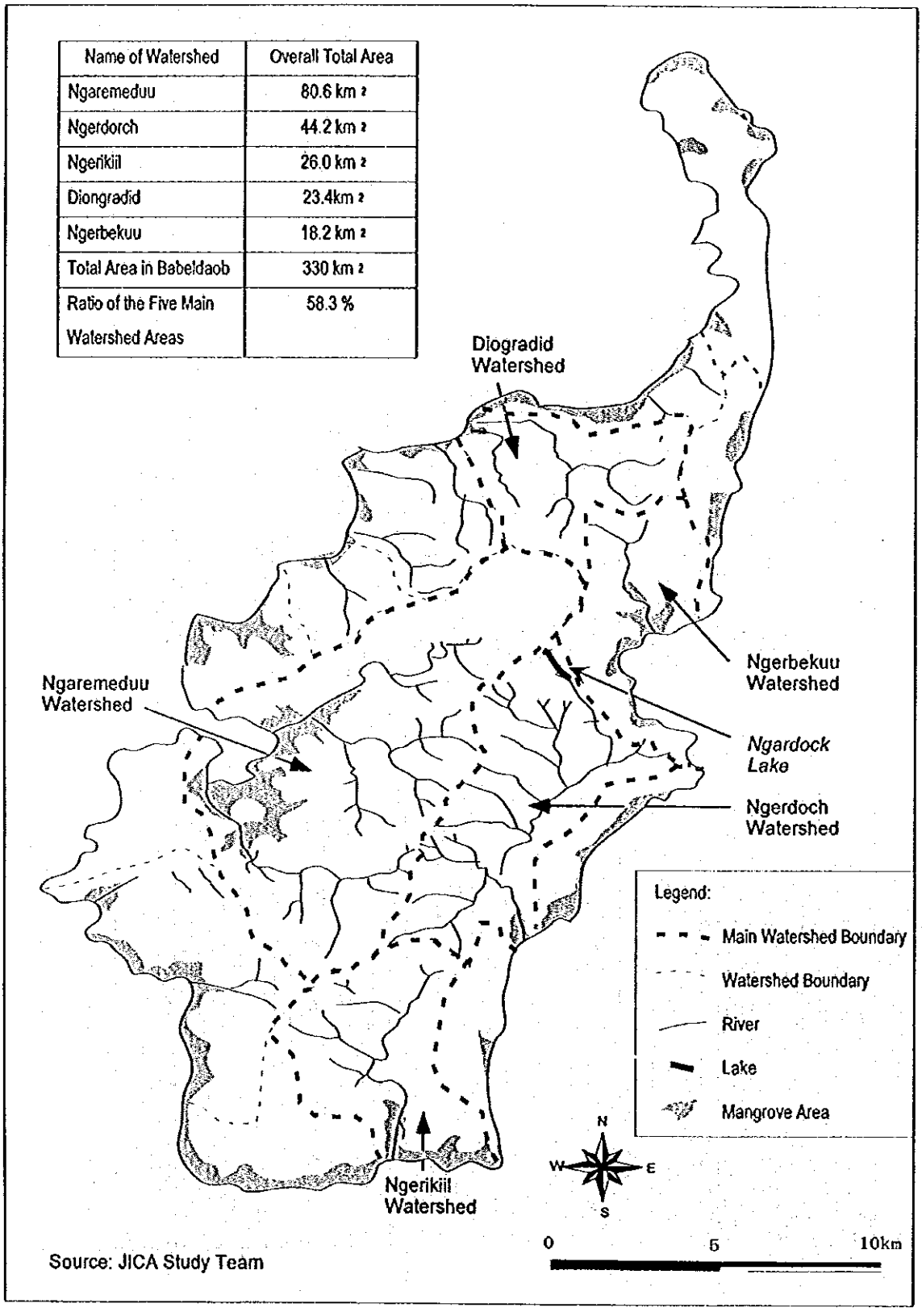
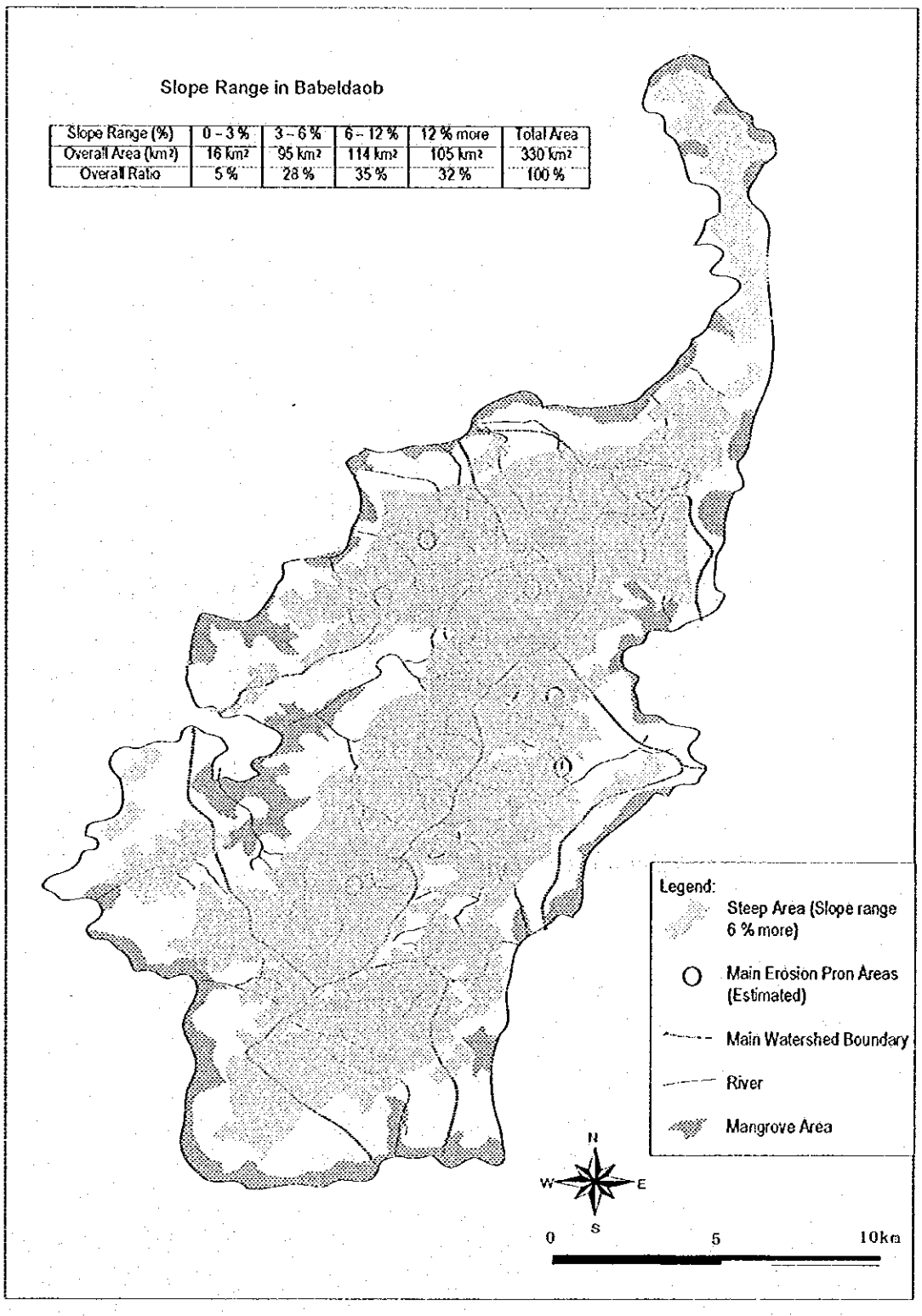


Figure 7.2.2 Slope Map In Babeldaob



Source: JICA Study Team

Table 7.2.2 Vegetation Cover in Palau

(Unit: ha)

Land Class and Type	Babeldaob	Other high islands	Coral islands	Rock islands	Total
Forest					
Upland Forest	21,690	201	0	0	21,891
Swamp forest	1,617	15	47	1	1,680
Mangrove forest	4,025	205	435	43	4,708
Plantation forest	24	2	0	0	26
Rock Island forest	104	210	0	802	1,116
Limestone forest	0	0	1,175	57	1,232
Casuarina forest	0	0	451	0	451
Atoll forest	0	0	97	58	155
Palm forest	0	< 1	0	0	0
Forest Total	27,460	633	2,205	961	31,259
Secondary Vegetation	515	79	131	2	727
Agroforest					
Agroforest	8	0	2	6	16
Agroforest with coconut	173	6	100	0	279
Coconut Plantation	743	0	0	71	814
Agroforest Total	924	6	102	77	1,109
Nonforest					
Marsh, fresh	448	< 1	27	0	475
Marsh, cultivated	107	2	25	0	134
Marsh, saline	0	0	25	< 1	25
Grassland	6,728	53	1	1	6,783
Strand	0	0	10	1	11
Cropland	140	59	4	0	203
Cropland/secondary vegetation	0	28	0	0	28
Urban	141	222	33	1	397
Urban/cropland	106	70	0	0	176
Urban/agroforest	0	0	61	0	61
Urban/secondary vegetation	0	3	0	0	3
Barren	149	5	26	0	180
Water	15	9	17	7	48
Nonforest Total	7,834	451	229	10	8,524
Total Area	36,733	1,169	2,667	1,050	41,619

Source: Vegetation survey of Palau

Table 7.2.3 Protected Species and Endangered Species in Palau (1)

Code	Category	Kind	Common name	Scientific name	Palauan name	Habitat area	Other Characteristics
M-1	Protected Species	Mammals	Dugong (Sea Cow)	*Dugong dugon*	Mesekiu	(1)west shallow coast area of Babeldaob island from southern Ngarchelong state to northern Ngaraard (2)West shallow coast area of Babeldaob island from southern Ngerdmau State to northern Ngelemlengui State. (3)East shallow coast area of southern Ngiwal State (4)The shallow area include offshore channel of Ngelemlengui State, Nenhane State,. (5)South shallow coast area of Airai State (6)Around Ngel Channel and (7) South shall coast of Koror (8)Around Denges Passage	feed on sea grass
B-1	Protected Species	Birds	Palau Gray Duck	*Anas superciliicea*	Debar	Babeldaob, Koror, Peleliu and Angaur	feeding on wetland vegetable matter
B-2	Protected Species	Birds	Micronesian Megapode	*Megapodius laperouse*	Bekai	Kayangel, Babeldaob, Koror, Rock Islands, Peleliu and Angaur	feed on seeds, vegetable matter,insects & crabs
B-3	Protected Species	Birds	Palau Nicobar Pigeon	*Caloenas nicobarica*	Laib	Babeldaob, Koror, including the Rock Islands and Peleliu	secretive forest bird feeding on wild fruits and
B-4	Protected Species	Birds	Palau Ground Dove	*Gallicolumba canifrons*	Omekrengukl	It is found in dense forest of major islands, Babeldaob to Angaur	feeding on grounds for seeds

Table 7.2.3 Protected Species and Endangered Species in Palau (2)

Code	Category	Kind	Common name	Scientific name	Palauan name	Habitat area	Other Characteritics
B-5	Protected Species	Birds	Palau Owl	*Pyrroglaux podargina*	Esuch	Common in forest areas of Babeldaob to Angaur	feeds in earthworms, insects, and other arthropods
B-6	Protected Species	Birds	Palau Fantail	*Rhipidura lepida*	Melimdelebteb	Babeldaob ,Koror, including the Rock Islands and Peleliu	feeds on insects flying or on foliage
B-7	Protected Species	Birds	Blue-Faced Parrotfinch	*Erythrura trichroa*		Koror to Mecherechar, rare in Babeldaob Is.	feed s on small seeds mature cones of casuarina are
B-8	Protected Species	Birds	White-breasted Wood-swallow	*Artamus trileucorhychus*	Mengaluliu	Upper savannas of Babeldaob	feed on flying insects
B-9	Endemic Species	Birds	Palau Bush Warbler	*Cettia annae*	Esisebarsech	Babeldaob, Peleliu and high limestone islands	feeds on insects, snails and small seeds
B-10	Endemic Species	Birds	Palau Greater White-eye	*Megazos terops palauensis*	Armbedel	Peleliu and high limestone islands of Ngeruktabel	feeds on caterpillars, other insects & small fruits
R-1	Protected Species	Reptiles	Hawksbill Turtle	*Eretmochelys imbricata*	Ngasech	Nesting area (1)The beaches of Kavangel State (2)The small islands beaches of northern Ngerchelong State (3)The beaches of around Chomedokl (4)The beaches of southern lagoon including Seventy Islands (5)The beaches of Angaur State Habitat area (6)Northern sea area of Babeldaob island (7)East shallow coast area of southern Ngiwal state (8)Around Ngel Channel and (9) South shall coast of Koror (10)Notheast shallow area of Peleliu island	all beaches in Palau with strand vegetation feeds on sponges, etc.

Table 7.2.3 Protected Species and Endangered Species in Palau (3)

Code	Category	Kind	Common name	Scientific name	Palauan name	Habitat area	Other Characteristics
R-2	Regulated Species	Reptiles	Green Turtle	*Chelonia mydas*	Melob	(1)Northern sea area of Babledaob island (2)East shallow coast area of southern Ngiwal state (3)Around Nigel Channel and requires clean and clear circulating water (5)Noreast shallow area of Peleliu island	sometimes it nests in Kayangel; major nesting are in Southwest island feeds on sea grasses
R-4	Endemic Species	Reptiles	Saltwater Crocodile	*Crocodylus porosus*	Ius	Most of the Babeldaob, Koror, Peleliu & Angaur	found in rivers, lakes, mangroves, estuarine areas, & fresh water wetlands
R-5	Endemic Species	Reptiles	Banded Sea Snake	*Laticauda colubrina*	Mengerenger	Present in Kayangel to Angaur	prefers rocky shorelines and isolated islets
P-1	Protected Species	Plants	Rock Island Palm	*Gulubia palauensis*	Bochela Uchererak; Eseche buuch	Only in the Rock islands of Palau	in high limestone islands in the Rock Islands
P-2	Protected Species	Plants	Palau Palm	*Prychosperma palauensis*	Esebouch	only in the Rock Islands of Palau	in high limestone islands in the Rock Islands, but close to Koror main islands
P-3	Proposed Protected Species	Plants	–	*Parkia parvifolia*	Kmekumer	only Babeldaob	Found near river bank
P-4	Proposed Protected Species	Plants	–	*Pericopsis mooniana*	Amansis	only Babeldaob	Found near river bank
BA-1	Endemic Species	Bats	Fruit Bats	*Pteropus pelewensis*	Olik	in all major islands from Babeldaob to Angaur	feeds on fruits and nectar
BA-2	Proposed Protected Species	Bats	Insectivorous Bats	*Emballonura paluensis*	Esisualik	in all major islands from Babeldaob to Angaur	fees on flying insects: fly at night; sleep in caves during daytime

Table 7.2.3 Protected Species and Endangered Species in Palau (4)

Code	Category	Kind	Common name	Scientific name	Palauan name	Habitat area	Other Characteritics
C-1	Regulated Species	Crab	Coconut Crab	*Birgus latro*	Ketat	(1) 3 islands of Kavangel state (2) East coast area of Baberdoab island (3)All round of Rock Islands (4) Peleliu island (5) Angaur island	comes up on sandy beaches; adult are found in places where sandy beaches are
C-2	Regulated Species	Crab	Mangrove Crab	*Scylla serrata*	Emang	(1) Mangrove area of Babeldaob island (2)Mangrove area of Koror St. (3) Mangrove area of Peleliu island	abundant where mangroves exist
S-1	Regulated Species	Shellfish	Giant Clams	*Tridacna gigas*	Oktang	Barrier Reefs, passes and channels south of Babeldaob island; found also in other parts of the reefs of	requires clean and clear circulating water
			Giant Clams	*Tridacna squamosa*	Ribkungal		prefers hard substrate bottom; needs a lot of sunlight
			Giant Clams	*Tridacna derasa*	Kism		
			Giant Clams	*Tridacna maxima*	Melibes		
			Giant Clams	*Tridacna crocea*	Oruer		
			Giant Clams	*Hippopus hippopus*	Duadeb		
			Giant Clams	*Hippopus porcellanus*	Duadeb		
F-1	Regulated Species	Fish	Groupers	*Epinephelus fuscoguttatus*	Meteungerel'temekai	All barrier Reefs , passes and channel	requires clean and clear circulating water
			Groupers	*Epinephelus polyphekadion*	Keau'temekal		
			Groupers	*Plectropomus areolatus*	Tiau		
			Groupers	*Plectropomus laevis*	Mokas		
			Groupers	*Plectropomus leopardus*	Tiau		
			Rabbitfish	*Siganus canaliculatus*	Mayas		
			Humphead parrotfish	*Bolbometopon muricatum*	Berdebed		
			Napoleon wrasse	*Cheilinus undulatus*	Ngimer		
CO-1	Regulated Species	Coral	—	—	—	—	—

7.2.2 Coastal and Marine Environment

(1) Characteristics of Reef and Coastline

Palau exhibits several islands and reef types, including volcanic islands, atolls, raised limestone, and low coral islands. Koror and the southern islands of Palau are separated from Babeldaob by a deep pass (30-40m), which also cuts in from east to west.

In the west side of Palau, a barrier reef is well developed and covering the main cluster of islands from north of Babeldaob and extending down to the southern lagoon merging into the fringing reef. In the east side, the barrier reef is not well developed. Only Ngchesar and Airai have a barrier reef.

Most of the Palau has very few beaches. Babeldaob has only one long beach (approximately 2km length) in the east side of Babeldaob at Ngaraard State. The other small beaches scattered in small islands. The coastline of Babeldaob is irregular. Small bays are numerous and covered by dense mangroves. Mangrove areas and edges of the coastline are covered with limestone (see Figure 7.2.3).

(2) Coral Reef Conditions

Based on the hearings from the locals/dive operators in Palau as well as dive observation, it could be assessed in overall coral reef conditions are as follows:

- Corals in the southwest region of Palau's reef are good condition, although the sedimentations are found in the area;
- Corals in the north and the west of Babeldaob Island are also good condition; and
- Corals around congesting diving spots are mainly not good conditions.

These recent conditions may caused by natural threats such as bleaching as well as human impacts such as the divers pressures (see Figure 7.2.4).

Table 7.2.4 shows the evaluation results of the present main diving spots. The evaluation is based on the data/information, such as the popularity of the spots and coral reef conditions from the hearing and dive observation by JICA Study Team.

(3) Sea Grass

Sea grasses are scattered around the whole Palau's islands. Peleliu Island has the biggest sea grass bed in Palau. The other main sea grass is distributed in the north of Babeldaob Island and the south of Koror Island, as well as the south of Macharchar Island (see Figure 7.2.5).

(4) Marine Species

A wide range of marine species is found in the coastal environment off the islands of Palau. Palau's marine environment is one of the most biologically diverse in the world. It is estimated that more than 1,000 species of inshore fish, 400 species of stony corals and 300 species of soft corals inhabit in the inshore of Palau. However, some of the marine protected species such as dugong, hawksbill turtle recognized as being highly endangered (refer to Table 7.2.2).

(5) Conservation Areas

At present, there are several conservation areas in Palau. Many types of conservation

areas exist or proposed by several entities such as state government, traditional chiefs. Table 7.2.5 shows present main conservation areas, which includes established conservation areas as well as recent enacted conservation areas.

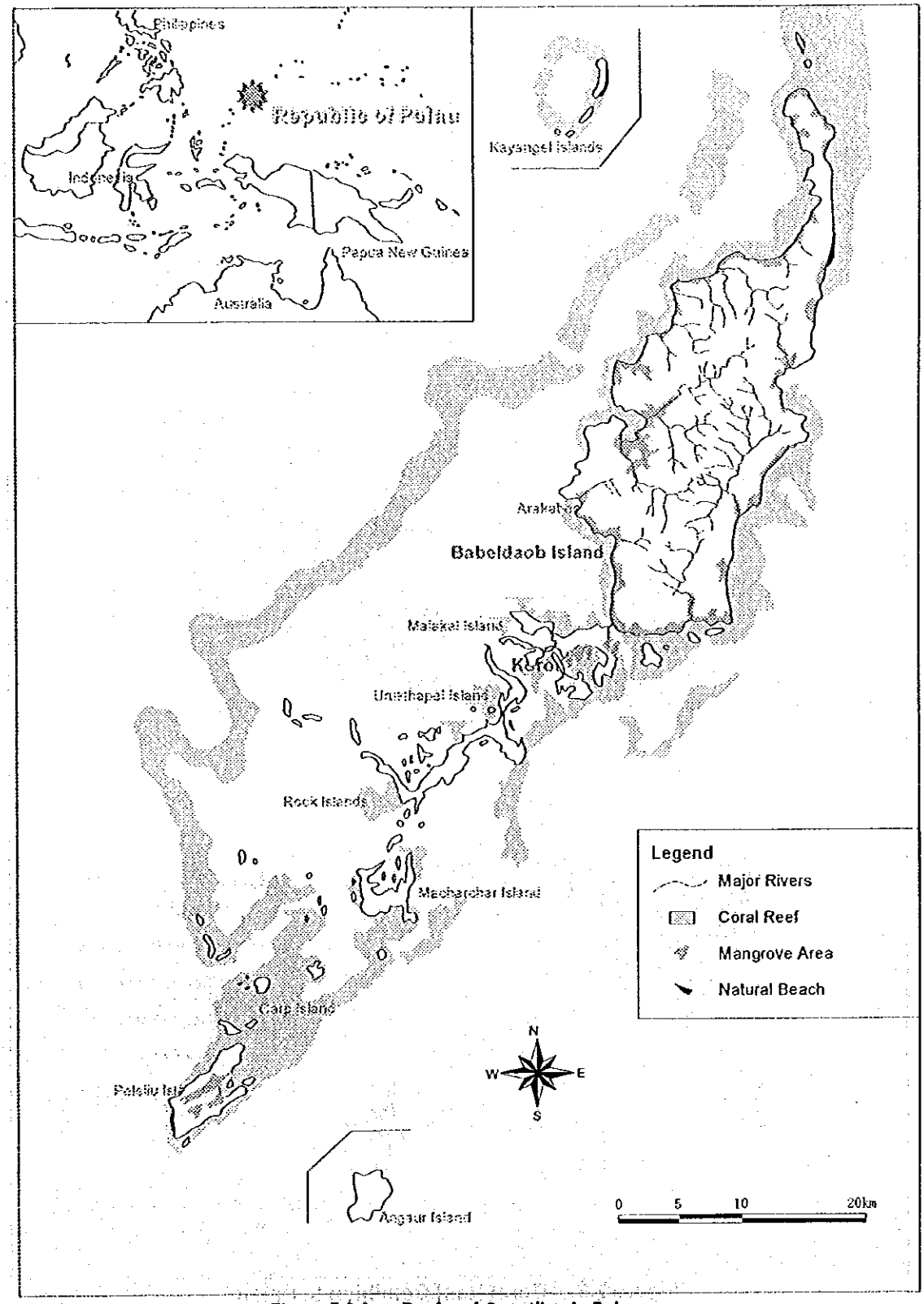


Figure 7.2.3 Reef and Coastline in Palau

Source: JICA Study Team

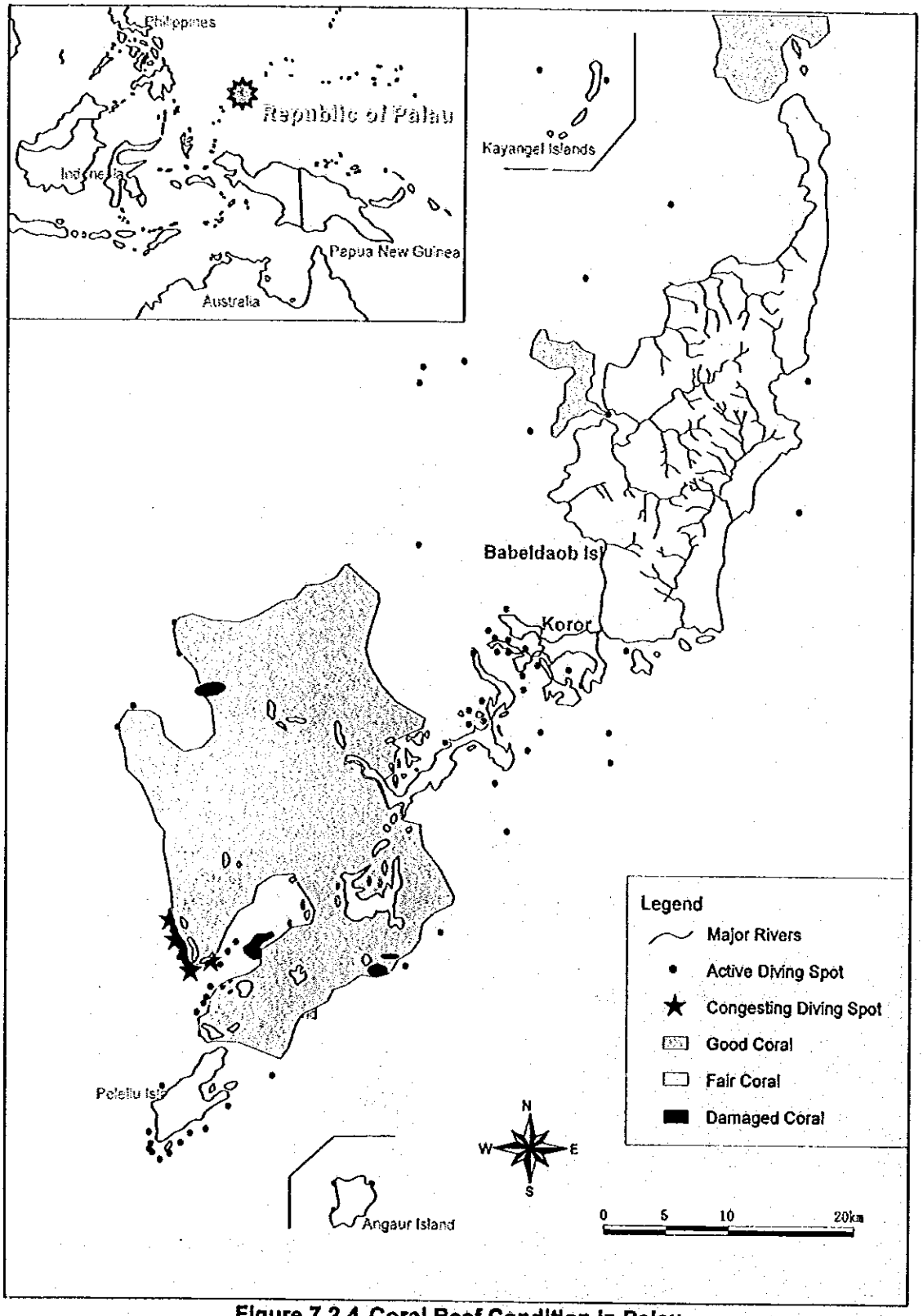


Figure 7.2.4 Coral Reef Condition in Palau

JICA Study Team

Table 7.2.4 Diving Spots Characteristics and Evaluation in Palau (1)

No.	Name of Diving Spot	Frequency	Level required	Attraction	Popularity	Coral Reef Conditions	Score	Class	Rank	Environmental Considered
70	Blue Corner	3	2	4	4	2	24.00	S	1	26.00
34	Iro (Tanker)*	1	1	4	4	3	16.00	S	2	19.00
57	Orange Beach	1	1	3	4	3	12.00	S	3	15.00
66	Big Drop-Off	1	1	4	3	3	12.00	S	4	15.00
38	Japanese Zero II*	1	1	3	3	2	9.00	A	5	11.00
65	Ngemelis Wall	1	1	3	3	3	9.00	A	6	12.00
23	Chadelier Cave*	1	2	4	4	2	8.00	A	7	10.00
55	Peleliu Wall	1	2	4	4	4	8.00	A	8	12.00
61	Turtle Cove	1	2	4	4	3	8.00	A	9	11.00
67	New Drop-Off	1	2	4	4	3	8.00	A	10	11.00
69	Virgin Blue Hole	1	2	4	4	2	8.00	A	11	10.00
71	Blue Holes	1	2	4	4	2	8.00	A	12	10.00
73	Ulong Channel	1	2	4	4	1	8.00	A	13	9.00
74	Siaes Tunnel	1	2	4	4	2	8.00	A	14	10.00
75	Siaes Corner	1	2	4	4	4	8.00	A	15	12.00
32	Lighthouse Channel	1	2	4	3	4	6.00	A	16	10.00
54	Peleliu Cut	1	3	4	4	3	5.33	B	17	8.33
26	Buoy 6 Wreck*	1	2	3	3	4	4.50	B	18	8.50
62	Barnum Wall	0.5	1	3	3	3	4.50	B	19	7.50
21	Chuyo Maru*	0.5	2	4	4	3	4.00	B	20	7.00
50	Peleliu Corner	1	3	3	3	3	3.00	B	21	6.00
37	Bichu Maru*	0.5	1	2	3	3	3.00	B	22	6.00
63	Manta Cleaning Station	0.5	2	3	4	1	3.00	B	23	4.00
6	Devilfish City	0.5	2	3	3	2	2.25	B	24	4.25
59	Ngedbus Drop-Off	0.5	2	2	3	3	1.50	B	25	4.50
40	Jellyfish Lake	0.1	1	3	3	2	0.90	B	26	2.90
16	Teshio Maru*	0.2	1	2	2		0.80	B	27	0.80
25	Depth Charge Wreck*	0.1	2	3	4	3	0.60	B	28	3.60
44	Ngerchong Drop-Off	0.1	2	3	3	2	0.45	C	29	2.45
48	Yellow Wall	0.1	2	3	3	2	0.45	C	30	2.45
31	Short Drop-Off	0.2	2	2	2	1	0.40	C	31	1.40
64	German Wall	0.1	1	2	2	2	0.40	C	32	2.40
39	Clam City	0.05	1	2	3	1	0.30	C	33	1.30
22	Ryuko Maru*	0.2	2	2	1	3	0.20	C	34	3.20
30	Japanese Zero*	0.1	2	2	2	1	0.20	C	35	1.20
68	Ngemelis Coral Garden	0.1	1	1	2	2	0.20	C	36	2.20
8	West Channel	0.3	2	1	1	3	0.15	C	37	3.15
10	Satan's Corner	0.3	2	1	1	2	0.15	C	38	2.15
11	Devil's Playground	0.3	2	1	1	2	0.15	C	39	2.15
9	Wild West Coral Garden	0.1	2	1	1	2	0.05	C	40	2.05
20	Amatsu Maru*	0.05	2	1	2	3	0.05	C	41	3.05
56	South Dock	0.01	1	2	2	2	0.04	C	42	2.04
49	Peleliu Express	0.01	3	3	2	2	0.02	C	43	2.02
13	Sunken Village	0.01	1	1	1	2	0.01	C	44	2.01
15	Blue Sea Lake	0.01	1	1	1		0.01	C	45	0.01
17	Jake Seaplane*	0.01	1	1	1		0.01	C	46	0.01
18	Raizan Maru*	0.01	2	1	1		0.01	C	47	0.01
19	LST T1*	0.01	2	1	1		0.01	C	48	0.01
53	Santa Maria Corner	0.001	3	2	2	2	0.00	C	49	2.00
51	Airport Wall	0.001	2	1	2	2	0.00	C	50	2.00
33	Sata (Tanker)*	0.001	3	1	2	3	0.00	C	51	3.00
27	Kaibaku Tunnel	0.0001	3	1	1	4	0.00	C	52	4.00

Table 7.2.5 Diving Spots Characteristics and Evaluation in Palau (2)

1	George Bush Wreck*	0						D	53	0.00
2	Destroyer Samidare*	0						D	54	0.00
3	Blue Hole		1	4	4	2		D	55	2.00
4	Ngkesol Channel							D	56	0.00
5	Ngesol Reef							D	57	0.00
7	Coresair Fighter*							D	58	0.00
12	Destroyer Wakatake*							D	59	0.00
14	Kibi Maru*							D	60	0.00
24	Urakami Maru*							D	61	0.00
28	Pillbox Channel							D	62	0.00
29	Jake Seaplanes and Cave*							D	63	0.00
35	Nagisan Maru*							D	64	0.00
36	Kamikaze Maru*							D	65	0.00
41	Cement Ship Lignite							D	66	0.00
42	Beluowar							D	67	0.00
43	Coral Garden							D	68	0.00
45	Ngerksiul							D	69	0.00
46	Stingray Point							D	70	0.00
47	Purple Beach Drop-Off							D	71	0.00
52	Turtle Reef							D	72	0.00
58	Shipwreck Point							D	73	0.00
60	Ngercheu Garden							D	74	0.00
72	Mutiyaur Wall							D	75	0.00

Source: JICA Study Team

Note: * means wreck spots
Frequncy: How many divers per weekon an average?
Level required: 1 beginner, 2 Intermediate, 3 Advanced
Popularity: 4 Excellent, 3 Good, 2 Moderate, 1 Poor
Coral reef conditions: 4 Excellent, 3 Good, 2 Moderate, 1 Poor
Class is calculated as follows: S=(Frequency) x (Attraction) x (popularity) / (Level required)
Classification of diving spot is as follows: S Excellent and most popular, A Good and very popular, C Good but not popular, Moderate, Not popular has potential

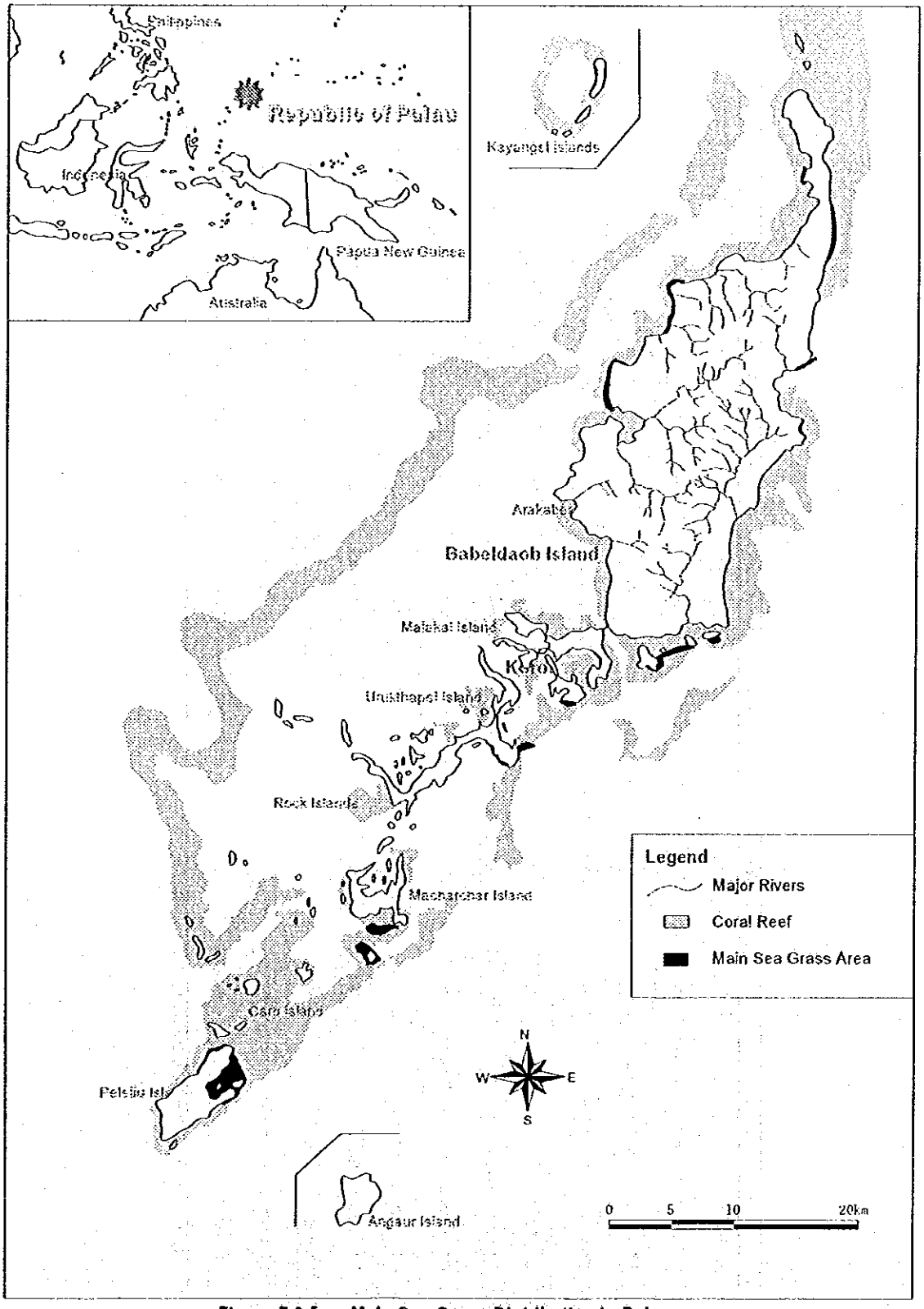


Figure 7.2.5 Main Sea Grass Distribution in Palau

Source: JICA Study Team

Table 7.2.6 Main Conservation Areas in Palau

No.	Name of Area	Location (State)	Total Areas	Reason of the Establishment	Authority (Law)	Effective Year	Stage	Main Restrictions
1	Nganuangel Reserve	Kayangel	35.0 km^2	Variety of fishes	State of Kayangel	1995	Implementaion	No entry, no fishing (3-year moratorium)
				(decline of fish resources)	KYPL 7-02-96			
2	Ngarchelong/Kayangel reef Channels	Ngarchelong & Kayangel	90.0 km^2	catch and release sport fishing	*Traditional Bul*	1994	Implementaion (shared manage)	No fishing in 8 channels April 1 - July 31
3	Ngaraard Mangrove Conservation Area	Ngaraard	1.8 km^2	Long and huge Mangrove Area	State of Ngaraard NSPL 4-4	1994	Implementaion	Only traditional, subsistance, and educational uses allowed
4	Ngemai Conservation Area	Ngiwal	1.0 km^2	Popular diving spots (but decline of fish variety)	State of Ngiwal NSPL 7-0004	1997	Proposed	No entry, no fishing (5-year moratorium)
5	Nganuangel Reserve	Kayangel	35.0 km^2	Variety of fishes (but decline of fish resources	State of Kayangel KYPL 7-02-96	1995	Implementaion	No entry, no fishing (3-year moratorium)
6	Ngeunmekaol Spawning Area	Koror	0.3 km^2	Grouper spawning area	National Gov. PL 6-2-4 (24PNCA 31)	1976	Implementaion	No fishing April 1 - July 31
7	Ngerukewid Islands Wildlife Preserve	Koror	12.0 km^2	Include seventy isalnds (sea scape and fish species)	National Gov. PDC 201(24PNCA 30)	1956	Implementaion	No fishing, hunting, or disturbance
8	Ngemelis Boat Diversion	Koror	30.0 km^2	Variety of fishes for divers	State of Koror K4-68-95	1995	Implementaion	No fishing, No motorboat operation
9	Medalaiechad Taki	Ngardmau	-	-	State of Ngardmau	1998	Enacted of the Law not fully defined the boundary	
10	Ngercheidous	Ngardmau	-	-	State of Ngardmau	1998	Enacted of the Law not fully defined the boundary	
11	Bkulachelid to Ngemasech Channel	Ngardmau	-	-	State of Ngardmau	1998	Enacted of the Law not fully defined the boundary	
12	Ebiil Channel	Ngarchelong	-	-	State of Ngarchelong	1998	Enacted of the Law not fully defined the boundary	

Source: Modified data from Palau Conservation Society (PCS)

7.3 Present Environmental Management Situations

7.3.1 Terrestrial Environment

(1) Land Resources Situations

Soil

According to the USDA Soil Conservation Services, there are basically 18 different soil types. Laterites, which are the main soil type, are widely observed in Babeldaob Island. Lithosols, bog soils, alluviums, and coralline sands are the other main soil types.

Most of the soils are infertile and quite prone to erosion once the protective vegetation is disturbed especially on steeper slopes.

Watershed and Slope

Babeldaob Island is the biggest island in Palau, which occupies an approximately 70 % of the total land. It is estimated that an average of almost 2,000 million liter of freshwater flow out of Babeldaob stream everyday.

Babeldaob Island could be divided into 16 watersheds, which has few flat areas and have some erodible areas due to the steepness as well as the types of soils. Within the 16 watersheds, there are five main watersheds in Babeldaob based on the coverage areas and the importance of the water sources for the peoples, as well as the ecological integrity (see Figure 7.3.1 and Table 7.3.1).

Peleliu Island and Angaur Island have some relatively flat areas, which may use for development activities such as tourism development.

Table 7.3.1 Slope Range in Palau

Slope Range (%)	0-3	3-6	6-12	12 more	Total Area
Overall Area (km^2)	80	99	114	195	488
Overall Ratio (%)	16	20	24	40	100

Source: JICA Study Team

Forest

It was estimated that primary forests, including mangroves covered approximately 75 % of total land of Palau in 1994. Palau's forestland in upland tends to revert to grasslands rather than reestablishing as secondary forests. It could be observed that many unproductive types of grassland are scattered mainly in Babeldaob at present.

However, no whole Palau's forest and vegetation survey have been done after 1979. It should be done a new vegetation survey in order to understand the present vegetation and forest cover.

Agriculture/forestry potentials and preservation needs

In general, agriculture requires fertile soil and flat to gently sloping lands. 42 soil units in Palau were categorized based on soil types and slope degrees. Table 7.3.2 shows soil association categories and each ratio for agriculture/forestry potentials and preservation needs based on characteristics of soil and slope degree.

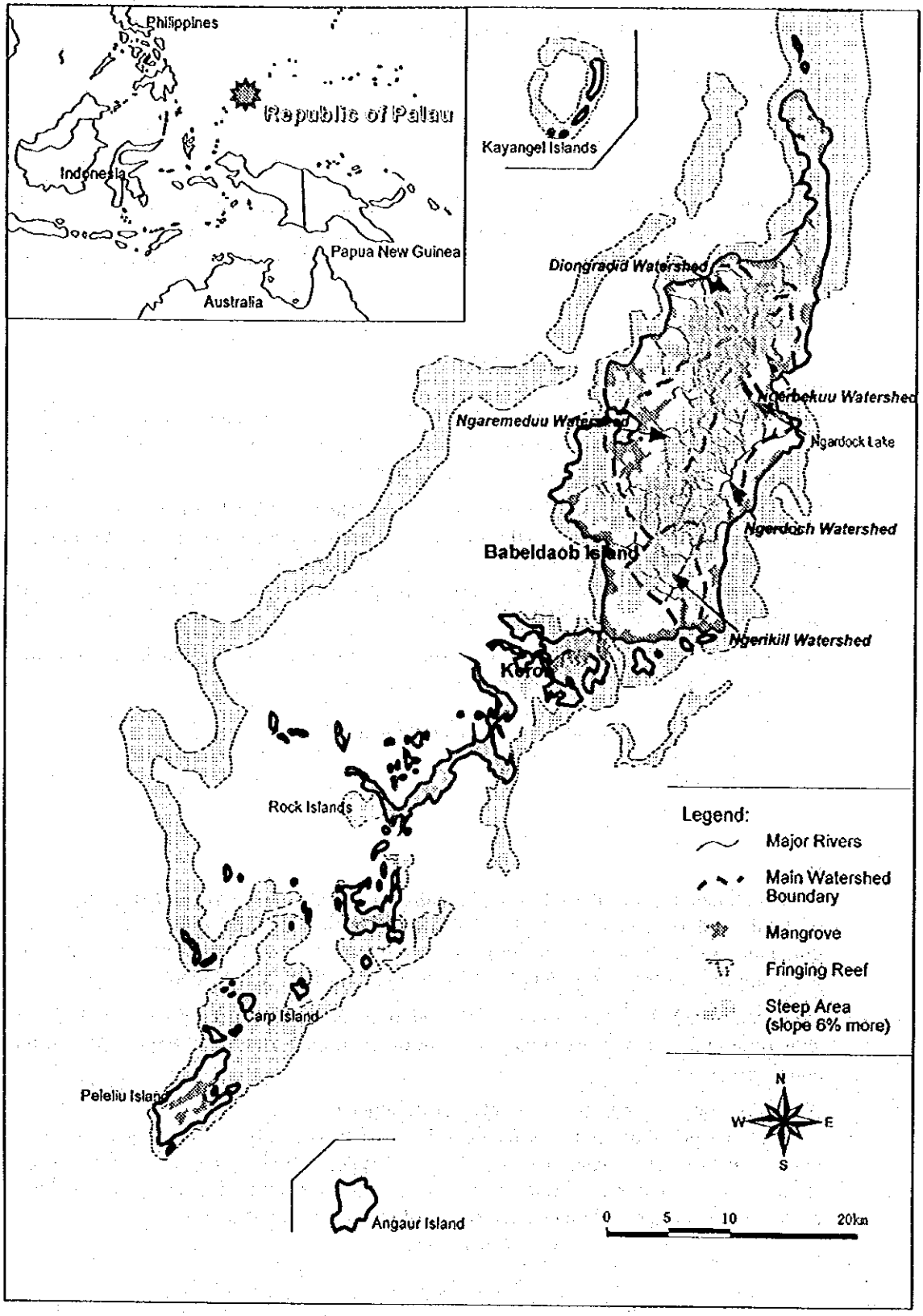


Figure 7.3.1 Main Watersheds and Steep Areas in Palau

Source: JICA Study Team

Table 7.3.2 Soil Association Category

Soil Association Category	Agriculture/Forestry Potentials and Preservation Needs	Soil Unit Number	Ratio for Total Land Area (%)
Potential High Intensity Use (Agriculture Use)	This category consists of those soil units more suited to various types of high intensity development including; clean- tilled crop production.	410, 415, 420, 421, 422, 423, 424, 431	6.8
Agroforestry Potential	This category consists of those soil units best suited to low intensity development by the introduction of fruit and food producing trees and some subsistence level agriculture.	400, 401, 402, 413, 414, 416, 435, 436	37.4
Forestry	This category consists of those soil units suited to forestry practices of timber harvest.	406, 428, 437, 438, 439	6.4
Hydric Soils	This category consists of those soil units lying within the flood plain or poorly drained valley bottoms. These soils are predominantly suited to the production of wetland taro and to some extent the development of rice production.	408, 426, 427	7.9
Mangrove Preservation	This category consists of the two soil units, which support mangrove forest.	407, 409	10.1
Forestry Rehabilitation	This category consists of those soil units, which require rehabilitation and restoration.	404, 405, 411, 418, 419	6.9
Watershed Preservation	This category consists of those soil units, which should remain in watershed preserve to protect the water quality and supply for Babeldaob.	403, 412, 417, 425, 429, 430, 432, 433, 434, 440	24.5
Total			100.0

Source: Land Use Inventory of Babeldaob 1992, and Soil Survey Island of ROP, 1983

Mineral Resources

Recent widespread extraction activities are gravel, soil, and sand in order to support local construction. But many deposits of bauxite and phosphate were mined on commercial base during German and Japanese colonial era in Babeldaob, Angaur, and Peleliu. The remaining mining sites are not rehabilitated by natural forest cover or planting.

It is doubted that soil erosion also occurs at these remaining steep mining sites, especially in Babeldaob.

(2) Land Resources Management Issues/Practices

In general, direct exploitation of land resources is not the major issue at present in Palau. However, the following land resources issues are still critical and should be tackled to solve:

- Soil erosion; and
- Habitat threats.

Soil erosion

Soil erosion is one of the natural processes, which has contributed to the development of the estuarine system, and not all erosion is bad phenomenon. However, human activity could effect a change and the rate of change within an ecosystem. It is understood that accelerated erosion rates deteriorate land resources, increase sediment loading to receiving water bodies, degrade water quality, and affect aquatic life adversely. In Babeldaob Island, with the development activities such as Compact Road construction and others, the increase of erosion already occurs or will occurs in some areas.

However, current relevant management practice is the only small-scale reforestation using fast growing and acid tolerant tree species such as *Acacia sp.* by Forestry Brach of Division of Agriculture.

Habitat threats

Recently, Palau identified the protected species as a part of Title 24, Palau National Code (PNC). Table 7.3.3 shows the list of the species. It is reported that habitat areas of the species have been decreased in Palau mainly due to human impacts. The other species such as saltwater crocodile are also recognized as highly endangered species.

Table 7.3.3 Protected Species in Palau

Kind	Common name	Scientific name	Palauan name
Mammals	Dugong (Sea Cow)	*Dugong dugong*	Mesekiu
Birds	Palau Gray Duck	*Anas superciliosa*	Debar
Birds	Micronesian Megapode	*Mepagodius laperouse*	Bekai
Birds	Palau Nicobar Pigeon	*Caloenas nicobarica*	Laib
Birds	Palau Ground Dove	*Gallicolumba canifrons*	Omekrengukl
Birds	Palau Owl	*Pyrroglaux podargina*	Esuch
Birds	Palau Fantail	*Rhipidura lepida*	Melimdelebteb
Birds	Blue-Faced Parrotfinch	*Erythrura trichroa*	-
Birds	White-breasted Wood-swallow	*Artamus trileucorhychus*	Mengaluliu
Reptiles	Hawksbill Turtle	*Eretmochelys imbricata*	Ngasech el Uel
Reptiles	Leatherback Turtle	*Demochelys*	Uel
Plants	Rock Island Palm	*Gulubia palauensis*	Bochela Uchererak
Plants	Palau Palm	*Ptychosperma palauensis*	Esebouch

Source: Title 24, Palau National Code
Note: These species except Whales

Although the Bureau of Natural Resources and Development (BDRD) is also responsible for protection of species habitat, few enforcement and management practices has been implemented for the following terrestrial habitat threats management issues:

- Inappropriate conservation measures for adverse ecological impacts on the habitats due to large-scale development activities such as Compact Road
- Increase in human intrusions to the habitats especially for unique birds

Land Tenure

Effective land resources management and conservation practices are based on clear and legally defined land tenure system. If many peoples declare the ownership of a certain land, the effective implementation of a land management /conservation not be proceed, even if the planning are well established.

Present land tenure system in Palau is extremely complicated. In the past, clans centered on the traditional chiefs owned most of the lands with unwritten rules for the allocation and use. During the colonial era, much of the lands had been belonged to four colonial governments. In addition, the return of former public lands to their original owners, as mandated by the national constitution, has resulted in increasing numbers of land disputes.

The above present land tenure system is the biggest barrier and issue for effective land resources management and conservation in Palau. It is need to be tackled the issues by appropriate specific measures.

For example, although no taxes can be imposed on land of Palau under the Constitution of Palau, reasonable taxes on land should be considered based on an authorized land valuation. Otherwise, the effective uses and conservation of the land resources will be impossible and time consuming practices.

7.3.2 Coastal and Marine Environment

(1) Coastal and Marine Resources Situations

Although the peoples, who live in Koror may eat meats rather than fishes in recent times, Palau is with abundance of marine resources, which historically have still provided one of the most important protein sources for the peoples especially in rural areas of Palau. Subsistence fisheries and domestic commercial marketing play an important role in household and national food security. Mangroves, estuarine bays, and shallow water lagoon and reef areas are habitats and feeding grounds for many species of fish and invertebrates. Mangroves are essential part of the marine ecosystem.

Mangroves

It is estimated that mangroves occupies approximately 9 % of total land area of Palau. Table 7.3.4 shows the estimated mangrove areas and main functions in each state:

Table 7.3.4 Estimated Mangrove Areas of Each State in Palau

State	Estimated Area (km^2)	Main functions of the Mangrove Area
Angaur	0.0	-
Peleliu	4.9	Maintaining water quality, filtering sediments and buffering nutrients, shoreline protection, and serving as critical habitat for the endangered crocodile.
Koror	1.6	Protecting shorelines and maintaining water quality around major residential area in Palau.
Airai	7.9	Maintaining marine and fisheries habitat, filtering sediments and buffering nutrients entering Airai Bay.
Aimeliik	2.8	Protecting near shore reefs by filtering sediments and buffering nutrients entering from adjacent uplands.
Ngatpang	6.3	Filtering sediments and buffering nutrients, entering Ngaremeduu Bay from adjacent uplands.
Ngeremlengui	4.0	Filtering sediments and buffering nutrients, entering Ngaremeduu Bay from adjacent uplands.
Ngardmau	7.2	Filtering sediments and buffering nutrients, entering the near shore coral.
Ngaraard	3.4	Filtering sediments and buffering nutrients, entering the near shore coral.
Ngarchelong	12.1	Maintaining critical marine and fisheries habitat, filtering sediments and buffering nutrients, and protecting shorelines from costal erosion.
Ngiwal	1.3	Maintaining critical marine and fisheries habitat and filtering sediments and buffering nutrients entering Ngemai Bay.
Melekeok	1.7	Maintaining critical marine and fisheries habitat and filtering sediments and buffering nutrients entering Ngemai Bay.
Ngchesar	1.8	Filtering sediments and buffering nutrients out welling from Ngerdorch River, which drains from Lake Ngardok.
Kayangel	0.0	-
Total	45.0	

Source: Division of Marine Resources 1990, Forest Service by USDA, 1999

Mangroves in Palau had been relatively conserved due to the uses of alternative sources for fuelwood, construction materials, and the Palauans conservation ethics.

However, mangroves are suffering from degradation threats due to the recent development activities such as the land reclamation for infrastructure improvements along the coastal shorelines.

Marine Species

A wide range of marine species is found in the coastal environment off the islands of Palau. Palau's marine environment is one of the most biologically diverse in the world. It is estimated that more than 1,000 species of inshore fish, 400 species of stony corals and 300 species of soft corals inhabit in inshore of Palau. However, some of the marine protected species such as dugong, hawksbill turtle recognized as being highly

endangered.

Natural and Human Threats on Coral Reefs

The main natural threats to Palau's coral reefs are crown-of-throne outbreak and coral bleaching. It is reported that crown-of-throne outbreak devastated the some reef areas of Palau in the late 1970's, and the areas have not been totally recovered at present. Also, significant coral bleaching occurs in 1998 mainly due to the warming of seawater temperature.

Human threats to coral reefs are also one of the main environmental issues in Palau. The one is erosion and sedimentation due to inappropriate construction activities. The other one is boat anchor damage and destructions of coral by tourists such as divers.

(2) Coastal and Marine Resources Management Issues/Practices

Fish Resources Management

In 1994, Marine Protection Act was enacted. Through this Act, Palau applied new restrictions on the exploitation, sale and export of marine resources such as groupers, napoleon wrasse, giant clams, lobsters, mangrove crab, coconut crabs and hard corals. At present, Koror state has more than 10 marine rangers, who are in charge of patrol for violators of the marine regulations, although the human resources and activities is not sufficient and appropriate.

It is not clear the fish resources have been depleted in recent years due to the lack of reliable fish resources data in Palau. At first, Palau needs to develop reliable times series basic data for fish catches or resources in order to assess the fish resources condition for marine resource conservation as well as fishery development in Palau

On the other hand, most of the Palau's fishermen are in Palau is on part time base. It is could not be observed the over-exploitation of fish by those local fishermen. Furthermore, some of the fish conservation activities thorough designating conservation areas by several entities, including traditional authorities may improve the marine resources conditions, except unique marine species such as dugong.

Mangrove Management

Although the importance of mangrove for fish resources and other ecological functions are recognized, Palau has no specific mangrove conservation act. Only a foreign mangrove specialist performed in 1999 in order to review the general status of mangroves and develop mangrove management options for their conservation.

Coastal Conservation Practices Through User Charge

At present, tourist visitors have to pay $15 per person per month in each state of Palau in principle. However, the user charge is actually applied as Koror state's dive fee especially for main parts of the salaries of Koror State marine rangers. The other remote states are very few opportunities for revenue generation from the user charge.

It should be consider more effective and reasonable user charge system for whole Palau's reef areas taking into account for cost effectiveness and equitability of the revenue between Koror State and the other remote states.

The concept of proposed user charge is that the national government should collect the charge and distributes it among the related states based on some clear criteria.

Sea Tenure

In terms of the marine resources management authority, sea tenure from the shoreline to 12 nautical miles formally belong to the state, but actually complicated inshore ownership still exist in Palau, which is the almost same as land tenure. If inshore ownership were integrated one authority, the management would become drastically effective.

It is need to consider a holistic approach that reflects the linkage between land resources and marine resources as well as cooperative linkage of the related states. Because, marine resources degradation does not cause not only by destruction of marine resources, but also by sedimentation from the uplands areas, which are prone to erosion by large-scale development activities such as Compact Road construction. Also, most of the marine species apparently move to other areas beyond the state boundary.

7.3.3 Pollution Control Issues and Practices

(1) Pollution Risks related to Solid Waste

The existing dumpsite in Koror, which are operated by the National Government is almost full and is not managed properly. For example, the lead and alkaline batteries are scattered along the near shore in the dumping site. In addition, illegal dumping is found not only on the land, but also in the sea. It is urgently need to develop a new national landfill site, while the existing dumpsite should be closed properly

Palau has few data in terms of pollution risks related to the solid wastes. A very limited risk assessment for water, sediment and soil at the existing dumping site was conducted by the USEPA in 1993. A foreign consulting firm conducted a more detailed risk assessment at the same site in 1997. According to the assessment in 1997, which includes the sampling and analyses of heavy metals such as mercury and lead, none of these compounds were detected at levels, which exceeds the standard or relevant standards in the other country. However, the conclusions was suggested that it should be conducted any countermeasures in order to mitigate serious health risks related to hazardous substances based on the results.

At least, it is imperative that it should be implemented an appropriate closure plan of the existing dumping site, which includes countermeasures for preventing possible water and soil contamination as well as other nuisances near the site.

In terms of other states, there is also no managed dumping site. For example, mixed garbage, including old car, old refrigerator are dumped at close to coastal area in Peleliu.

Regarding to the waste reduction, although one equipment company conducts a recycling business as one of the side businesses, and EQPB holds voluntary recycling campaign for car batteries, these are insufficient to reduce the main waste stream. The accumulated total waste volume in Koror and Babeldaob exceeds 0.1 million ton during year 2016 – 2020 according to an estimate by JICA Study Team.

Any effective countermeasures such as establishment of economically viable recycling system for recyclable items in order to reduce the solid wastes generation are urgently needed in Palau.

(2) Pollution Risks related to Wastewater

At present, there is no effluent standard in Palau. Palau needs specific effluent standard in order to enforce the quality of discharge waters based on more specific criteria.

Palau has the only centralized wastewater system in Koror State. The wastewater treatment plant is located in Malakal Island. Bureau of Public Works, Ministry of Resources and Development handle the daily operation and maintenance of the Koror State wastewater system. However, there is no actual data on wastewater system and sanitation facilities in Palau.

In terms of the water quality for influent and effluent of the wastewater treatment plant,

the monitoring responsibility lies with the Bureau of Public Works, but EQPB conducted only limited monitoring of Malakal Wastewater Treatment Plant in 1998.

There are some water quality pollution risks according to a limited water quality monitoring of Malakal wastewater plant by EQPB in 1998. It should be conducted a regular wastewater monitoring for wastewater to assess the possible adverse impact of the discharge to the receiving water and marine species and to consider the effective measures for the adverse impacts.

(3) Pollution Risks related Human Waste

In general, lack of good sanitation, combined with poor personal hygienic behavior, in relation to disposal and management of human waste put people at risk of epidemic diseases. Systems for human wastes should be adequate and managed properly in order to protect human health from diseases.

In Palau, most of the residents of the rural states live on near the shoreline. Most privies are constructed on soil and mixed with sand, which have rapid permeability. The geology of the site will facilitate contamination of water supplies. Although the USEPA provided financial assistance to Palau in order to implement a rural sanitation program in 1992, the program has come to an end at present

Only Bureau of Public Health reported that health hazards posed by human waste facilities, such as privies in some rural states in 1999. The Division of Environmental Health and Sanitation, Ministry of Health just start to conduct a limited environmental inspection related to human waste in 2000 on six states of Babeldaob Island.

It is need to strengthen water quality monitoring in order to assess the water pollution risk from an environmental point of view.

(4) Pollution Potentials related to Used Oil

Vehicles in Palau have been drastically increased in recent years. With the increase in the vehicles, pollution risks related to the used oil will be one of the critical pollution issues in Palau. Although Aimeliik Power Plant has a facility that process used oil as fuel for the diesel engine generator, over 500,000 gallons of the used oil, which cannot be processed due to the sludge is stored at Aimeliik Power Plant.

Furthermore, there is no facility in automobile shop in Palau in order to dispose the used oil properly. It is reported that the used oils are discharged into rivers and sea in Palau. This will be one of the main causes for water pollution in Palau.

At present, an environmental pollution coordinator of EQPB has been conducted proper used oil collection from companies such as the automobile repair shops, which deal with the used oil to the storage of Aimeliik Power Plant since 1996 in order to eliminate un-recyclable used oil. However, the practices are not sufficient and need to consider an effective measure to dispose it properly.

7.3.4 Environmental Institutions and Enforcement

(1) National Government

The National Environmental Agencies are summarized as follows:

Environmental Quality Protection Board (EQPB)
EQPB is a statutory body responsible for regulating and monitoring all earth moving activities, water quality, air quality, potable water use, marine monitoring, sewage and solid waste management and disposal, pesticide use, and Environmental Impact Assessment/Environmental Impact Statement. EQPB has six sections; administrative

support section; engineering section; regulatory and enforcement section; monitoring and inspection section; laboratory section; and environmental education section. However, the actual present technical staffs are less than 15 persons at present.

Bureau of Natural Resources and Development (BNRD)
As the primary national government for natural resources management, BNRD is responsible for the promotion, development and conservation of the all natural resources of Palau. BNRD directs the various activities of its divisions including the Division of Conservation and Entomology Division (DCE), the Division of Marine Resources (DMS), the Division of Agriculture and Mineral Resources (including Forestry Branch), and Conservation Area Support Office (CASO).

Although the DCE has the general mandate in order to develop and implement national policies in terms of resources conservation of Palau, the enforcement and management powers are extremely insufficient.

Division of Environmental Health and Sanitation (DEHS), Ministry of Health
DEHS is responsible for health related development activities such as vector control. DEHS is also involved in urban and rural sanitary improvement programs. Regarding recent rural sanitary improvement programs such as healthy island program funded by the United States is vital.

(2) State Governments

According to the Palau Constitution, states are responsible for the management and development of all resources from the land to 12 nautical miles as the exclusive owners. On the other hand, the national government retains its control over the resources that beyond 12 nautical miles from the shoreline. Each state in general has the following main tasks in terms of management and conservation of the natural resources:

- Establish regulations and a permitting system for the marine and land resources;
- Prohibit illegal harvest or catches for land and marines resources through the state conservation enforcement program;
- Establish zoning and other regulations in order to limit and control the development activities on the state land, and
- Promote sustainable development of resources in order to maximize economic benefits to the state.

However, actual resource management powers are depended on the state. For example, only Ngatpang, Melekeok, and Ngchesar State have complete decision-making power concerning conservation and management of the natural resources. On the other hand, most of the states in Palau have strong influences from the traditional authorities such as chief and clans.

(3) Traditional Authorities

In the past, traditional leaders (chiefs) were the strongest stakeholders of both land and marine resources. At present, although much of the powers have been taken over by the national and state governments, the Palau Constitution grants the chiefs considerable authority to continue in their traditional roles not only for environmental management but also for many government affairs in Palau.

For example, the chiefs of Kayangel and Ngarchelong together put a seasonal closure area *(bul)* on reef channels known to be spawning grounds for groupers and other fishes.

(4) Other Organizations

Other organizations have very important roles for environmental conservations and management especially for natural resources conservation planning in Palau.

United States Department of Agriculture (USDA)
USDA has two field offices in Palau; Natural Resource Conservation Services and the Rural Development Services. Especially in the Natural Resources Conservation Services are much involved for land conservation activities in Palau. In terms of conservation fields, USDA conducted soil and vegetation surveys during late 1970's and 1980's. In 1999, one mangrove specialist by USDA conducted detailed mangrove survey in whole Palau region.

The following Non Government Organizations (NGOs) have very important roles especially for environmental conservation in Palau.

Palau Conservation Society (PCS)
PCS is the most vital in terms of environmental conservation and management with involvement of local communities in Palau. PCS has also strong partnerships with not only local community, but also governmental agencies and international scientific organizations.

The Nature Conservancy (TNC)
TNC has a field office in Palau. The office has focused on providing technical assistance for marine and terrestrial environmental conservation and capacity building by supporting to its local partners such as PCS, and Koror/Kayangel States.

7.4 Critical Environmental Issues

Present critical environmental issues and their required counter measures in Palau could be summarized in Table 7.4.1.

Table 7.4.1 Critical Environmental Issues and Required Countermeasures

Environmental Impacts Items	Critical Environmental Issues	Required Countermeasures
Soil Erosion/Sedimentation and water pollution risk	- Soil erosion from the upland areas and sedimentation on the reef caused by development activities such as Compact Road construction in Babeldaob - Soil erosion and water pollution risk caused by construction of candidate capital site in Melekeok State	- Implement integrated watershed management focus on land conservation such as replanting on steep areas - Conduct water quality monitoring for assessing pollution risks as one of the measures of integrated watershed management
Deterioration of reef caused by natural and human threats	- Reef deterioration caused by human pressures such as diving activities - Reef deterioration caused by natural threats such as recent bleaching and crown-of-throne outbreak	- Decentralize diving spots and enhance the conservation manners of diving activities - Conduct a cooperative study for natural impacts on the reef with neighboring countries to consider the effective countermeasures
Habitat Threats	- Decrease in habitat areas of unique species caused by development activities as well as intrusion of tourists or local peoples - Degrade ecological and nursery functions of mangrove for marine habitats	- Implement effective management of the priority preservation and conservation areas - Implement integrated watershed management focus on mangrove conservation
High risks of water and soil contamination related to wastes	- Risks of water and soil contamination due to illegal dumping on the land and in the sea by insufficient garbage collection and people's awareness - Risks of water and soil contamination due to inappropriate management and insufficient capacity of the existing dump site in Koror - Pollution and health risks related to human waste, especially in rural areas - Pollution potential related to Inappropriate of used oil disposal	- Improve garbage collection system and strengthen prohibition of illegal dumping and people's awareness for the waste reduction (conduct comprehensive solid waste management project) - Conduct appropriate closure of the existing dump site in Koror and develop a new landfill site (conduct comprehensive solid waste management project) - Strengthen water quality monitoring in rural areas for assess the pollution impacts - Consider effective reuse or recycling of used oil

Source: JICA Study Team

7.4.1 Terrestrial Environment

(1) Soil Erosion and Sedimentation

Most of the soils especially on Babeldaob Island are highly erodible. Heavy rainfall and these highly erodible soils have resulted in major erosion events, if effective prevention measures have not been conducted in conjunction with development projects.

It is recently reported that evidence of soil erosion on Babeldaob Island has been observed along the existing unpaved dirt roads as well as inappropriate construction sites of the Compact Road. Deforestation due to development activities and disturbances to the land and soil, which left in unvegetated area, may promote erosion, especially during periods of heavy rainfall.

In addition, sedimentation resulting from this erosion can smother mangrove forest habitat and have an adverse impact on the reef in Palau.

(2) Habitat Threats

The status of terrestrial species is strongly determined by the availability of adequate habitat. Although little is known about the quantity of terrestrial habitat, which has been extinct, it is understand that the chance of watch the unique species has been decreased recently.

In terms of terrestrial habitat in Palau, decrease in unique bird populations is a major issue in Palau. The adverse impacts by development activities on uplands limits the habitats of forest birds. Also, tourist's pressures on small islands such as Rock Island has resulted in disturbance of unique birds such as Micronesian Megaspore habitat area.

7.4.2 Coastal and Marine Environment

(1) Deterioration of Reef by Natural and Human Threats

The main causes of deterioration of reef of Palau are natural threat and human pressures. It is reported that high densities of crown-of-thorns have been reported often around Palau's reefs since 1990's. Some reefs areas of Palau have been devastated by crown-of-thorns are not able to recover at present. Also, after the coral-bleaching event 1998, crown-of-thorns has been targeting the remaining corals.

On the other hand, the congestion and the inexperience of many divers is resulting damage to the reefs of some diving points from both anchors and divers colliding with the corals.

Furthermore, presently, unique marine species such as dugong are seldom to watch in the reefs of Palau. It is reported that the noise from speedboat engine is one of the significant adverse impacts for dugong.

(2) Degradation of Ecological Functions of Mangroves

Mangrove serves as a settling and filtering ground for waters entering lagoons. Healthy mangroves help to sustain coastal environments by preventing the intrusion of excess sedimentation into coastal water, which may damage fish and other marine species. Also, mangroves provide a habitat for important subsistence and commercial marine resources such as inshore fishes and mangrove crabs.

Although Palau abounds with mangrove and had been relatively protected, the recent primary loss of the mangroves is attributed to coastal development activities related to infrastructure developments along coastal shorelines, especially in Babeldaob Island and Koror State.

7.4.3 Living Environment

(1) Water and Soil Contamination Risks related Solid Wastes

Presently, public work department of Koror state government is responsible for the collection, haulage, and disposal of the solid waste, which generated from households, commercial facilities, and institutional facilities. However, the present solid waste collection system is inappropriate and insufficient, such as no segregation of the waste in Koror State as well as the whole Palau region.

The existing dumpsite in Koror is almost full and is not managed properly. Also, there is no intermediate facility in Palau. Although solid waste from households is collected in Koror State, many wastes are scattering around the town. Illegal dumping is found not only on the land, but also in the sea.

In terms of other states, there is no managed dumping site. For example, mixed garbage,

including old car, old refrigerator are dumped close to coastal area in Peleliu.

There are high pollution risks by the wastes such as water pollution and soil contamination.

(2) Pollution and Health Hazard Risks related to Wastewater and Human Waste

The other pollution risks related to wastewater and human wastes should be considered. Koror State has waste waster treatment plant in Malakal Island. Although there is few data in terms of wastewater quality in Palau, there are some water quality pollution risks according to a limited monitoring for the receiving water from Malakal wastewater plant in 1998 by EQPB. Also, it should be considered pollution risks by the wastewater discharges into the sea from the vessels especially in Malakal Port.

With respect to a risk related to human wastes, Bureau of Public Health reported that health hazards posed by human waste facilities, such as privies in some rural states in 1999. Most of the rural states uses septic and latrine systems for human wastes. In general, a condition for the proper operation of these systems must be properly sited and have a sufficient depth of unsaturated soil between the bottom of the infiltrative surface and the top of the high water table. As the condition could not be confirmed in most of the houses in those rural states, contamination of the surface waters and ground water may occur. There are high pollution and health risks related to wastewater and human wastes. At first, it is need to strengthen water quality monitoring especially in rural areas to assess the water contamination symptom.

(3) Pollution Potential related to Used Oil Disposal

Vehicles in Palau have been drastically increased in recent years. With the increase in the vehicles, pollution risks related to the used oil will be one of the critical environmental issues in Palau. Although Aimeliik Power Plant has a facility that process used oil as fuel for the diesel engine generator, over 500,000 gallons of the used oil, which cannot be processed due to the sludge is stored at Aimeliik Power Plant.

Furthermore, there is no facility in automobile shop in Palau in order to dispose the used oil properly. It is reported that the used oil are discharged into rivers and sea in Palau. This will be one of the main causes for water pollution in Palau.

8. INFRASTRUCTURE

8.1 Land Use Plan

8.1.1 Existing Land Use

(1) Koror State

Population

Land use patterns in Koror State and other states are quite different. 76% of the total population in Palau is living in the Koror State due to urbanization tendency over the past period. Table 8.1.1 shows the population and density by major residential block in the Koror State. The population in the Koror State reaches a ceiling from a viewpoint of population density, as high as 40 persons per hector since there is little land available for residential development due to steep topographic feature and existence of forest. Most major blocks have the similar population density ranging from 30 to 50 persons per hector.

Table 8.1.1 Population by Village in Koror

	Village	Population	Area (ha)	Density (person/ha)
1	Ngermid	603	37	16.3
2	Ngerchemai	1,419		
3	Lebukal	680	58	46.3
4	Meketil	584		
5	Dngerongel	513	15	34.2
6	Ikelau	371	13	28.5
7	Idid	667	20	33.4
8	Ngerkasoaol	721	19	37.9
9	Ngerbeched	1,646	23	71.6
10	Eang	256		
11	Meyuns	894	44	33.0
12	Ngerkabesang	303		
13	Madalaii	3,642	76	47.9
	Koror	12,299	305	40.3

Source: Population Census (1995)

The future population in the Koror State is forecasted in Table 8.1.2.

Table 8.1.2 Future Population in Koror

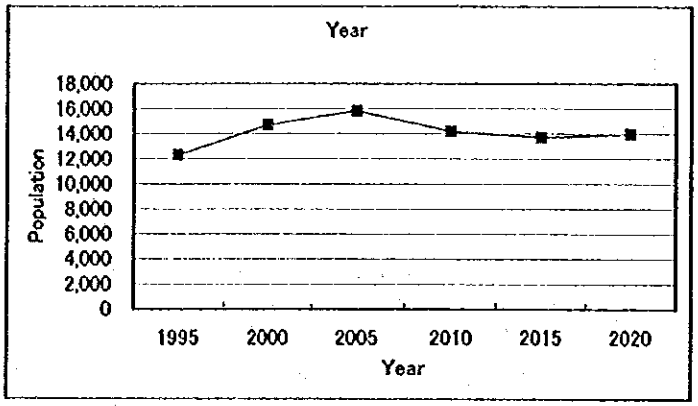
(Unit: Population)

1995	2000	2005	2010	2015	2020
12,299	14,734	15,799	14,183	13,687	13,956

Source: JICA Study Team

According to the population forecast, the population in Koror State will increase toward the year 2005 and is expected to decrease to around 14,000 in 2020 due to the relocation of the national capital and job generation by the large-scale tourism development in the remote area, Kayangel, Ngarchelong and Peleliu States. It is obvious that the relocation of the current national capital to Melekeok State and tourism development is expected to greatly contribute to equilibrium development in Palau. In addition, this is also effective to control the population pressure in Koror State.

Figure 8.1.1 Population Forecast



Source: JICA Study Team

Existing Land Use

The land use pattern is rather simple because of its small population size (see Figure 8.1.2). Commercial and business function is concentrated alongside the national trunk road passing through from the west to the east in the center of the Koror Island. Most governmental offices currently located in the center of the populated area. Small bunch of restaurants and souvenir shops including Nikko Hotel and Palauan Pacific Resort Hotel can be observed here and there in Koror State. Other area is occupied as relatively low-density residential areas.

On the other hand, Malakal Island is characterized as port and related land use including warehouse, industrial area and so forth.

(2) Other States

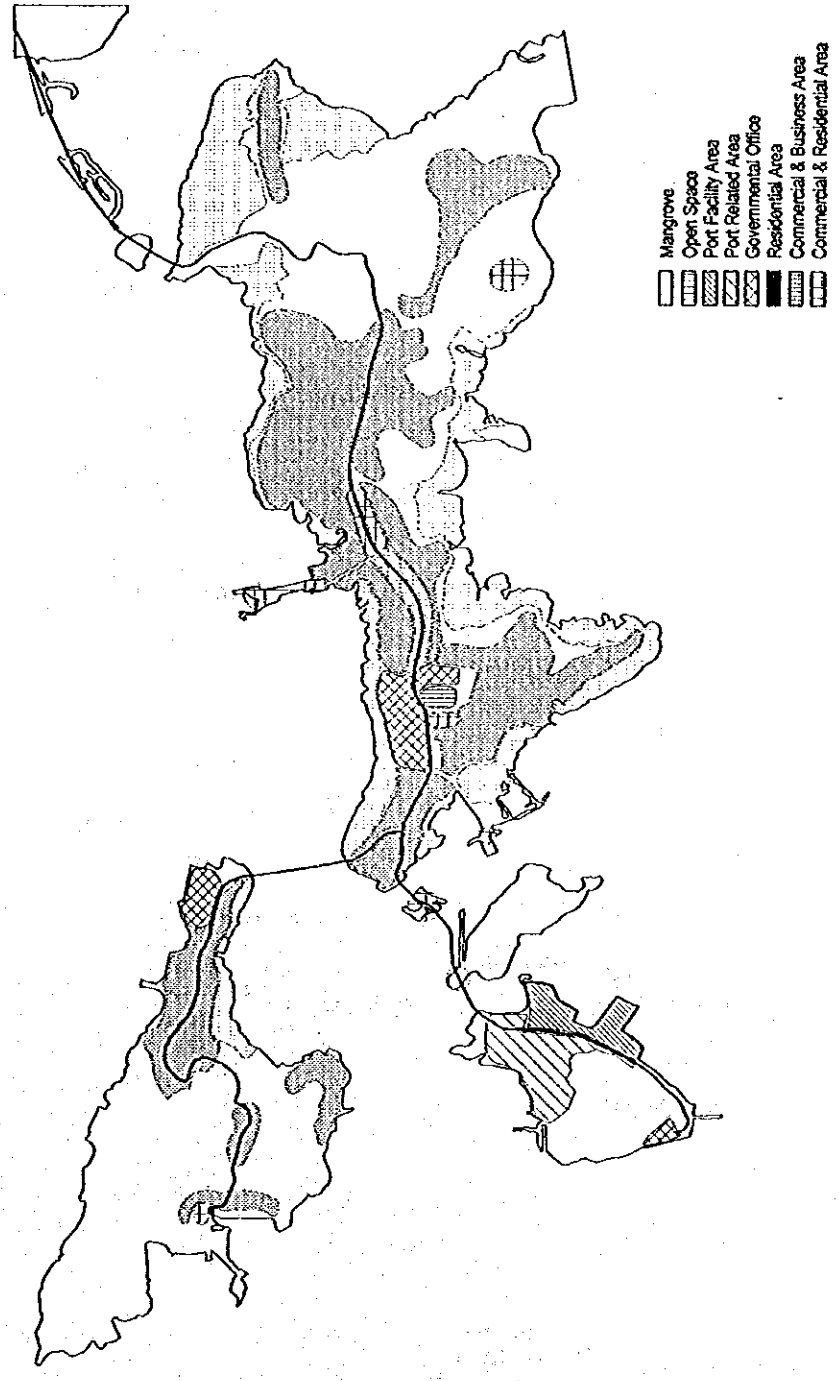
Location of Villages in the Babeldaob Island is very limited due to inadequate infrastructure facilities such as water, hospitals and school. In addition, the past population decreasing accelerates the unification of the villages. Figure 8.1.3 shows the current major villages distribution in the Babeldaob Island.

In the meanwhile, almost all of villages in other island states are unified into one village at this moment.

(3) Legislative System

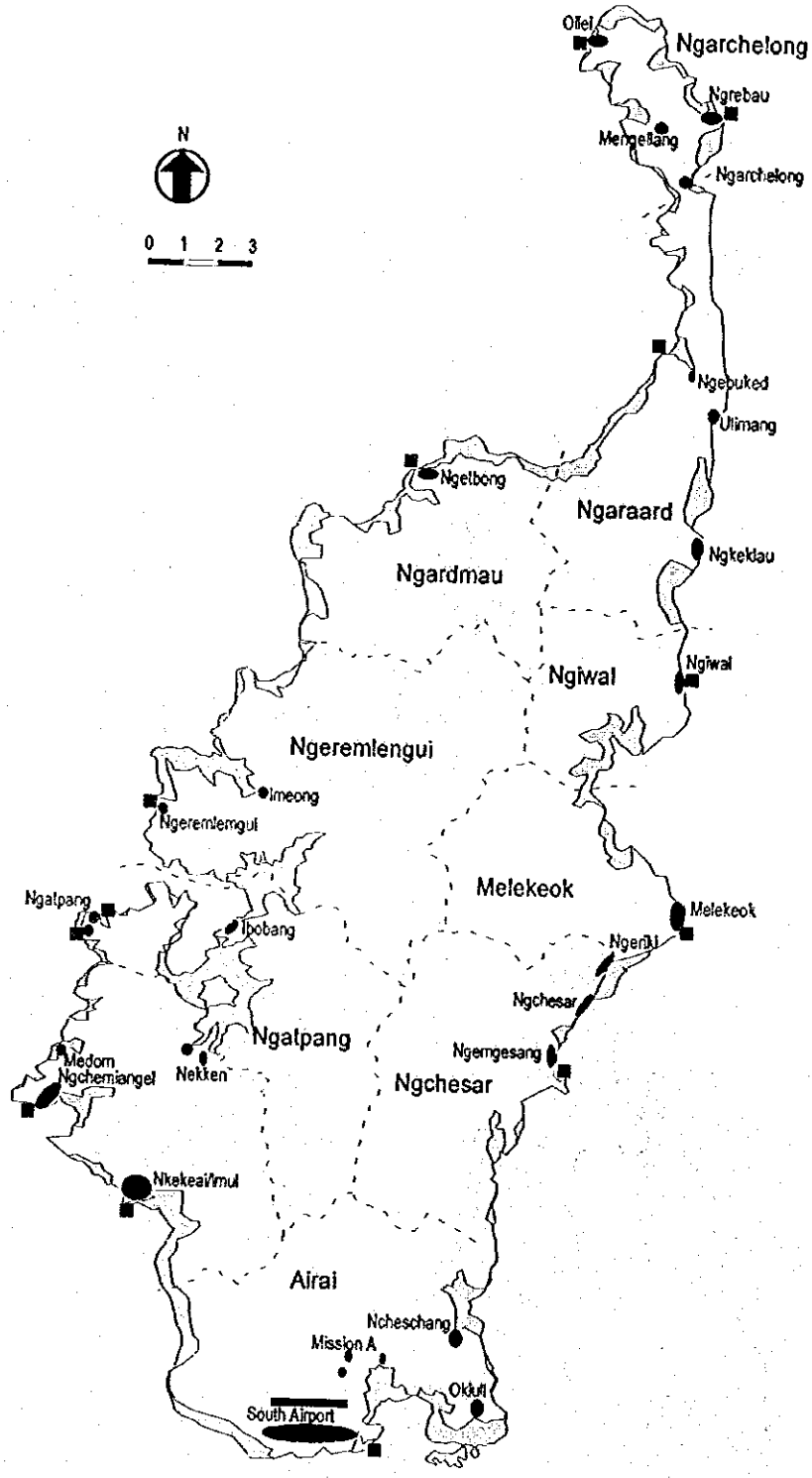
Title 31 regulates the matter of land use including establishment of planning commission and land zoning system. However, there is no zoning system except Koror State in Palau. Even in Koror State, the latest master plan was formulated in 1976 but it is out-dated now and no zoning code and subdivision law has been enacted by Koror State as of June 1994 according to the Koror Zoning Law, Division 3. The planning commissions were established in several states but most states are under consideration at present. The Governmental budget in order to formulate a master plan is prepared for all the states these days and some states set about this.

Figure 8.1.2 Existing Land Use in Koror State



Source: JICA Study Team

Figure 8.1.3 Major Villages Distribution in Babeldaob



Source: JICA Study Team

8.1.2 Current Problems and Issues

(1) Problems

Problems and issues on land use is summarized as follows:

Koror State

- Population density is very high in comparison with other states and residential environment and water supply, solid waste management and traffic congestion become worsened;
- Infrastructure and utility facilities have been expanded with a view to meet population pressure over the long period;
- Well-planned open space/green space cannot be provided. This brings about lack of amenity;
- There is no master plan available to indicate future land use, so that area development is not well controlled, and
- There is no uniform building code commonly applicable in Palau.

Babeldaob Island

- Population in the most villages is ranging from 30 to 250 on average, so that economic activity is in active and full scale infrastructure development is difficult; and
- Houses in villages are located in piece here and there, so that infrastructure and utility facility development becomes inefficient and costly.

(2) Development Issues

Development issues are summarized as follows:

Koror State

- Population control to prevent living environment from degradation is essential;
- Amusement facility development including beautification from a viewpoint of townscape as a gateway of tourism activities should be provided,
- Pedestrian facility development for convenience of tourists should be provided, and
- Formulation of land use plan (zoning map) and related codes such as building code is essential.

Babeldaob Island and Other States

- Formulation of zoning system for both environmental preservation and control of haphazard development.

8.2 Transportation

8.2.1 Road

(1) Current Conditions

The roads in Palau are classified into three categories that are national road, state road and others. The national road comprises backbone roads connecting the Malakal, Ngerekebesang and Koror Islands in Koror State, and a ring road in the Babeldaob Island. The national road in the Babeldaob Island has been deteriorated and only 4-wheel-drive vehicles can pass through, since almost all of the national roads are earth and gravel roads with steep longitudinal gradients and narrow width. Consequently,

traffic is very small. On the other hand, all national roads in Koror State are constructed in paved standard and saturated showing as many as 1600 vehicles per peak hour.

In terms of the state roads except in Koror State, almost all of the roads are also earth and gravel standard and traffic is very small.

Table 8.2.1 sets forth the existing road length by state.

Table 8.2.1 Existing Road Length

(Unit: mile)

States	Asphalt	Coral	Dirt	Total
Aimeliik		6	5	11
Airai	3.3	5	5	13.3
Angaur		10.8		10.8
Hatohobei		2		2
Kayangel		2		2
Koror	19	2.3		21.3
Melekeok	2.5	4	10	16.5
Ngaraard		3.1	11.5	14.6
Ngarchelong	2	7	1	10
Ngardmau		2	4	6
Ngatpang		3	12	15
Ngchesar		4	6	10
Ngeremlengui	3		15	18
Ngiwal	3			3
Peleliu		24		24
Sonsorol		2		2
Total	32.8	77.2	69.5	179.5

Source: National Master Development Plan, Office of Planning and Statistics

(2) Major On-going Projects

The prevailing most important road project is the Compact Road, which will connect all states in the Babeldaob Island with a total length of 53 (85km) miles. The construction work was recently in place and is expected to complete within three (see Figure 8.2.1).

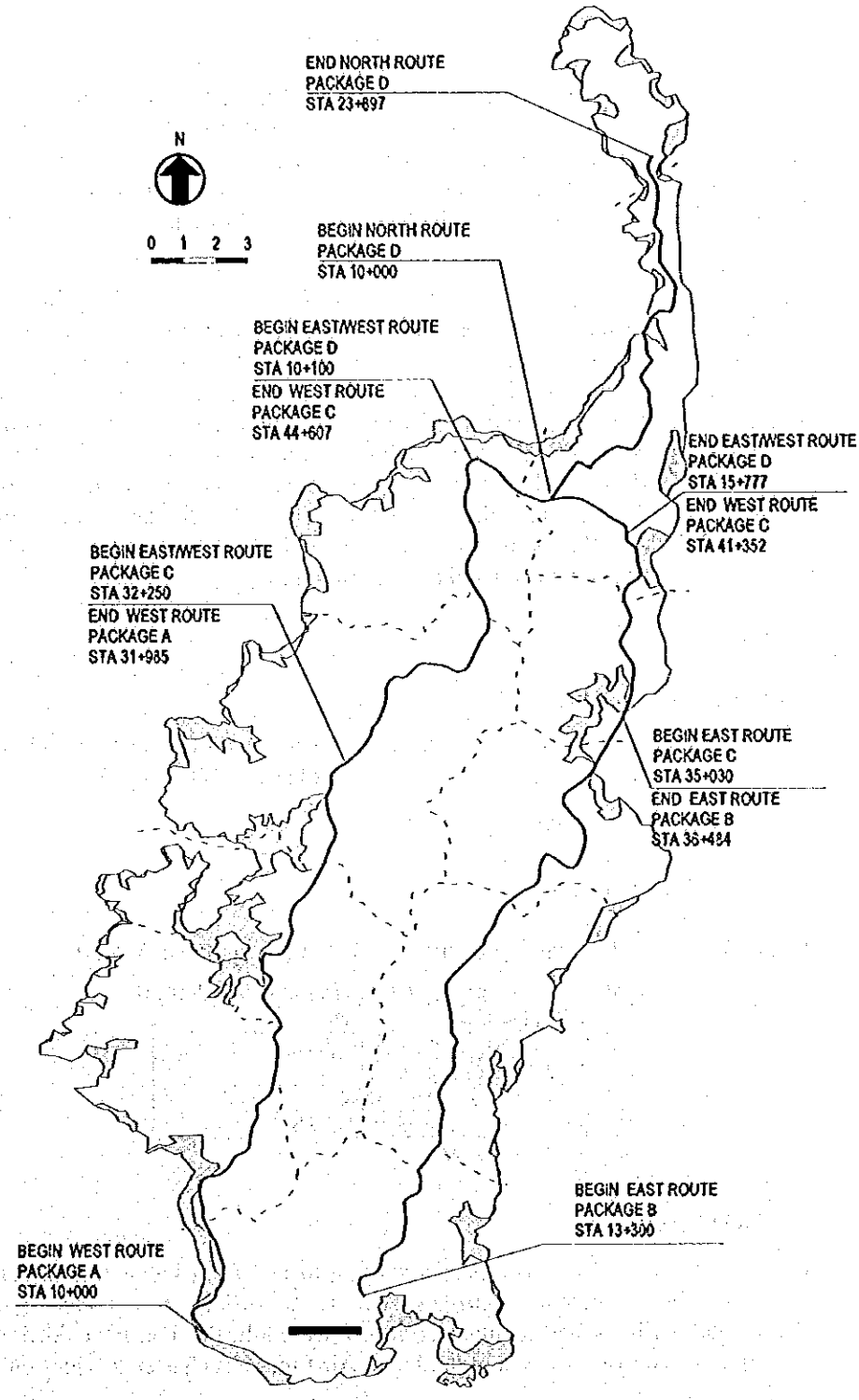
KB Bridge construction, which funded by the Japanese grand aid is another notable project and is expected to complete by the year 2002.

(3) Traffic Demand

Current traffic volume on the national trunk road in the center of the Koror Island is around 20,000 vehicles per day, which is almost equivalent to capacity of the road. Moderate traffic growth is anticipated since the population will not increase in Koror State due to relocation of the new national capital and large-scale tourism development in Kayangel, Ngarchelong, and Peleliu States. In addition, current high car ownership may be also another factor not to increase the traffic volume in the future.

Moreover, the Reef Road functions as a bypass route to the national trunk road in the Koror Island. Although exact traffic volume, which will diverge to Reef Road, cannot be forecast at this stage, around a 20-30% of diversion ratio is approximately expected.

Figure 8.2.1 Compact Road



Source: CIP Office