The Independent State of Papua New Guinea
East New Britain Provincial Administration (ENBPA)

NEGID-Plan

[Northeast Gazelle Peninsula Infrastructure Development Plan]

The Project for Kokopo-Rabaul Infrastructure Development Plan

Final Report Summary

July 2024

Japan International Cooperation Agency (JICA)

Oriental Consultants Global Co., Ltd.
Kokusai Kogyo Co., Ltd.

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Table of Contents

Table of Contents i
List of Figures v
List of Tables vii
List of Abbreviations ix

PART I Introduction

Chapter 1 Introduction 1
1.1 Background 1
1.2 Objectives of the Project 2
1.3 Study Areas and Planning Areas of the Project: Northeast Gazelle Peninsula 2
1.4 Project Management Structure 5
1.5 Phases of the Project 5
1.6 Organisation of the Final Report 5

PART II Review of National Development Plans and Development Trends

Chapter 2 National Visions and National Development Plans for Papua New Guinea 7
2.1 National Development Plans 7
2.2 Special Economic Zones: Policy, Law, and Organization 9
2.3 Papua New Guinea National Disaster Risk Reduction Framework 2017-2030 11

Chapter 3 National and Regional Development Trends 12
3.1 Review of Past Development Situation of Papua New Guinea 12
3.2 Economy 12
3.3 Investments 13
3.4 Population 14

PART III Present Situational Analysis of Location, Nature Societies and Disasters of Northeast Gazelle Peninsula

Chapter 4 Present Locational, Natural and Social Characteristics of Northeast Gazelle Peninsula 16
4.1 Locational Characteristics of Northeast Gazelle Peninsula within Papua New Guinea 16
4.2 Natural Condition in Northeast Gazelle Peninsula 18
4.3 Social Condition in ENBP 21

Chapter 5 Disaster Risk Profile of Northeast Gazelle Peninsula 25
5.1 Background 25
5.2 Rabaul Volcanic Complex 25
5.3 Review of Disaster Risk Assessment Report for ENBP, 2002 26
5.4 Review of "Integrating Hazard and Exposure for East New Britain, 2013" 30
5.5 Volcanic Ash Hazard (Tephra Fall Hazard) 31
5.6 East New Britain Provincial Disaster Management Plan 2022-2032 33
5.7 Rabaul Volcanological Observatory (RVO) 33
5.8 Resettlement Areas for Affected Communities of 1994 Volcanic Eruptions in Northeast Gazelle Peninsula 34

PART IV Visions, Socio-economic Framework, and Basic Development Strategies for Northeast Gazelle Peninsula

Chapter 6 Visions and Strategies for Regional Development of Northeast Gazelle Peninsula 36
6.1 Overall Issues 36
6.2 Visions, Objectives and Strategies for Regional Development of Northeast Gazelle Peninsula 36

Chapter 7 Future Socio-economic Framework for Northeast Gazelle Peninsula 42
7.1 Population of Northeast Gazelle Peninsula 42
7.2 Economy of Northeast Gazelle Peninsula 43
7.3 Future Socio-economic Framework for Northeast Gazelle Peninsula 43

PART V Development Strategies for Economic Sectors of Northeast Gazelle Peninsula

Chapter 8 Development Strategies for Economic Sectors of Northeast Gazelle Peninsula 49
8.1 Issues on Development of Economic Sectors 49
8.2 Vision for Development of Economic Sectors 50
8.3 Objectives for Economic Sectors Development 50
8.4 Strategies for Economic Sectors Development 51

PART VI Present and Future Regional Spatial Structures and Urban Areas of Northeast Gazelle Peninsula

Chapter 9 Present and Future Regional Spatial Structure of Northeast Gazelle Peninsula 52
9.1 Objectives for Transforming the Regional Spatial Structure of Northeast Gazelle Peninsula 52
9.2 Future Regional Spatial Structure of Northeast Gazelle Peninsula 52

Chapter 10 Future Urban Areas in Northeast Gazelle Peninsula 58
10.1 Future Urban Areas for Northeast Gazelle Peninsula and Planning Areas for Urban Infrastructure 58
10.2 General Land Use Plan 60

PART VII Infrastructure Development Plan for Northeast Gazelle Peninsula

Chapter 11 Objectives for Infrastructure Development and Integrated Strategies for Regional Development in Northeast Gazelle Peninsula 65
11.1 Objectives for Infrastructure Development in Northeast Gazelle Peninsula 65
11.2 Integrated Strategies for Regional Development with Emphasis of Infrastructure Development by Paying Attention to Different Areas in Northeast Gazelle Peninsula 65

Chapter 12 Development Plan for Trunk Roads 69
12.1 Issues on Development of Trunk Roads 69
12.2 Objectives of Development of Trunk Roads 69
12.3 Strategies for Development of Trunk Roads 70
12.4 Trunk Road Projects 71

Chapter 13 Development Plan for Port 73
13.1 Issues on Development of Ports 73
13.2 Objectives for Development of Ports 73
13.3 Strategies for Development of Ports 74
13.4 Projects for Development of Ports 77

Chapter 14 Development Plan for Airports 80
14.1 Issues on Airports 80
14.2 Objectives for Development of Airports 80
14.3 Strategies for Development of Airports 80
14.4 Projects for Development of Airports 81

Chapter 15 Development Plan for Urban Roads 82
15.1 Issues on Urban Roads 82
15.2 Objectives for Development of Urban Roads 82
15.3 Strategies for Development of Urban Roads 82
15.4 Projects for Development of Urban Roads 83

Chapter 16 Development Plan for Water Supply 85
16.1 Issues on Water Supply 85
16.2 Objectives for Development of Water Supply 85
16.3 Strategies for Development of Water Supply 85
16.4 Projects for Development of Water Supply 86

Chapter 17 Development Plan for Power Supply 88
17.1 Issues on Power Supply 88
17.2 Objectives for Development of Power Supply 88
17.3 Strategies for Development of Power Supply 88
17.4 Projects for Power Supply 89

Chapter 18 Phased Implementation Plan of High-Priority and Priority Projects for Infrastructure Development in Northeast Gazelle Peninsula 92
18.1 Identified Important Projects by Infrastructure Sector 92
18.2 Selection High Priority Projects and Priority Projects by Infrastructure Sector for NEGID-Plan 93
18.3 Phased Implementation Plan for High-Priority Projects and Priority Projects 94
18.4 Selection of Candidates for Pre-Feasibility Studies in NEGID-Plan 97

Chapter 19 Profiles of Eleven High-Priority Projects for Northeast Gazelle Peninsula 99

PART VIII Strategic Environmental Assessment

Chapter 20 Strategic Environmental Assessment 100
20.1 SEA for NEGID-Plan 100
20.2 Progress of SEA Study 100
20.3 Impact Assessment for Alternative Scenarios 101
20.4 Mitigation Measures for Implementing Alternative Scenario 3 for Regional Spatial Development 104
20.5 Recommendations from SEA 105

PART IX Pre-Feasibility Study on the Project for Strengthening of Kokopo-Rabaul Coastal Road

Chapter 21 Pre-Feasibility Study on the Project for Strengthening of Kokopo-Rabaul Coastal Road ... 106
21.1 The Target Project for Pre-Feasibility Study 106
21.2 Rationale for the Target Project for Pre-Feasibility Study 107
21.3 Future Traffic Demand Forecast 109
21.4 Present Road Conditions and Natural Conditions 111

21.5 Review of Existing Plans and Projects 112
21.6 Road Improvement Plan 112
21.7 Preliminary Design 114
21.8 Preliminary Cost Estimates 118
21.9 Economic Analysis of the Project 119
21.10 Environmental and Social Considerations for the Project 122
21.11 Conclusions and Recommendations from the Pre-FS 125

PART X Pilot Projects

Chapter 22 Pilot Projects 126
22.1 Introduction 126
22.2 Pilot Project for Kokopo/Vunamami Urban LLG 126
22.3 Pilot Project for Rabaul Urban LLG 128
22.4 Recommendations for Pilot Projects 129

PART XI Conclusions and Recommendations

Chapter 23 Conclusions and Recommendations 131
23.1 Conclusions 131
23.2 Recommendations 132

List of Figures

Figure 1.1 Northeast Gazelle Peninsula in the ENBP and Papua New Guinea 3
Figure 1.2 Northeast Gazelle Peninsula: Planning Study Area for Regional Infrastructure Development 3
Figure 1.3 Planning Study Area for Urban Infrastructure in Kokopo District 4
Figure 1.4 Planning Study Area for Urban Infrastructure in Rabaul District 4
Figure 3.1 GDP Trend of Papua New Guinea (2000 – 2021) 12
Figure 4.1 Location of ENBP in the New Britain Island and in Papua New Guinea 17
Figure 4.2 Gazelle Peninsula in ENBP 17
Figure 4.3 Influential Areas or Service Coverage Areas of Rabaul Port 18
Figure 4.4 Existing Trunk Roads and Undeveloped Trunk Roads in New Britain Island 18
Figure 4.5 Distribution of Languages in EMBP 22
Figure 5.1 Geological Setting of Papua New Guinea 25
Figure 5.2 Rabaul Volcanic Complex 26
Figure 5.3 Distribution of Pumice Rafts on Simpson Harbour After 1994 Volcanic Eruptions 28
Figure 5.4 Effect of Mudflow Along Namanula Road in Rabaul During 1994 Eruption 28
Figure 5.5 Pyroclastic Flow, Pyroclastic Surge and Mudflow Hazard Zones for the Major Volcanic Centres of East New Britain Province: A. Flow Hazard Zones for Small-Moderate Scale Eruptions from Source Vents associated with Rabaul Caldera 31
Figure 5.6 Pyroclastic Flow, Pyroclastic Surge and Mudflow Hazard Zones for the Major Volcanic Centres of East New Britain Province: B. Flow Hazard Zone for Moderate-Large Scale Eruptions from Rabaul Caldera 31
Figure 5.7 Rabaul Volcanic Ash Fall Hazard (Tephra Fall Hazard) 32
Figure 5.8 Resettlement Areas for Resettlement-Related Projects, 1997-2001, After the 1994 Volcanic Eruptions in Northeast Gazelle Peninsula 35
Figure 6.1 Major Aspects and Relations Considered in Formulating Regional Development Strategies in Northeast Gazelle Peninsula 38
Figure 7.1 Population Projections for PNG by UN between 2000-2052 44
Figure 7.2 Projected GRDP by Broad Economic Sector in Northeast Gazelle Peninsula 48
Figure 9.1 Present Regional Spatial Structure of Northeast Gazelle Peninsula 53
Figure 9.2 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 1 55
Figure 9.3 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 2 55
Figure 9.4 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 3 56
Figure 9.5 Phased Development Plan of Regional Spatial Structures for Northeast Gazelle Peninsula (Regional Spatial Development Scenario): Selected Spatial Structure 3 57
Figure 10.1 Growth Areas and Proposed Future Urban Areas in Northeast Gazelle Peninsula 58
Figure 10.2 General Land Use Plan for Kokopo (Kokopo Town to Takubar) 61
Figure 10.3 General Land Use Plan for Kokopo (Takubar to Tokua) 62
Figure 10.4 General Land Use Plan for Rabaul Town 63
Figure 10.5 General Land Use Plan for Kurakakaul-Nonga Area 64

Figure 12.1 Backbones of Trunk Road Network in Northeast Gazelle Peninsula at Present and in the Next Decade until 2032 69
Figure 12.2 Priority Trunk Road Projects for Year 2025 to 2032 72
Figure 12.3 Priority Trunk Road Projects for Year 2033 to 2042 72
Figure 13.1 Alternative Port Locations including Rabaul Port 76
Figure 13.2 Conceptual Plan for New Tanker Berth and Extension of Berth 2 78
Figure 14.1 Locations of Old Airstrips and Tokua Airport 81
Figure 15.1 Important Urban Road Project in Rabaul Town 83
Figure 15.2 Integrated Kokopo Ring Road and Kokopo Town Bypass in Kokopo-Tokua Urban Corridor: Proposed Urban Road Plan by NEGID-Plan 84
Figure 16.1 Water Supply Expansion Areas by Short-Term and Middle-Term Project 87
Figure 17.1 Project Site of the Priority Project for 66kV Transmission Lines 90
Figure 17.2 Project Site of Priority Project for 22kV Distribution Lines 91
Figure 18.1 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 1: 2024-2027) 95
Figure 18.2 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 2: 2028-2032) 95
Figure 20.1 Alternative Scenarios for Regional Spatial Development 102
Figure 21.1 Location Map of Kokopo-Rabaul Coastal Road 106
Figure 21.2 Logistics Route in Northeast Gazelle Peninsula Region 108
Figure 21.3 Kokopo-Rabaul Coastal Road and Top Road (Inland Road) in Northeast Gazelle Peninsula Region 109
Figure 21.4 Location Map of Slopes to Be Protected 112
Figure 21.5 Road Sections of Kokopo-Rabaul Coastal Road 113
Figure 21.6 Typical Cross-Section of the Project Road 114
Figure 22.1 Site Plan of the Night Market Pilot Project in Kokopo Town 127
Figure 22.2 Locations of the Installed Facilities in Rabaul Town 129

List of Tables

Table 1.1 Project Management Structure (Steering Committee and TWG)..... 5
Table 2.1 SPAs of Medium Term Development Plan IV 2023-2027 8
Table 2.2 Various Types of SEZs Allowed to be Operated in PNG 10
Table 2.3 Types and Activities Potential SEZs in Provinces and Districts 10
Table 3.1 FDI Proposed in ENBP between 2017 and 2021 14
Table 3.2 FDI Values Proposed in ENBP between 2017 and 2021 by Country of Origin..... 14
Table 3.3 Populations of the Whole Country, Regions and Provinces..... 15
Table 4.1 Land Cover by Category in Northeast Gazelle Peninsula (2019) 19
Table 4.2 Protected Areas in ENBP..... 21
Table 4.3 Features of Social Services in ENBP, 2016-2018..... 23
Table 4.4 Features of Socioeconomic Condition in ENBP, 2016-2018..... 24
Table 4.5 Total Fertility Rates in PNG in 2006 and 2016-2018 24
Table 5.1 Percentage Probability of Exceeding the Ash Load Thresholds 32
Table 5.2 Summary of Disaster Risk Assessment in Six Regions in ENBP Based on Geology..... 33
Table 7.1 Population in Northeast Gazelle Peninsula and ENBP (2000 and 2011) 42
Table 7.2 Employed Population by Industrial Sector in ENBP (2011)..... 43
Table 7.3 Population Projection for PNG for NEGID-Plan (2000-2052) 44
Table 7.4 NSO's Projected Current Population of ENBP..... 45
Table 7.5 Population by LLG in Northeast Gazelle Peninsula (2011 and 2022) 45
Table 7.6 Projected Population by LLG in Northeast Gazelle Peninsula (2032, 2037, 2042 and 2052)..... 46
Table 7.7 GDP Projections in the Existing Plans and Strategies 46
Table 7.8 Estimated GRDP of Northeast Gazelle Peninsula in 2011..... 47
Table 7.9 GRDP Projection of Northeast Gazelle Peninsula by Broad Economic Sectors in 2022-2052..... 48
Table 8.1 Expected Directions of Economic Development by Subsector..... 49
Table 9.1 Infrastructure, Gateways and Urban Centres in Alternative Regional Spatial Structures for the Super Long Term (2052)..... 54
Table 13.1 Phased Development of Spatial Structure and Port Facilities 75
Table 13.2 Timeline for Division of Functions of Rabaul Port and New Port..... 75
Table 13.3 Summary of Comparative Evaluation of Three Candidate Locations in Northeast Gazelle Peninsula 76
Table 13.4 Summary of Comparative Evaluation of Three Candidate Locations in Ataliklikun Bay Area..... 77
Table 13.5 Summary of Phased Implementation of Priority Projects for Port Development in Northeast Gazelle Peninsula 79
Table 18.1 Important Projects Identified for Each Infrastructure Sector 92
Table 18.2 Selected High-Priority Projects and Priority Projects for Infrastructure Development Plan in Northeast Gazelle Peninsula 94
Table 18.3 List of Projects in Phase 1 (2024-2027)..... 96
Table 18.4 List of Projects in Phase 2 (2028-2032)..... 96
Table 18.5 List of Projects in Phases 3 and 4 (2033-2042)..... 97
Table 19.1 List of High Priority Projects..... 99

Table 20.1 Evaluation of Alternative Development Scenarios 102
Table 20.2 Result of Sustainable Tests for Alternative Development Scenarios 104
Table 21.1 Four Growth Cases of Traffic Demand for Kokopo-Rabaul Coastal Road and Top Road 109
Table 21.2 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Baseline 110
Table 21.3 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Baseline 110
Table 21.4 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Case 4 with Project 110
Table 21.5 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Case 4 with Project 110
Table 21.6 Improvement Measures for Road Sections 113
Table 21.7 Pavement Structure of the Project Road 115
Table 21.8 Inundation Length along Proposed Kokopo-Rabaul Coastal Road 115
Table 21.9 Design Scale and Freeboard 115
Table 21.10 Necessary Culvert Size and Numbers for Kokopo-Rabaul Coastal Road 116
Table 21.11 Necessary Road Side Ditch Length for Kokopo-Rabaul Coastal Road 116
Table 21.12 Lengths and Sand Pit Volumes of Three Sediment Ponds 117
Table 21.13 Approximate Construction Cost of Three Sediment Ponds 117
Table 21.14 List of Target Slope for Protection Works 118
Table 21.15 Construction Cost of the Project Road 119
Table 21.16 Cash Flow of the Project (PGK Million) 120
Table 21.17 EIRR and NPV by Case 122
Table 21.18 Scoping Results for the Pre-Feasibility Study 122

List of Abbreviations

Abbreviations	
ADB	Asian Development Bank
AusAID	Australian Agency for International Development
COVID-19	Coronavirus Disease of 2019
DA	District Administrator
DBST	Double Bituminous Surface Treatment
DHS	Demographic and Health Survey
DoWH	Department of Works and Highways
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENBP	East New Britain Province
ENBPA	East New Britain Principal Administration
ENBP-EDP 2003-2030	East New Britain Province Economic Development Plan (2003-2030)
ENBP-ISDP	East New Britain Provincial Infrastructure Sector Development Plan
ENBP-SDP 2011-2021	East New Britain Provincial Strategic Development Plan (2011-2021)
ENBP-SDP 2023-2033	East New Britain Provincial Strategic Development Plan (2023-2033)
EU	European Union
FDI	Foreign Direct Investment
FS	Feasibility Study
GDP	Gross Domestic Product
GPDP	Gross Provincial Domestic Product
GRA	Gazelle Restoration Authority
GRDP	Gross Regional Domestic Product
HDI	Human Development Index
HIES	Household Income and Expenditure Survey
ICDC	Industrial Centres Development Corporation
ICT	Information and Communication Technology
IEE	Initial Environmental Evaluation
JICA	Japan International Cooperation Agency
LLG	Local Level Government
LNG	Liquefied Natural Gas
MM	Minutes of Meeting
MTDP	Medium Term Development Plan
NAC	National Airports Corporation
NEC	National Executive Council
NEGID-Plan	Project for Northeast Gazelle Peninsula Infrastructure Development Plan or Project for Kokopo-Rabaul Infrastructure Development Plan
NEP	National Energy Policy
NGO	Non-Governmental Organization
NTS	National Transport Strategy
O&M	Operations and Maintenance

Abbreviations	
PA	Provincial Administrator
PIU	Project Implementation Unit
PMV	Passenger Motor Vehicle
PNG	Papua New Guinea
PNG-DSP 2010-2030	Papua New Guinea Development Strategic Plan 2010 – 2030
PNG Ports	PNG Port Corporation Limited
PNG Power	PNG Power Limited
POM	Port Moresby
PPL	PNG Power Ltd.
PPP	Public-Private Partnership
Pre-FS	Pre-Feasibility Study
PV	Photo-Voltaic
RVO	Rabaul Volcanological Observatory
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SC	Steering Committee
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
S/S	Substation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TOR	Terms of Reference
TWG	Technical Working Group
Water PNG	Water PNG Limited
WB	World Bank
WNBP	West New Britain Province

PART I Introduction

Chapter 1 Introduction

1.1 Background

The Independent State of Papua New Guinea (PNG) is a country with a population of approximately nine million in 2018. It consists of over 600 islands, spreading over the eastern half of New Guinea Island and Bismarck Archipelago. Located in the northeast of the country, the New Britain Island has the second largest surface area following the New Guinea Island in PNG. It is comprised of East New Britain Province (ENBP) and West New Britain Province (WNBP).

Northeast Gazelle Peninsula includes the towns of Kokopo, Rabaul and Kerevat functions as the primary centre of government administration, trade, industry and logistics not only for the ENBP, but also for its surrounding islands connected by marine and air transport. Rabaul Port handles the fourth largest amount of cargoes in PNG, and Tokua Airport has the fourth largest volume of passengers throughput in PNG.

The major economic sectors of the Northeast Gazelle Peninsula are composed of the primary sector that includes agriculture (cacao, palm oil and coconut) and fisheries (tuna), as well as the tertiary sector that includes tourism, government and other service industries. To support such economic sectors, regional infrastructure like seaports, airport and trunk roads, as well as urban infrastructure, such as urban roads, power supply, and water supply, are essential.

The population of ENBP, according to 2011 population census, was 328 thousand. It grew at a rate higher than 3% in recent years. As a result, the population of ENBP, especially that of North Gazelle Peninsula, is expected to increase rapidly.

Despite the fact that the Northeastern Gazelle Peninsula, centred on the provincial capital Kokopo and the port of Rabaul, is thus a relatively populous and export-oriented industrial area within ENBP, Rabaul Town and its surrounding areas have been repeatedly hit by volcanic eruptions, with two volcanic eruptions in the 20th century in 1934 and 1994 The city was severely damaged (both eruptions were caused by the Tavurvur and Vulcan volcanoes). In particular, the 1994 eruption brought down volcanic ash several metres thick, crushing many buildings under the weight of the ash and rendering major infrastructure, such as airports, ports and roads inoperable, forcing many residents to relocate in and around Rabaul Town. Within 1994, after the eruption, it was decided that the provincial capital in Rabaul Town would be relocated to Kokopo and the district government building to Rabaul Airport was relocated to Tokua, east of Kokopo Municipality. After 30 years of restoration and reconstruction efforts following the 1994 eruption disaster, the local economy is gradually recovering.

Under these circumstances, aiming for prosperous and sustainable development, the Government of ENBP formulated the "East New Britain Economic Development Plan (2003-2030)" (ENBP-EDP) and "East New Britain Provincial Strategic Development Plan (2011-2021)" (ENBP-SDP). The strategies addressed in these development plans are oriented to development of modern industries, such as agro-processing and tourism industries, based on the development of the agricultural, forestry and fisheries sectors.

However, the main roads from Tokua Airport to Kokopo Town and further to Rabaul Port, which are part of the main road network, have many potholes due to drainage problems. Furthermore, some of their road sections are prone to landslide during the rainy season that hinders stable connectivity within the Northeast Gazelle Peninsula. At the same time, the increasing transport demands are considered to catch up with the facilities' capacity of Tokua Airport and Rabaul Port.

In addition, well-planned provision of economic infrastructure, including electricity and water supply, is a challenge for attracting investments in economic sectors.

Consequently, the Government of PNG requested the Government of Japan for this project of infrastructure development planning for seeking sustainable and resilient socio-economic development in Northeast Gazelle Peninsula in ENBP.

In response to this request, Japan International Cooperation Agency (JICA) dispatched a detailed plan formulation study team to PNG in February and August 2019 to discuss the contents of the project request and the framework of this project based on a study by visiting the Northeast Gazelle Peninsula. In July 2020, the ENBPA and JICA agreed to implement this project and signed a Record of Discussion (R/D). In line with the agreed R/D, this project will formulate an infrastructure development plan for the Northeast Gazelle Peninsula with a target year 2032.

1.2 Objectives of the Project

The objectives of the Project are as follows:

- To promote development of infrastructure in harmony with economic sectors and environment in the Northeast Gazelle Peninsula
- To contribute to budget planning necessary for infrastructure development in the Northeast Gazelle Peninsula

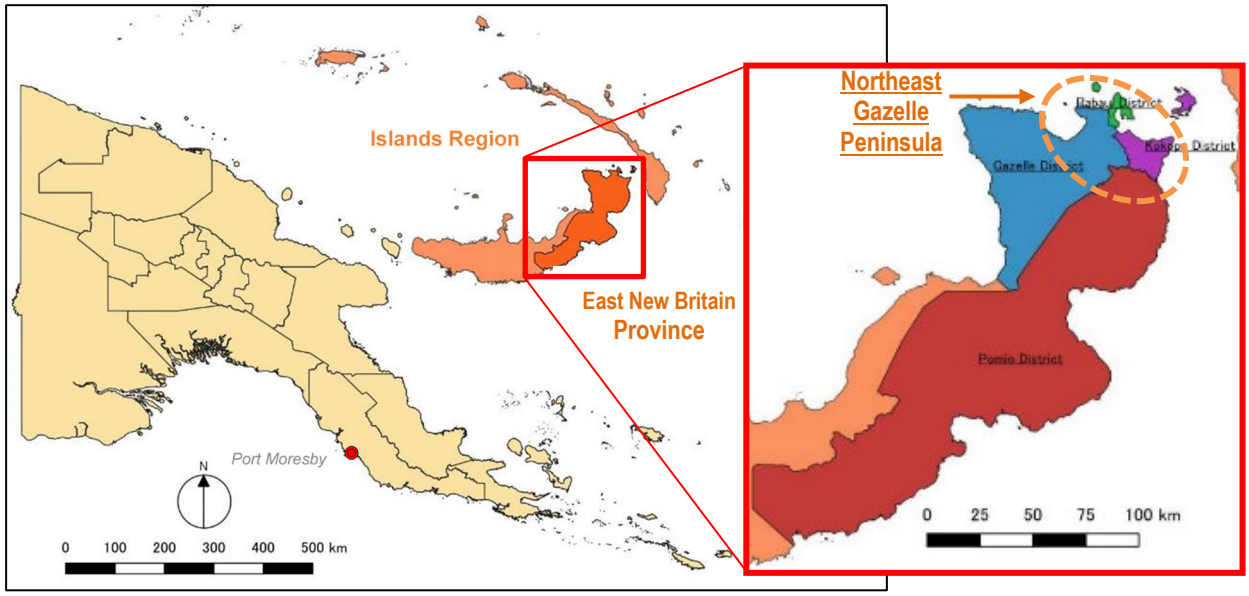
The expected outputs of the Project are as follows:

- Formulation of an infrastructure development plan for the Northeast Gazelle Peninsula with a target year of 2032
- Conduct of capacity development for the formulation of infrastructure development plan
- The infrastructure development plan to be formulated are to cover the following contents:
  - Development Vision
  - Socioeconomic Framework
  - Future Regional Spatial Structure
  - General Land Use Plans in Urban Areas
  - Policies, Strategies and Priority Projects for Target Infrastructure Sectors
  - Result of Strategic Environmental Assessment
- Pre-Feasibility Study for a selected one of the highest-priority infrastructure projects proposed by the infrastructure development plan to be formulated

The infrastructure development plan is to deal with two types of infrastructure. The one is regional infrastructure, such as trunk roads, ports and airports. The other is urban infrastructure including urban roads, water supply infrastructure and power supply infrastructure.

1.3 Study Areas and Planning Areas of the Project: Northeast Gazelle Peninsula

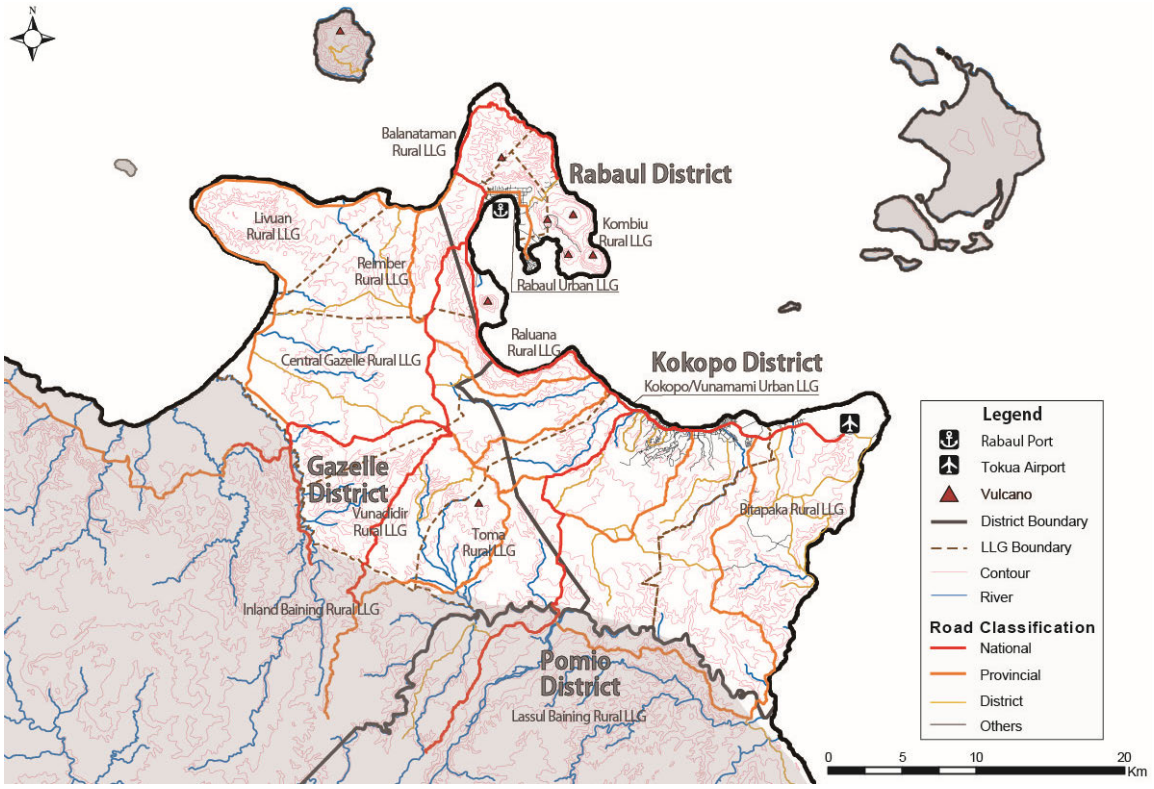
The Study Area of the Project is the Northeast Gazelle Peninsula in ENBP as shown in Figure 1.1.



Source: JICA Expert Team

Figure 1.1 Northeast Gazelle Peninsula in the ENBP and Papua New Guinea

The Northeast Gazelle Peninsula covers Kokopo District (excluding the islands), Rabaul District (excluding the islands) and the north-eastern Gazelle District. Administratively the Northeast Gazelle Peninsula is comprised of three LLGs in Kokopo District (Bitapaka Rural LLG, Kokopo/ Urban LLG, and Raluana Rural LLG), three LLGs in Rabaul District (Rabaul Urban LLG, Balanataman Rural LLG, and Kombiu Rural LLG), and five LLGs in Gazelle District (Central Gazelle Rural LLG, Vunadidir Rural LLG, Toma Rural LLG, Livuan Rural LLG and Reimber Rural LLG). (See Figure 1.2.)



Note: The district boundaries shown in the map are based on the data from the National Mapping Bureau (NMB), Papua New Gunia. However, there are some disparities between NMB's district boundaries and actual village boundaries within each district in Northeast Gaelle Peninsula. In the base map, the LLG boundaries prepared by ENBPA are adjusted to match the district boundaries.

Source: JICA Expert Team

Figure 1.2 Northeast Gazelle Peninsula: Planning Study Area for Regional Infrastructure Development

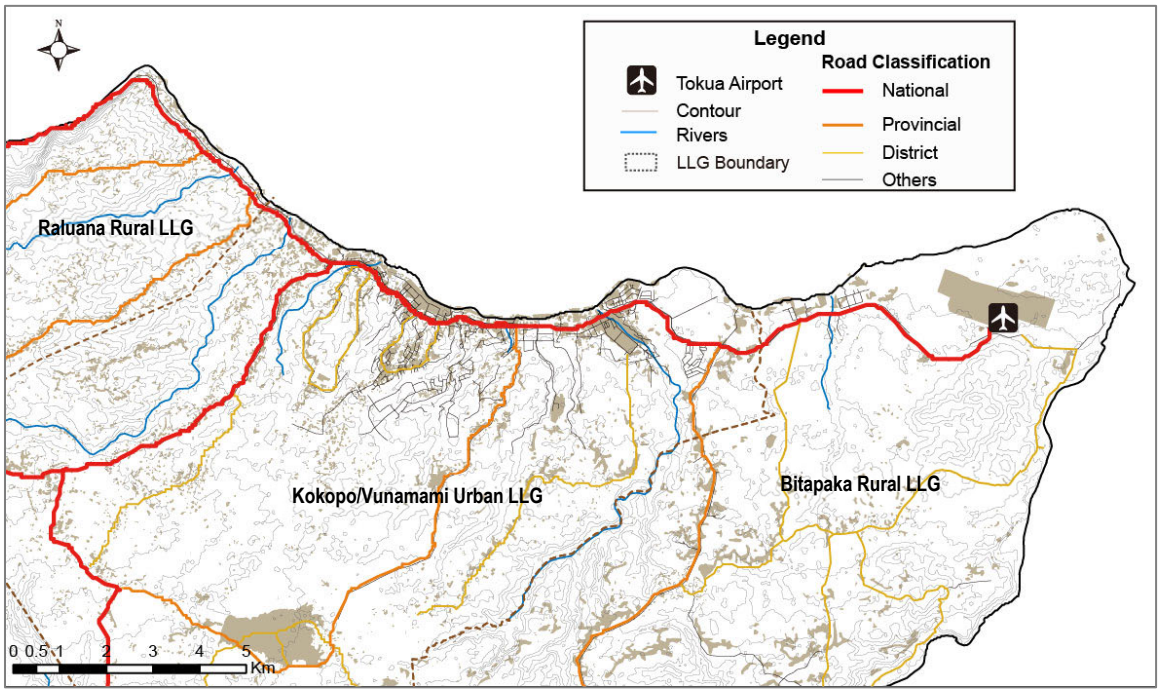
1) Regional Infrastructure Planning Study Area

Development plans for regional infrastructure (trunk roads, ports and airports) were formulated for the Northeast Gazelle Peninsula.

2) Urban Infrastructure Planning Study Area

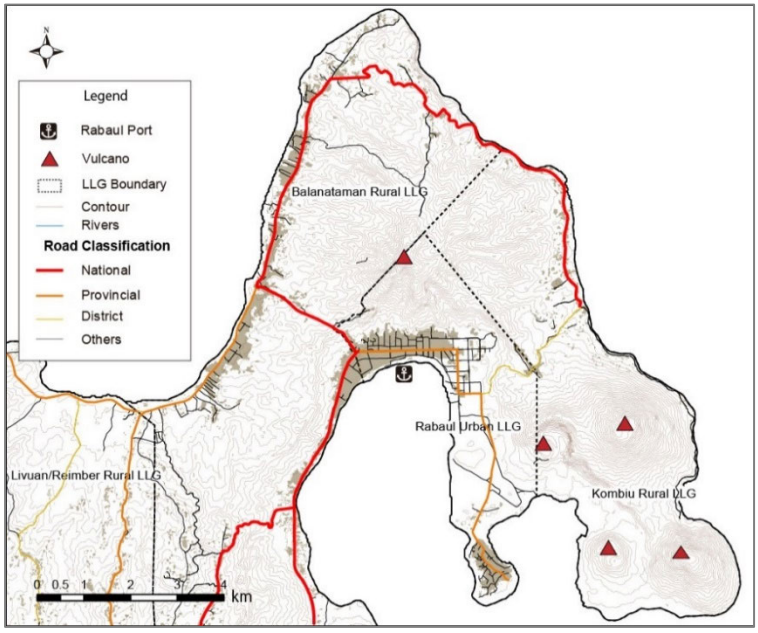
Development plans for urban infrastructure (urban roads, water supply and power supply) were formulated in the areas to be urbanised in Kokopo District and Rabaul District by 2032.

Development plans for urban infrastructure cover the urban areas in three Local Level Governments (LLG) of Kokopo District (Bitapaka Rural LLG, Kokopo/ Urban LLG, and Raluana Rural LLG) and three LLGs in Rabaul District (Rabaul Urban LLG, Balanataman Rural LLG, and Kombiu Rural LLG). （See Figure 1.3 and Figure 1.4.）



Source: JICA Expert Team

Figure 1.3 Planning Study Area for Urban Infrastructure in Kokopo District



Source: JICA Expert Team

Figure 1.4 Planning Study Area for Urban Infrastructure in Rabaul District

1.4 Project Management Structure

In order to carry out the project effectively and efficiently, the SC and seven TWGs are organised on the PNG counterpart side. A Joint TWG was also added for conveying the contents of the discussion and coordination at the SC meeting to the local level, and grasp what is being discussed for the overall project at the local level.

The JICA Expert Team also proposed to establish a Project Implementation Unit headed by the Provincial Administrator of ENBP as the Project Director and Deputy Provincial Administrator as the Project Manager with core counterparts.

The roles of the SC, Joint TWG, the seven TWGs and Project Implementation Unit are shown in Table 1.1.

Table 1.1 Project Management Structure (Steering Committee and TWG)

Project Management Structure	Roles and Timing of Meetings
Steering Committee (SC)	• To discuss and define main items of the Project to facilitate inter-organisational coordination, and take necessary actions required for smooth implementation of the project. • To hold a meeting whenever a main report of the Project becomes ready for discussion, and/or whenever it is deemed necessary
Joint Technical Working Group (Joint TWG)	• To discuss and define main items of the Project at the provincial level • To hold a meeting whenever a main report of the Project becomes ready for discussion and/or whenever it is deemed necessary
Technical Working Group (TWG)	• To promote the coordination among ENBPA, JICA Expert Team and other related organisations • To monitor the progress of the project • To hold a meeting at least once a quarter
Project Implementation Unit (PIU)	• To discuss daily issues and take direct actions for smooth implementation of the project • To hold a regular meeting.

Source: JICA Expert Team

1.5 Phases of the Project

The development planning study was conducted from January 2022 to March 2024 in PNG. The JICA Expert Team completed and submitted the Final Report in June 2024.

The Project was conducted in the following three phases:

Phase1: Analysis of present situation, preparation of base map, formulation of development vision, preparation of future socioeconomic framework, consideration of concepts of pilot projects

Phase2: Formulation of infrastructure development plans, conducting of Strategic Environmental Assessment (SEA), consideration of project ideas for pre-feasibility study, and selection of pilot projects

Phase3: Finalisation of infrastructure development plans, conducting of a pre-feasibility study, and implementation and evaluation of pilot projects

1.6 Organisation of the Final Report

The Final Report is composed of the following volumes:

- Summary
- Main Text

Both the summary and the main text are organized by 11 parts and 23 chapters:

- Part I: Introduction
- Part II: Review of National Development Plans and Development Trends
- Part III: Present Situational Analysis of Location, Nature, Societies and Disasters of Northeast Gazelle Peninsula
- Part IV: Visions, Socio-Economic Framework, and Basic Development Strategies for Northeast Gazelle Peninsula
- Part V: Present Situation of Economic Sectors and Development Strategies for Economic Sectors of Northeast Gazelle Peninsula
- Part VI: Present and Future Regional Spatial Structures and Urban Areas of Northeast Gazelle Peninsula
- Part VII: Infrastructure Development Plan for Northeast Gazelle Peninsula
- Part VIII: Strategic Environmental Assessment
- Part IX: Pre-Feasibility Study on the Project for Strengthening of Kokopo-Rabaul Coastal Road
- Part X: Pilot Projects
- Part XI: Conclusions and Recommendations

In the main text, there are five appendices which cover the analysis of present situations and review of existing development policies and plans at the national level and in Northeast Gazelle Peninsula.

PART II Review of National Development Plans and Development Trends

Chapter 2 National Visions and National Development Plans for Papua New Guinea

2.1 National Development Plans

The long-term plan and medium development plan of Papua New Guinea are summarised in this section.

(1) PNG Vision 2050

In December 2007, the National Executive Council (NEC) of Papua New Guinea decided to formulate a framework for a long-term development strategy — "The Papua New Guinea Vision 2050" — that identifies future directions for PNG, reflecting the aspirations of its people.

The vision to be realised for PNG by 2050 is as follows:

"Papua New Guinea will become a smart, fair, wise, healthy and happy nation."

Vision 2050 sets a national development goal of raising PNG's Human Development Index (HDI) to the top 50 or higher in the world by 2050. A wide range of economic activities is considered essential to improve household income.

As an intermediate target for economic development, the real GDP was set to grow from 15 billion to 24 billion PGK by 2020, and the per capita GDP from 1,820 to 2,820 PGK. In order to achieve these economic targets, as well as the national goal, the need for infrastructure development was argued to be essential.

(2) PNG Development Strategic Plan (PNG-DSP) 2010-2030

By translating the focus areas of Vision 2050 into clear directions for economic policies and sector interventions, Development Strategy Plan 2010-2030 (PNG-DSP 2010-2030) was prepared by the guidance of the National Goals and Directive Principles (NGDPs) in the preamble to the Constitution, Eight Point Plan and Vision 2050.

PNG-DSP 2010-2030 is the third edition of its kind (Development Strategic Plan). In the past for DSP 1997-2002 and DSP 2005-2010, integrated economic development plans were intended from medium-term perspectives to promote the integration of different sectors. Not preoccupied with or too much bounded by annual government budgets, PNG-DSP 2010-2030 was formulated by considering national development directions from long-term perspectives.

The vision for PNG-SDP 2010-2030 is to achieve the status of a middle-income country by 2030.

The DSP 2010-2030 is to be implemented by four five-year Medium Term Development Plans.

The priorities and directions set in the PNG-DSP are to guide the development of sector policies, plans and strategies.

Strategic targets and objectives for infrastructure development by 2030 set by PNG-DSP 2010-2030 includes the following:

- Tripling national roads coverage
- An increase in the proportion of national roads in good condition from 29% to 100%
- Expenditure on upgrading and rehabilitation to be directed to the 16 priority roads

- New road developments to be focused on economic corridor roads
- A three-fold increase in the provision of marine infrastructure
- All 22 regional airports to meet international certification standards
- 10 airports to be upgraded to high-seat jet capacity
- 50 airstrips to be rehabilitated

(3) Medium Term Development Plan (MTDP)

Under the guidance of the following vision and strategic plan, medium term development plans (MTDPs) are to be formulated every five years:

- The PNG Vision 2050
- The PNG Development Strategic Plan (DSP) 2010-2030
- MTDP I, MTDP II and MTDP III translated the Vision 2050 and DSP 2030 into more specific programmes for implementation over the relevant five-year period.

1) MTDP III 2018-2022

The overall goal of the MTDP III 2018-2022 is as follows:

"Securing our future through inclusive sustainable economic growth."

To achieve the overall goal of MTDP III, the following 8 Key Result Areas (KRAs) are set:

- KRA 1: Increased revenue and wealth creation
- KRA 2: Quality infrastructure and utilities
- KRA 3: Sustainable social development
- KRA 4: Improved law and justice and national security
- KRA 5: Improved service delivery
- KRA 6: Improved governance
- KRA 7: Responsible sustainable development
- KRA 8: Sustainable population

2) MTDP IV 2023-2027

The theme of the MTDP IV 2023-2027 is as follows:

"National Prosperity through Growing the Economy"

The objectives of the MTDP IV 2023-2027 are as follows:

- To achieve a K200 billion PNG economy by 2030;
- To create one million additional jobs; and
- To improve the quality of life for all PNG citizens.

To achieve the objectives of MTDP IV, 12 Strategic Priority Areas (SPAs) are set as pillars for MTDP IV as follows:

Table 2.1 SPAs of Medium Term Development Plan IV 2023-2027

SPAs	Descriptions
SPA 1: Strategic Economic Investment	To expand the PNG's economic base, the government of PNG focuses on strategic investment in critical economic sectors for the country such as agriculture, forestry, fisheries, mining and petroleum, clean energy, and the Micro, Small and Medium Enterprises (MSME).
SPA 2: Connect PNG Infrastructure	Connect PNG, a long-term infrastructure program, aims to improve connectivity around the country through the development of critical infrastructure including transport infrastructure, energy grids and ICT networks, water and sanitation systems, and affordable housing.
SPA 3: Quality and Affordable Health Care	The Government of PNG intends to secure quality and affordable health care services for every citizen in collaboration with private health care providers.
SPA 4: Quality Education and Skilled Human Capital	In addition to existing initiatives such Tuition Fee Free (TFF) education policy and investment in Technical Vocational Education and Training (TVET), the PNG Government intends to invest to provide "accessible,

	affordable and quality education" for early childhood, primary and secondary education.
SPA 5: Rule of Law and Restorative Justice	The Government aims towards restoring the "respect for the rule of law" by improving effective policing, public safety, crime prevention, restorative justice, access to justice systems, community peace and capacity building for effective delivery of justice services.
SPA 6: National Security	The Government of PNG has concerns about increase of external threats and emphasis securing National Security by improve the capabilities of the National Defense systems.
SPA 7: National Revenue and Public Finance Management	National revenue and public finance management are intended to be improved by supporting tax and non-tax revenue mechanisms through strengthen of compliance and collection, capacity enhancement, reporting, and new revenue sources.
SPA 8: Digital Government, National Statistics and Public Service Governance	Digitisation and integration of public service are encouraged to improve governance and service delivery at the National, Provincial and District levels.
SPA 9: Research, Science and Technology	The Government intends to invest in Research, Science and Technology (RST) strategically to make a smart country.
SPA 10: Climate Change and Natural Environment Protection	The Government aims to build a resilient economy to climate change which threatens public assets, export commodities, private investments and the well-being.
SPA 11: Population, Youth and Women Empowerment	To support sustainable population growth, the government empowers youths through skills training and addresses issues affecting women and requirements of people living with disability and vulnerable.
SPA 12: Strategic Partnerships	The government is concerned with strengthen of bilateral and multilateral partnerships for strategic development cooperation arrangements to advance economic, development, security and other strategic interests of PNG.

Source: PNG Medium Term Development Plan IV 2023-2027

2.2 Special Economic Zones: Policy, Law, and Organization

(1) Law for Special Economic Zone (SEZs)

The Special Economic Zone Authority Act was enacted in November 2019.

This Act removed the effectiveness of the Free Trade Zone Act 2000 and the Industrial Centres Development Corporation Act (ICDC Act) 1990.

According to the Act, the Act is intended to do the following things:

- To enable the establishment, development, operation and regulation of SEZs in PNG.
- To encourage the development of new and additional business activities in SEZ
- To create a Special Economic Zone Authority to develop and regulate SEZs including the selection of sites for development and operation for related purposes

(2) The Special Economic Zone Authority

Under the SEZ Authority Act, a Special Economic Zones Authority was established to regulate the establishment and development of Special Economic Zones in PNG. It was organized in 2019 by taking over the Industrial Centers Development Corporation (ICDC), but it has not yet carried out any substantive activities. ICDC has managed industrial parks in Lae (Malahang) of Morobe Province and Kokopo (Ulaveo) of ENBP.

The SEZ Authority was provided with the power and responsibilities to be able to acquire land, evaluate submissions from enterprises that have the intention to develop and operate SEZs, and make final determinations on the provision of licences to operate within a zone.

(3) Special Economic Zones

Special economic zones are any delimited geographic areas that are designated under the SEZ Authority Act. They will have on-site single services including administrative regulation, and management, infrastructure.

Special Economic Zone Development Programme (SEZDP) is PNG's national programme to institutionalise the development and operation of SEZs including planning, implementation, monitoring and evaluation. The SEZDP is to adopt a flexible policy in which various types of Special Economic Zones listed in Table 2.2 are to be operated in PNG:

Table 2.2 Various Types of SEZs Allowed to be Operated in PNG

1	Free Trade Zone	9	Science Technology Park	17	Industrial Park
2	Export Processing Zone	10	Petroleum Park	18	Agriculture Park
3	Free Port Zone	11	Metals Refinery Park	19	Arts and Crafts Park
4	Enterprise Zone	12	Energy Park	20	Border Free Trade Zone
5	Tourism Zone	13	Logistics Park	21	Residential Estate Zone
6	Bonded Area	14	Airport Free Zone	22	Eco-Industrial Zones
7	Single Factory Zone	15	Airport City	23	Finance SEZ
8	Marine Industrial Zone	16	Forestry Park	24	Comprehensive SEZ

Source: SEZ Authority's presentation material of SEZ Summit 2024 in PNG

(4) Taxation of Special Economic Zone Enterprises

In the designated SEZ, operating enterprises will get benefits of free of taxes and duties for 10 years, to promote Foreign Direct Investment (FDI) to build critical capital Infrastructures, industries, facilities, establishes and to increase export.

Free Trade Zones (FTZs) can be the main functions of any SEZs, in which only certain classified goods and services may be exempted from taxes and duties after 10 years' concession to maintain maximum export.

(5) Potential Areas for Setting SEZs in PNG

The SEZ Authority Act has an attachment of a list of 20 potential SEZ areas as shown in Table 2.3.

Table 2.3 Types and Activities Potential SEZs in Provinces and Districts

No.	Province.	Districts	Type / Activity.
1	East New Britain	All Districts	Tourism
2	West New Britain	All Districts	General
3	Autonomous Regional of Bougainville	All Districts	Agriculture
4	National Capital District	All Districts	General
5	Central	All Districts	General
6	Oro	All Districts	Tourism
7	Milne Bay	All Districts	Tourism
8	Western	All Districts	Agriculture
9	Gulf	All Districts	Industrial
10	Morobe	Finschhafen	Technology
11		Markham District	Agriculture Park
12		Huon Gulf	Industry
13	Madang	All Districts	Marine and Tourism
14	East Sepik	All Districts	Agriculture
15	West Sepik	All Districts	Agriculture
16	Western Highlands	All Districts	Agriculture and General
17	Jiwaka	All Districts	Agriculture and General
18	Hela	All Districts	Petroleum and General
19	Southern Highlands	All Districts	Petroleum and General
20	Eastern Highlands	All Districts	Agriculture

Source: Attachment of the SEZ Authority Act, 2019 (PNG)

Under the new Act, the government allocated a certain amount of budget for newly establishing the SEZ Authority and for preparation of Ihu Special Economic Zone in Gulf Province. A new SEZ in Manus Province is also at the stage of preparation.

(6) PNG SEZ Summit 2023

In order to activate and accelerate the establishment of SEZs in PNG, Ministry of International Trade & Investment and SEZ Authority organised a summit (a conference) for promoting and diffusing a new SEZ policy from 7th until 9th of May 2023 in Port Moresby. About 500 participants from government and private sectors, including international speakers and investors gathered this summit for the following objectives:

- To understand the definition, types, functions and benefits of Special Economic Zones,
- To understand why the last 30 years effort at Free Trade Zones (FTZ), Export Processing Zones (EPZ) and other types of promoting FDIs have failed in PNG, and
- To discuss the directions of implementing the SEZ policy by overcoming difficulties related to a variety of government sectors including lands, transport, power, telecommunication, and security.

The SEZ Authority has been engaged in the formulation of a SEZ Master Plan for PNG, including evaluations about 20 candidate SEZs all over the provinces in PNG in respect of potential investment targets, location and land suitability and preparedness for establishing SEZs. According to the SEZ Master Plan presentation at the SEZ Summit 2023, the top several SEZ candidates have been identified as high potential to work toward the establishment and operation of SEZs in PNG.

Moreover, the amendment of the SEZ Authority Act and capacity development of government officers in charge of SEZ administration under the SEZ Authority have been considered for substantiating the efforts at establishment and operation of SEZs in PNG.

2.3 Papua New Guinea National Disaster Risk Reduction Framework 2017-2030

(1) Expected Outcome and Goal by 2030

The Papua New Guinea Government's National Disaster Centre formulated and established a National Disaster Risk Reduction Framework in 2017.

The Expected Outcome by 2030 is as follows:

> "The substantial reduction of disaster risk and increased resilience of communities in PNG."

To achieve this expected outcome, the following goal should be achieved:

> "Reduce existing and prevent new disaster risk through the implementation of integrated structural and non-structural risk reduction measures that prevent and reduce hazard exposure and vulnerability to disasters, increase preparedness for response and recover capacity, and thus strengthen resilience."

(2) National Targets

To assess the progress in achieving the outcome and goal of the present framework, seven national targets are set.

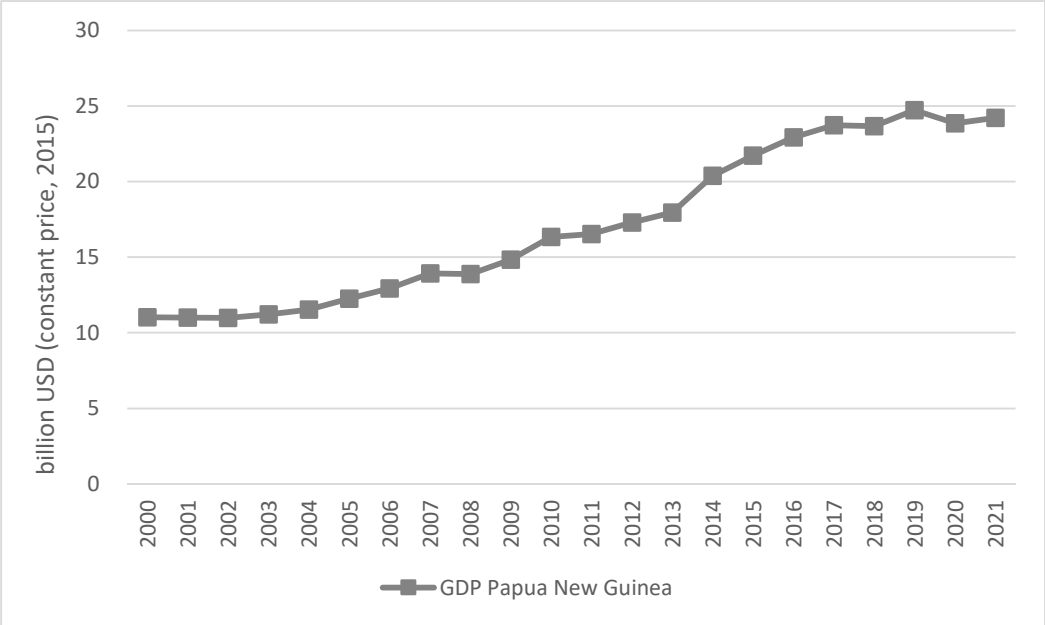
The national targets are as follows:

- Target 1: Reduce Disaster Mortality in PNG by 2030
- Target 2: Reduce the Number of People Affected by Disasters in PNG by 2030
- Target 3: Reduce Direct Disaster Economic Loss in Relation to National Gross Domestic Product (GDP) by 2030
- Target 4: Reduce Disaster Damage to Critical Infrastructure and Disruption of Basic Services
- Target 5: Increase the Number of Provinces with Provincial and Local Disaster Risk Reduction Strategies by 2030
- Target 6: Enhance International Cooperation through Adequate and Sustainable Support to Complement National Actions for Implementation on this Framework by 2030
- Target 7: Increase the Availability of and Access to Multi Hazard Early Warning Systems and Disaster Risk Information and Assessments to People in PNG by 2030

Chapter 3 National and Regional Development Trends

3.1 Review of Past Development Situation of Papua New Guinea

Papua New Guinea (PNG) is a lower-middle-income country with gross domestic product (GDP) per capita of USD 2,916 in 2021. The GDP of PNG was steadily increasing in late 2000 to early 2010. However, since 2016, the economy has been stagnating.



Source: World Development Indicators (data as of 20th July 2022)

Figure 3.1 GDP Trend of Papua New Guinea (2000 – 2021)

The coronavirus disease (COVID-19) pandemic has significantly affected PNG's economy (GDP), which had contracted by 3.5% in 2020, followed by a weak recovery to 1.3% growth in 2021 according to the IMF's World Economic Outlook (July 2022 data).

GDP per capita (current US$) had increased from US$ 1,949 in 2010 to US$ 2,757 in 2020. Inflation and unemployment rates were in the 4-6% range and in the 2% range, respectively.

Investment levels were likely lower in 2021. Investment in the mining and liquefied natural gas (LNG) sectors had been rising until 2019. However, investment dropped sharply in 2020. Investment in the non-extractive sector also appears to have declined. It is said that this decline in investment is likely to have the greatest long-term impact on future growth.

3.2 Economy

(1) Review of Gross Domestic Product (GDP) in the Whole Country

The gross domestic product of PNG was PGK 65,714 million (2013 constant prices) in 2019. The annual average growth rate between 2011 and 2019 was approximately 5.2%.

The growth rate of the mining and quarrying sector is highest at approximately 15% mainly by the contribution of the extraction of crude petroleum and natural gas, followed by information and communication sector at 7.8%, education at 5.8%, and electricity, gas and steam at 5.7%, respectively. The agriculture sector has been increasing steadily at 2.9%. On the other hand, the growth rates of manufacturing and construction are negative; and those of wholesale and retail trade, and transport and storage are low at around 1%.

The share of the mining and quarrying sector in gross value added (GVA) has rapidly increased since 2015 in particular. As for major economic sectors, the shares of agriculture, manufacturing, construction, wholesale and retail trade, and transport and storage have decreased since 2011. On the other hand, the share of information and communication sector increased from 1.8% in 2011 to 2.2% in 2019.

(2) Economically Active Population and Number of Employed Persons by Sector

Economically active population of PNG was 3.34 million in 2011, which was 46% of the total population.

The total number of employees above 10 years old of the whole country in 2011 was approximately 3.27 million. The agriculture sector had the largest number with 2.48 million, followed by wholesale and retail trade with 0.36 million, construction with 64 thousand, and education with 59 thousand.

The shares of the major industrial sectors in ENBP were almost the same as those of the whole country. On the other hand, the share of the agriculture sector at 68.8% in Northeast Gazelle Peninsula was smaller than the national average at 75.9%; and the shares of manufacturing at 1.6%, construction at 3.5%, and transport and storage at 2.3% in the Northeast Gazelle Peninsula were larger than those of the whole country.

(3) Export of Products

PNG exports are mainly raw materials such as petroleum gas, gold, vegetable fats and oils, copper ores, etc. The share of the exports in the top five code accounts for slightly less than 90% of the total exports in the recent five years. Value-added processing of existing mining products and the export value of manufactured products are still very limited. PNG's main export partners are Australia, China, Singapore, Japan and USA.

(4) Import of Products

PNG imports mineral fuels, machinery and equipment, vehicles, electric machinery and equipment, cereals, meat, plastic, iron and steel, etc. PNG's main import partners are Australia, China, Japan, and Singapore.

(5) Major Trading Partners

PNG’s biggest importer and exporter, Australia, accounts for 23% of its exports, and 37% of its imports. Apart from Australia, Asian countries such as China, Japan, Singapore and Malaysia are PNG’s important trading partners.

3.3 Investments

(1) Foreign Direct Investment (FDI) in PNG

The total foreign direct investment (inflows) has sharply dropped since 2019 due to the decline of both the extractive sector and non-extractive sector’s investments. This decline in investment is likely to have a long-term impact on future growth.

According to Investment Promotion Authority, a total of 249 FDI approvals was given with a total investment value of PGK 1.3 billion between 2020 and 2021. The top five investing countries/territories as of September 2021 were Australia with PGK 375.9 million, Malaysia with PGK 374.4 million, USA with PGK 205.1 million, Hong Kong with PGK 121.5 million, and China with PGK 120.6 million.

(2) Foreign Direct Investment (FDI) in ENBP

The total proposed FDI in ENBP amounted to PGK 430 million for five years (2017-2021) as shown in Table 3.1, while the proposed jobs amounted to 2,244.

Table 3.1 FDI Proposed in ENBP between 2017 and 2021

Year	Proposed FDI Values (PGK)	Proposed Jobs
2017	38,229,548	245
2018	201,238,754	504
2019	62,695,887	865
2020	79,732,242	358
2021	47,646,835	272
Total	429,543,266	2,244

Source: Investment Promotion Authority

On the other hand, the total proposed amounts of FDI by country between 2017 and 2021 are shown in Table 3.2. China keeps the top position with 48.7%, followed by Malaysia with 17.8%.

Table 3.2 FDI Values Proposed in ENBP between 2017 and 2021 by Country of Origin

Country of Origin	Proposed FDI Values		No. of Approvals	
	PGK	Share (%)	Number	Share (%)
Australia	3,980,098	*0.9*	14	*11.8*
China	209,233,188	*48.7*	53	*44.5*
Philippines	4,252,420	*1.0*	10	*8.4*
Hong Kong	0	*0.0*	1	*0.8*
Japan	109,750	*0.0*	3	*2.5*
Malaysia	76,336,256	*17.8*	32	*26.9*
New Zealand	368,284	*0.1*	1	*0.8*
Sri Lanka	353,300	*0.1*	1	*0.8*
UK	1,059,840	*0.2*	3	*2.5*
Not specified	133,850,130	*31.2*	1	*0.8*
Total	429,543,266	*100.0*	119	*100.0*

Source: Investment Promotion Authority

3.4 Population

The present projected population of PNG is approximately 9.5 million (2022). [1]

The populations by region and province in the whole country between 1980 and 2011, as enumerated in the censuses[2], are shown in Table 3.3. In 2011, the total population of Papua New Guinea was about 7.3 million, and the annual growth rate between 2000 and 2011 was 3.1%. On the other hand, the population of the East New Britain Province was 328,369 in 2011 with an annual growth rate of 3.7% in the same period, which was much higher than the national average.

In Northeast Gazelle Peninsula, the population totalled 198,745 in 2011 with an annual growth rate of 3.5% in the same period, which was also higher than the national average. The population of Northeast Gazelle Peninsula accounted for 2.7% of the population of the whole country and 60.5% of that of ENBP.

The growth rates of the populations vary across the different regions and provinces. Between 2000 and 2011, the Island Region showed the highest growth at 3.5%, followed by the Highlands Region at 3.3%, the Southern Region at 3.0%, and the Momase Region at 2.4%.

[1] See Table 7.3.1 Population Projection (2000-2052) for PNG for NGID-Plan.
[2] In Papua New Guinea, a population census is due to be conducted in 2024. However, at the time of writing this report, the results of the census have not yet been published.

Table 3.3 Populations of the Whole Country, Regions and Provinces

Region/Province	Population				Annual Growth Rate (%)			
	1980	1990	2000	2011	1980 – 1990	1990 – 2000	2000 - 2011	1980- 2011
Papua New Guinea	3,010,727	3,761,954	5,190,786	7,275,324	2.2	3.3	3.1	2.9
Southern Region	588,700	771,193	1,041,820	1,456,250	2.7	3.1	3.0	2.9
Highlands Region	1,121,258	1,373,673	1,973,996	2,854,874	2.0	3.7	3.3	3.0
Momase Region	857,773	1,027,600	1,433,432	1,867,657	1.8	3.4	2.4	2.5
Islands Region	442,996	589,488	741,538	1,096,543	2.9	2.3	3.5	2.9
Manus Province	26,036	32,840	43,387	60,485	2.3	2.8	3.0	2.7
New Ireland Province	66,028	86,999	118,350	194,067	2.8	3.1	4.5	3.5
East New Britain Province	**133,197**	**185,459**	**220,133**	**328,369**	**3.3**	**1.7**	**3.7**	**2.9**
Northeast Gazelle Peninsula (Nine LLGs)	**86,128**	**121,155**	**135,826**	**198,745**	**3.5**	**1.1**	**3.5**	**2.7**
West New Britain Province	88,941	130,190	184,508	264,264	3.8	3.5	3.3	3.5
AR Bougainville	128,794	154,000	175,160	249,358	1.8	1.3	3.2	2.1

Source: National Statistical Office

PART III Present Situational Analysis of Location, Nature, Societies and Disasters of Northeast Gazelle Peninsula

Chapter 4 Present Locational, Natural and Social Characteristics of Northeast Gazelle Peninsula

4.1 Locational Characteristics of Northeast Gazelle Peninsula within Papua New Guinea

4.1.1 Geography of Northeast Gazelle Peninsula, Gazelle Peninsula and East New Britain

(1) ENBP in the New Britain Island

New Britain Island is part of the Bismarck Archipelago. It is the largest island (Area: 36,520 km²) in the archipelago. Administratively, it is part of the Islands Region of Papua New Guinea. There are two provinces in New Britain: East New Britain, whose provincial capital is Kokopo, and West New Britain, whose capital is Kimbe.

The population size of the island was small, only 513,926 based on 2011 population census, in comparison to the large landmass of the island. The average population density was about 14 persons/km^2 in 2011.

The two provinces are not well physically connected by roads in the New Britain Island. In fact, the two provincial capital towns (Rabaul and Kimbe) are planned to be connected by the New Britain Highway. At present, the road sections connecting the two provinces are not so well maintained.

Kokopo, the provincial capital city of ENBP, is approximately 800km northeast from Port Moresby, the national capital city and approximately 650km from Lae, the second largest city in Papua New Guinea.

(2) Gazelle Peninsula in ENBP

Gazelle Peninsula is located at the east end of New Britain Island and ENBP.

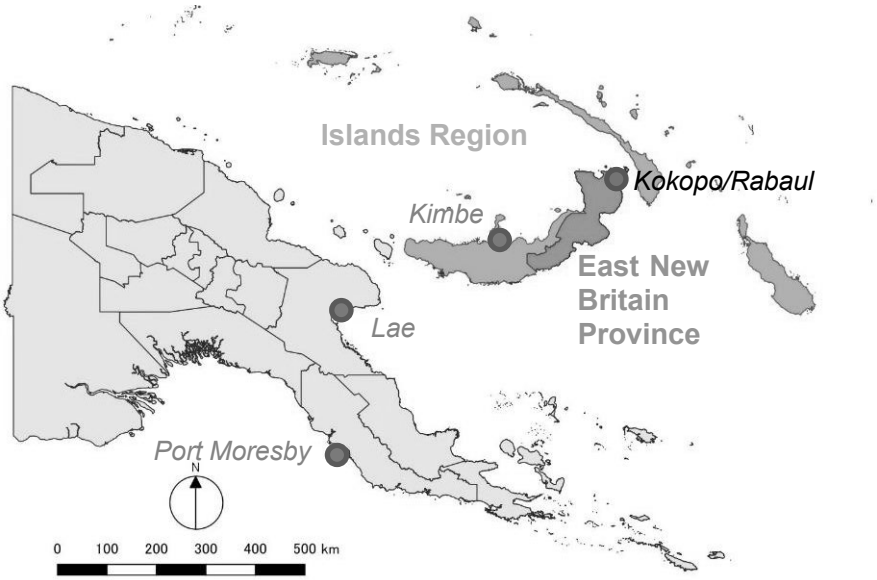
The shape of Gazelle Peninsula is roughly rectangular, and its area size is about 6,000 km^2.

Gazelle Peninsula is connected with the main part of New Britain Island through a 35 km width of isthmus. The isthmus is located between Open Bay on the west and Wide Bay on the east.

(3) Northeast Gazelle Peninsula in Gazelle Peninsula

Gazelle Peninsula is divided into four physiographic areas, namely: 1) North Baining Mountains, 2) Central Mountains, 3) South Baining Mountains, and 4) Northeast lowlands (encompassing Rabaul Town and Kokopo Town). Northeast Gazelle Peninsula corresponds to the Northeast lowlands. The Northeast Gazelle Peninsula is a low altitude area of less than 700m. The lowlands are surrounded by the Kerevat River and the Warangoi River.

The ENBP is administratively divided into four districts, namely: Rabaul District, Kokopo District, Gazelle District, and Pomio District. The boundaries of these four districts are also shown in Figure 4.2. The Northeast Gazelle Peninsula is composed of Rabaul District, Kokopo District and eastern part of Gazelle District.



Source: JICA Expert Team, based on GIS data from the National Statistical Office

Figure 4.1 Location of ENBP in the New Britain Island and in Papua New Guinea

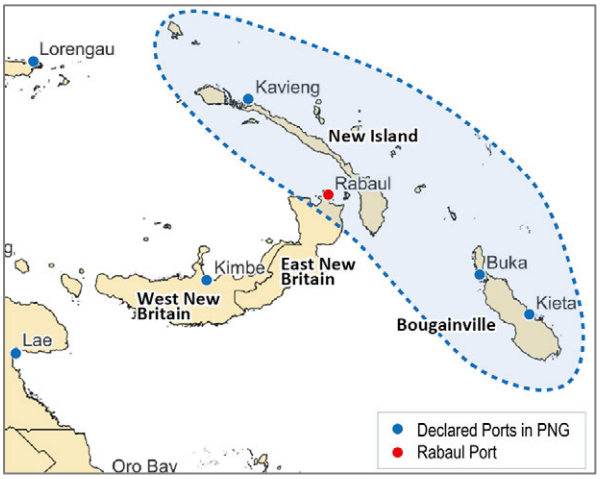
Source: CartoGIS Services, College of Asia and the Pacific, The Australian National University

Figure 4.2 Gazelle Peninsula in ENBP

4.1.2 Rabaul Port and Its Influential Areas over Surrounding Islands

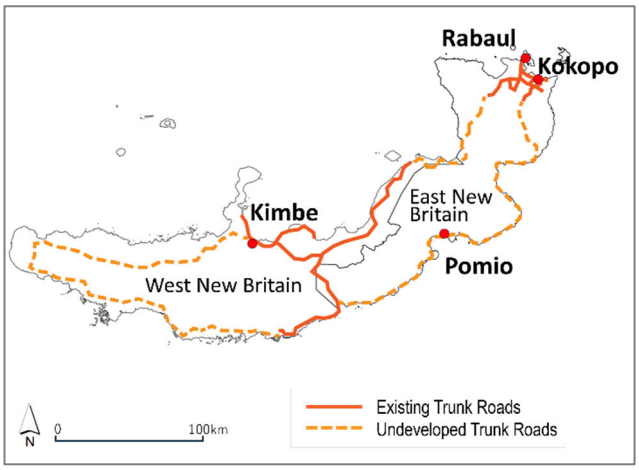
The estimated population of Northeast Gazelle Peninsula in 2020 is 260,000, which is small. However, the area is connected with the islands, as shown in Figure 4.3, with regional logistic network by sea route starting at Rabaul Port. For example, agricultural products (cacao and coconut) from Bougainville and New Ireland are transported to Rabaul Port, where these products are transhipped to large ships and exported.

In the future, the production of agricultural products (coconut, cacao, etc.) is expected to increase, so the increase in production in the surrounding islands will be also reflected in the increase in cargo exports from Rabaul Port. This is also the case for road infrastructure. Although ENBP currently has not fully extended the trunk roads throughout the province, the national government intends to lengthen the trunk roads, connecting WNBP and ENBP with a northern corridor (New Britain Highway). At the same time, there is also a plan to connect the two provinces by a corridor along the southern coast (see Figure 4.4). By extending the trunk road of ENBP, it is expected that the agricultural production areas connected to the port will expand and the cargo export volume from Rabaul Port will increase.



Source: JICA Expert Team

Figure 4.3 Influential Areas or Service Coverage Areas of Rabaul Port



Source: Alamgir, et al., 2019, Infrastructure Expansion Challenges Sustainable Development in Papua New Guinea

Figure 4.4 Existing Trunk Roads and Undeveloped Trunk Roads in New Britain Island

4.2 Natural Condition in Northeast Gazelle Peninsula

4.2.1 Geological Condition

(1) Geological Overview of the Project Area

In the Project Area (Northeast Gazelle Peninsula), most of the units, if not all, are part of the original volcanic activities in the build-up of New Britain Island. Generally, the Quaternary and recent age deposits of alluvium and undifferentiated volcanic ashes are observed at present.

The whole of New Britain Island is prone to the risk of volcanic activities, earthquakes, landslides, tsunami and sudden

The whole of New Britain Island is at risk from volcanic activity, high density and high intensity earthquakes, landslides, tsunamis and rapid tectonic movements (subduction, collapse and sliding). These geological hazards are discussed in more detail in Chapter 5.

(2) Soil

According to the U.S. Department of Agriculture (USDA) Soil Taxonomy, Vitrandepts, Eutrandepts and Dystrandepts are found on the Northeast Gazelle Peninsula. Among these three

types of volcanic ash origin soils, Dystrandepts is the most widely distributed in the Project Area. "Dystrochrept" is a coined term to describe immature soils (Inceptisols Order) that are nutrient poor (Dystric Subgroup) due to little accumulation of humic substances with light-colored surface layer (Ochric surface horizon). Primitive soil developed on an accumulated parent material with weak weathering and infiltration of humic substance from soil surface. This soil is widely used as aggregate at construction sites, but the weathered unconsolidated matrix is floating through the air as wind dust.

In contrast to Dystrandepts, Eutrandepts is relatively rich in nutrients (eutrophic) and is used for various types of agriculture. This soil is well developed with aggregates and superior water retention and aeration.

In addition, Vitrandepts is a volcanic ash soil with a consolidated clayey subhorizon that is strongly affected by soil moisture movement due to the alternation of wet and dry seasons.

4.2.2 Vegetation and Land Cover

Lowland tropical rainforest is distributed in the Project Area, with many species of *Dipterocarpaceae*, *Cercidiphyllaceae*, *Mucuroideae*, *Asteraceae* and *Urticaceae*. The vegetation generally consists of three layers, with an upper canopy group of about 30-40 m, under which grows different plant species, such as palms, vines, and larches. In addition, wild sugarcane, reed-type plants, nipa palms and sago palms grow in the wetlands and estuaries.

The surface area of each category in Northeast Gazelle Peninsula is shown in Table 4.1. According to this classification, most of the study area is covered by forest and shrubs (approximately 87%). Grassland is mainly distributed along the roads. Urban areas are concentrated around the towns of Kokopo and Rabaul. Bare lands are scattered around the volcanos and along the rivers.

Table 4.1 Land Cover by Category in Northeast Gazelle Peninsula (2019)

Category	Area (km^2)	Ratio (%)
Forest	272.75	32.4
Shrub / Bush	457.15	54.4
Grassland	83.87	10.0
Urban / Bare land	27.03	3.2
Water body	0.20	0.0
Total	841.00	100.0

Source: JICA Expert Team, based on SPOT data.

4.2.3 Climate

In the Köppen climate classification, New Britain Island belongs to the equatorial climate (Af), but the temperature difference is small, and the maximum temperature rises to around 30°C throughout the year.

The average rainfall amount recorded at the Tokua Airport Observatory based on the rainfall data for 10 years between 2009 and 2018 is 2,498 mm/year. The climate in Papua New Guinea is mainly divided into two seasons: dry season from May to November, and rainy season from December to April. But the distinction between rainy season and dry season in the Project Area is smaller than in other regions because of its relativity on the equator.

4.2.4 Flora and Fauna

(1) Flora

Vast land in the Northeast Gazelle Peninsula is currently utilised for cocoa, balsa, and coconut plantations. The original natural vegetation has been mostly cleared for plantation development,

but remnants of the original forest and secondary growth are present. The original forest, prior to agricultural conversion, likely consisted of large to medium-sized trees with canopy heights of 30-35 metres and had a high degree of flora diversity, including species such as *Pometia pinnata* and *Octomeles sumatrana*.

The plantations have a mix of young to mature balsa and cacao trees, shaded by taller coconut trees and other species. Ground cover in less shaded areas includes common weeds and grasses, and the area is home to a variety of plants including cassava, pawpaw, bananas, and orchids. This area is adjacent to a range of habitats, from mangrove and beach forests to plantations. The mangroves are vital for coastal protection but are threatened by dredging, pollution and urban development.

(2) Fauna

Mammal diversity in the Northeast Gazelle Peninsula is relatively low compared to that in the Baining Mountains. This observation may be due to limited sampling, as only a few species were recorded. However, bird diversity in the area is more significant, with over 50 species recorded, including 15 that are rare, threatened, and endemic or protected under CITES II or PNG legislation. These birds are distributed throughout the peripheral forests and plantations.

Amphibian diversity includes five species, including the cane toad (*Bafo marinus*) and *Platymantis papuensis*, the latter being endemic to the area. Most amphibians, except the cane toad, are sensitive to disturbance and are usually found near streams and rivers.

The monitor lizard is of traditional importance to the local people, particularly for its skin, which is used to make cultural instruments such as the kundu drum. Other reptiles such as skinks, geckos and snakes are recognised but traditionally considered of little or no importance. Insect diversity under old coconut plantations is unclear, but economically important groups include several families of butterflies, weevils, beetles and moths. Endemic species are rare due to the depleted vegetation, but smaller animals may persist in the riparian forests.

(3) Marine Environment

The marine habitats of Kabaira Bay and Ragaga Bay in Ataliklikun Bay Area are diverse and ecologically abundant with healthy coral reefs and systems. Ragaga Bay is a deep coastal basin and characterised by a nearshore fringing coral reef system, seagrass and macroalgae habitats, beaches, and mangrove communities. The most conspicuous coral presence has been associated with water depths between approximately 5 to 10 m. The International Union of Conservation (IUCN) Red List has identified one coral species categorised as Endangered (*Cantharellus noumeae*), and 134 species classified as Vulnerable with distributions that overlap Blanche Bay and Ragaga Bay. *Cantharellus noumeae,* is endemic to New Caledonia, has a restricted range size and is naturally rare.

On the other hand, crown thorns of starfish which feeds on corals were also observed at Kabaira Bay and Ragaga Bay in Ataliklikun Bay Area, indicating the reason for the coral mortality. There is also high abundance of corallivorous snails which cause coral mortality. Potential of pollution coming from neighbouring oil palm plantation and logging operations cannot be discounted.

Ragaga Bay nearshore habitats support a range of biota, some of which are of conservation and resource significance on local and international scales. There is presence of seagrasses and mangroves along the coast at Ragaga, Kabaira, Kerevat River/Tavilo (Ataliklikun Bay) and Kabakaul (Tokua). Seagrass communities are important nursery habitats for prawns, lobsters, crabs, turtles, and fish, aid in stabilising the substrate, and can also be important feeding sites for dugong.

4.2.5 Protected Areas

There were no observable native flora or fauna species, nor landmarks and culturally significant sites which must be protected, nor there are flagship terrestrial flora and fauna species of conservation concern in ENBP. However, in the surrounding waters of Northeast Gazelle Peninsula, there are two protected areas acknowledged by Conservation and Environmental

Protection Agency (CEPA) and ENBPA, which are Talele Island Reserve Area and Nanuk Provincial Park/Recreational Area. (See Table 4.2.)

Table 4.2 Protected Areas in ENBP

Protected Area	Location	Surface Area
Tavolo Wildlife Management Area	Melkoi LLG, Pomio District	23.08 km^2
Kavakuna Cave	Central/Inland Pomio LLG, Pomio District	45.91 km^2
Talele Island Reserve Area	Reimber/Livuan LLG, GazelleDistrict	0.12 km^2
Klampun Wildlife Management Area	East Pomio LLG, Pomio District	45.91 km^2
Nanuk Provincial Park/Recreational Area	Duke of York Island LLG, Kokopo District	0.12 km^2

Source: JICA Expert Team based on inverview with ENBPA in 2019

Besides these protected areas, there is evidence of dolphin breeding in the surrounding water of Kokopo District. Moreover, residents also reported that dugongs are found near Duke of York Island and in Ataliklikun Bay.

There are no areas of archaeological and historical significance in the Project Area. However, Northeast Gazelle Peninsula is known as the tourist site with war legacy from World War II.

4.3 Social Condition in ENBP

4.3.1 Ethnicity

(1) Ethnic Groups and Languages in ENBP

There are sixteen Austronesian languages spoken by various ethnic groups in ENBP. The Kuanua language is the most widely spoken by the Tolai people in the Gazelle Peninsula. Other Papuan languages, such as Baining, Taulil, Ata, Kol, Makolkol, and Sulka languages, are also spoken in ENBP.

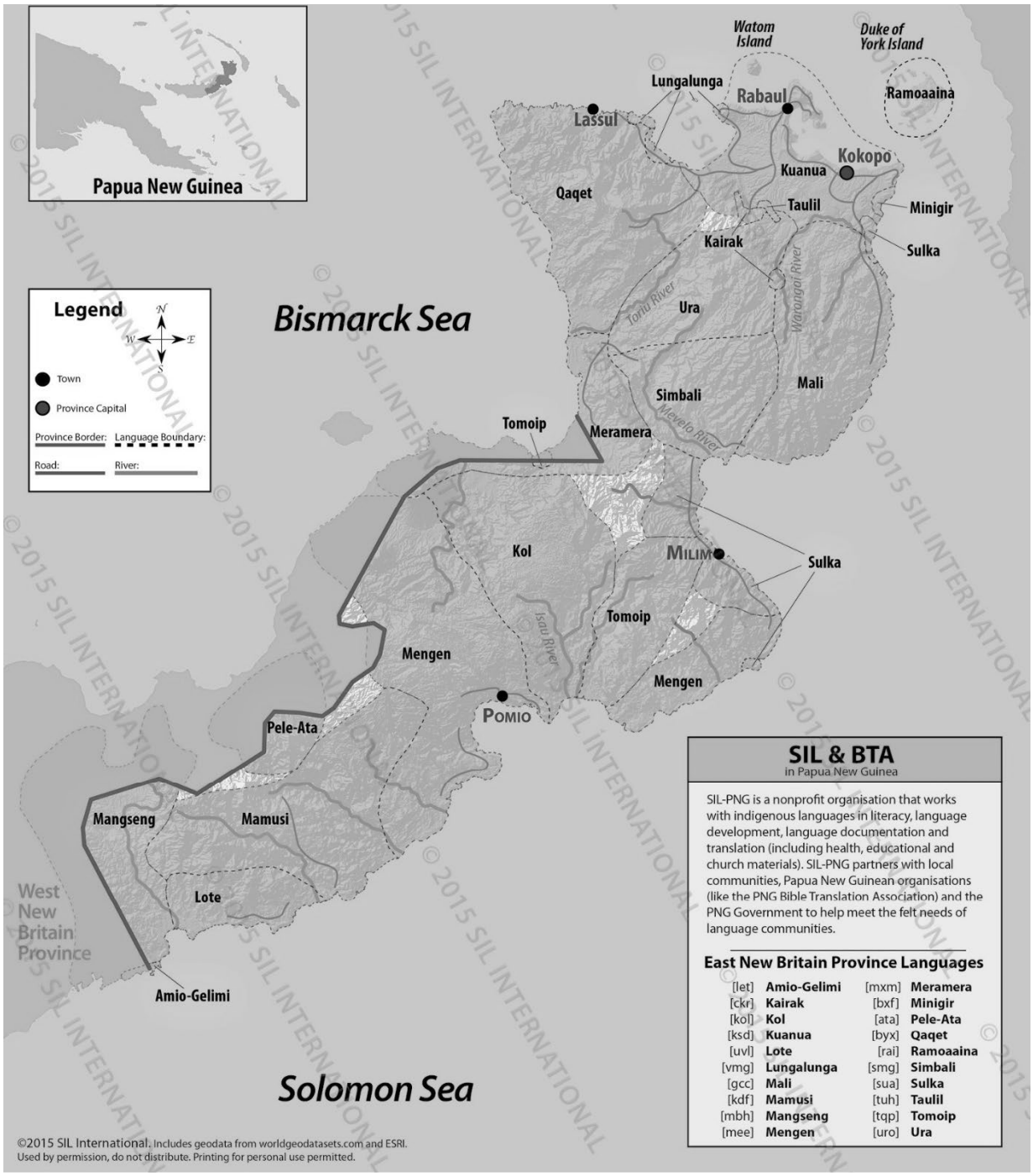
(2) Ethnic Groups and Languages in Gazelle Peninsula[3]

The Tolai people live mostly in the northern and eastern parts of Gazelle Peninsula in the east, while the Pomio people live in the southwest, as shown in Figure 4.5.

The Baining people are the original inhabitants of the Gazelle Peninsula in ENBP. Linguistically, the Baining language is different from those spoken by the Tolai and Pomio people. While the Baining are the original people in the region, they have smaller population than the Tolai and Pomio.

Due to differences among the Baining and Tolai people, the Baining moved farther into the hinterland. Occupying primarily the remote parts of East New Britain, the Baining mostly continue their life and daily activities in isolation. It was not until the early 1960s that the Baining became visible in Rabaul and Kokopo towns for selling their cash crops.

[3] Faik-Simet, 2017, "The Politics of the Baining Fire Dance" was referred to in writing this section.



Source: Website of Languages of Papua New Guinea, https://pnglanguages.sil.org/resources

Figure 4.5 Distribution of Languages in EMBP

4.3.2 Poverty

According to the previous Household Income and Expenditure Survey (HIES) conducted in 2009-2010, the poverty situation of PNG is summarised as follows:

- Applying the national poverty line based on basic needs, 39.9 percent of the population lived below the poverty line.
- Using the international poverty line of $1.90 per person per day, the poverty rate was estimated at 38.0 percent. By using the two different poverty lines for urban and rural areas (the international poverty lines), the poverty rate turned out to be 40 percent in rural areas and 27 percent in urban areas. In PNG, the percentage of urban population is 13%.

- The poverty rate was 65.6% and very high, being measured against the Lower Middle Income Class Poverty Line of $3.20.
- According to the multi-dimensional poverty measure considering not only monetary aspects, but also other education and other public services, the poverty rate was 85.7 percent.

The previous HIES was conducted in 1996 and the poverty rate of Papua New Guinea has decreed from approximately 51% in 1996 to approximately 38% in 2009.

PNG was planned to conduct the next Household Income and Expenditure Survey in 2021. However, due to COVID-19, it has not yet been conducted.

4.3.3 Social Services Conditions in ENBP

In 2016-2018, a demographic and health survey (DHS) was conducted and compiled for PNG by the National Statistical Office of PNG and the Demographic and Health Surveys (DHS) Program of ICF, USA.

This DHS was a sampling survey covering various basic indicators of fertility, fertility preferences, family planning practices, childhood mortality, maternal and child health, knowledge and awareness of HIV/AIDS, domestic violence, and other related health issues.

Based on the survey results, some features of ENBP's social services are summarised in Table 4.3.

Table 4.3 Features of Social Services in ENBP, 2016-2018

1. Accessibility to Drinking Water
Access to relatively good quality drinking water (tap, managed wells, water trucks, etc.) was relatively high (62.2%) compared to other provinces.
Access to sanitary toilets was higher in ENBP than in other provinces (the best level, except in the National Capital District).
2. Accessibility to Health Facilities
In ENBP, a very high percentage of women (58.4%, the highest among all provinces) had problems obtaining permission to receive treatment in medical facilities (from family members).
The percentage of women who visited a health facility in the past year in ENBP was higher than the national and region averages. Reasons for visiting medical facilities were about average compared to other states. There were few visits due to accidents or family planning consultations.
The percentage of men visiting medical facilities in ENBP was about average compared to other provinces. The percentage of men's visits for health check-up reasons was lower than those in many other provinces.
The percentage of women who were aware of facilities where they could receive HIV testing in their areas was much higher than the national average and regional average. However, the percentage was low for men.
3. Accessibility to School Education
While the proportion of women and men (aged 15-49) with a primary school diploma or above was higher than men on the average across the country, the opposite was true in East New Britain. (In ENBP, the percentage of men who graduated from secondary school or above was slightly higher). Women's median of years of school completion (6.7 years) was above the national average, while that for men (6.3 years) was below it, and the percentage of men dropping out of primary school was high.
4. Literacy Rates
The literacy rates of both men and women combined and women alone were well above the national average. Also, the Islands Region has a higher literacy rate than other Regions. Moreover, there is no significant difference between male and female literacy rates in ENBP.
5. Accessibility to Internet Services
The percentage of people who used the internet in the past years was average for both men and women. However, the percentage who used the internet at least once a week was below the national average.

Source: JICA Expert Team summarising the results of "Papua New Guinea Demographic and Health Survey 2016-18"

4.3.4 Socioeconomic Condition in ENBP

The Demographic and Health Survey (DHS) 2016-2018 contained some information on socioeconomic aspects, especially about fertility rates, cash incomes, employment and safety.

Based on the survey results, some features of the socioeconomic condition in ENBP are summarised in Table 4.4.

Table 4.4 Features of Socioeconomic Condition in ENBP, 2016-2018

1. Fertility Rates
The Islands Region's total fertility rate (4.5 in 2016-2018) was relatively higher than those of the other regions in PNG. In the Demographic and Health Survey 2016-2018, there were no data on total fertility rates by province, but data by region are available.
2. Household Cash Earnings
In the Islands Region, the proportion of households who grew cash crops to those who grew food crops was relatively low, and the proportion of livestock holdings was relatively high.
The percentage of households where the wife earned more cash than the husband was lower than the national average. In the ENBP, the share of households in which husbands and wives jointly decide how to use women's cash earnings was higher than the national average, and this was easily influenced by male family members. The percentage of households where men control their own cash earnings was higher than the national average.
3. Employment
The employment rates of women in the past 12 months were higher than the national average and the regional average. Comparing within the Islands Region, the proportion of women engaged in agriculture was high, while the respective proportions of sales and service personnel, professional engineers and managers were low.
The employment rates for men in the past 12 months were lower than the national average, and 60% were unemployed. Compared to the national average and the regional average, the percentage of skilled manual workers was high.
4. Security Related to Women
The percentage of women who had been physically assaulted in the past 12 months was below the national average. It was about the same as the Islands Region average. ENBP had lower rate than the national and region averages for sexual assault.

Table 4.5 Total Fertility Rates in PNG in 2006 and 2016-2018

	2006	2016-18
Highlands Region	3.87	3.8
Southern Region	4.48	4.5
Momase Region	4.97	4.4
Islands Region	4.59	4.5

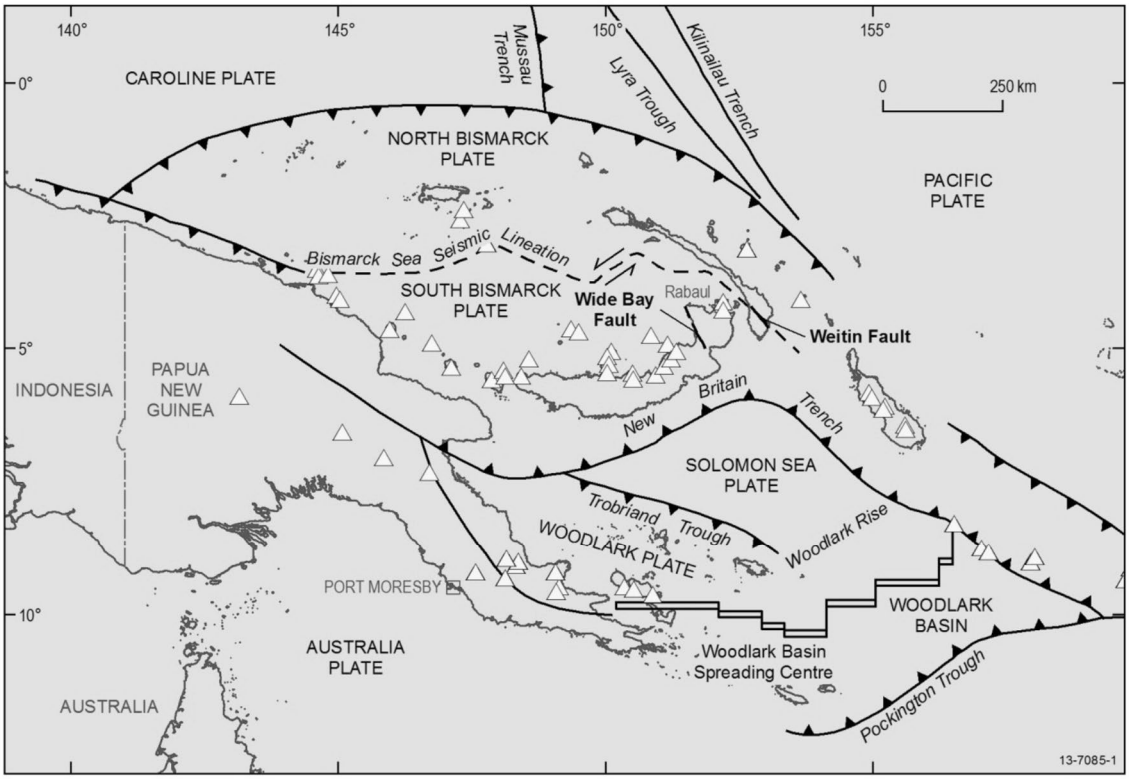
Source 1: 2006 - Papua New Guinea Demographic and Health Survey 2006 National Report
Source 2: 2016-18 - Papua New Guinea Demographic and Health Survey 2016-18

Chapter 5 Disaster Risk Profile of Northeast Gazelle Peninsula

5.1 Background

ENBP is prone to a variety of serious disasters caused by geological setting in and around the province, including characteristics of techno plates, trenches, fault lines, and volcanoes, as shown in Figure 5.1. Especially, Northeast Gazelle Peninsula's disaster hazards are due to the geological setting of New Britain Island and presence of active volcanoes.

Existing documents concerning disaster hazards have been reviewed, and the results are summarised in this chapter.



Source: Moihoi, et al., July 2013, "Integrating Hazard and Exposure for East New Britain," Geoscience Australia, Australian Government

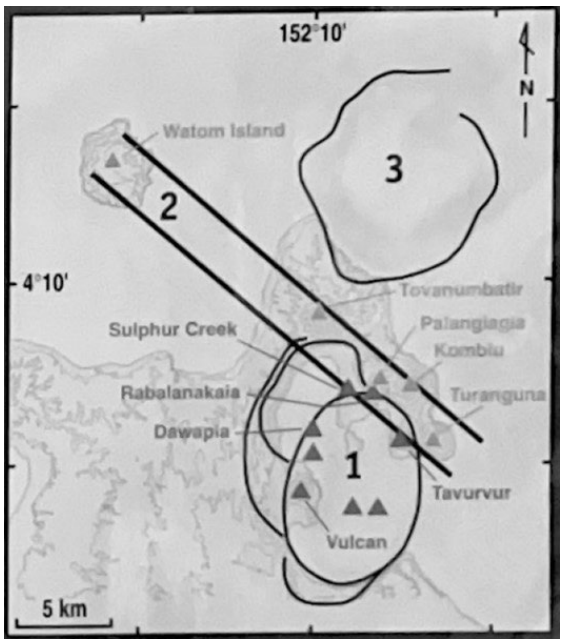
Figure 5.1 Geological Setting of Papua New Guinea

5.2 Rabaul Volcanic Complex

Rabaul has many volcanoes which overlap with each other. Volcanologists refer to them as a "volcanic complex." It is composed of several calderas (large craters) that have been formed over thousands of years. These calderas in the south have been flooded by sea, forming the Rabaul Harbour (Simpson Harbour).

Magma generation and eruption have happened in the Rabaul area at least in the past 500,000 years. The Rabaul volcanic system is much larger than the present Rabaul Caldera. It is about 35 km from Watom Island to Kokopo.

In the past, the large Rabaul volcanic system had at least 9 major caldera-forming eruptions. It is considered that its latest major eruption was about 1,400 years ago, which devastated the area within 50 km diameter and made the Rabaul Caldera deeper and wider.



Source: Rabaul Volcanic Complex Poster

Figure 5.2 Rabaul Volcanic Complex

5.3 Review of Disaster Risk Assessment Report for ENBP, 2002

The Disaster Risk Assessment Study was conducted for 10 months by a group of officers from Gazelle Restoration Authority (GRA) and ENBP Administration (ENBPA) with the support of AusAid. Experts of Rabaul Volcanological Observatory (RVO) also played a major role in providing expert investigations.

Major strength of this disaster risk assessment report is a comprehensive coverage of varieties of disaster hazards. The following hazard assessments were done, and these are described below.

- Geological Hazard
- Volcanic Hazard
- Earthquake Hazard
- Landslide Hazard
- Tsunami Hazard
- Coastal Erosion Hazard
- Floods Hazard
- Drought Hazard

However, the analyses and assessments in the Disaster Risk Assessment Report for ENBP (2001) were mostly qualitative based on geological information and maps, and historical disaster information.

(1) Geological Hazard [4]

East New Britain is one of the most seismically active regions in PNG. The whole Island of New Britain is prone to volcanic activities, high density and intensity earthquakes, landslides, tsunamis and rapid tectonic plate movements (subduction, sinking or slips).

It is considered that most parts of the province are geologically made of soft structure, and are highly prone to landslides, ground subsidence and rapid erosion through contact with water and high seismic movements.

(2) Volcanic Hazard

All volcanoes pose danger. In particular, a sea-filled caldera like Rabaul pose more danger because during eruption, the seawater can make contact with the magma and react intensely to cause massive explosions.

Within the present caldera of Rabaul, small volcanoes might erupt again within 40-60 years with the same magnitude as the eruption in 1994. While simultaneous eruptions of Tavurvur and Vulcan volcanoes are highly likely, and there is a possibility of eruptions from other vents. Tavui (a submerged volcano), Kombiu and Turanguna volcanoes also have potential volcanic risks.

The possibility of medium-scale eruptions in Rabaul, whose accumulated volcanic ash could damage areas within 8-10 km radius, should not also be disregarded or underestimated.

With massive volcanic ash emitted by volcanic eruptions in 1994, buildings, infrastructure, vegetation, properties and villages were heavily damaged in Rabaul Town. About 80% of the houses were damaged by the weight of volcanic ash in Rabaul Town. Direct and indirect costs of damages to homes, properties, plantations and businesses were estimated to exceed PGK 300 million.[5] The government conducted relocation programmes to assist affected communities.

There are different types of events in volcanic eruptions.

1) Tephra Falls

Tephra materials are most widely spread during eruptions. The distribution of tephra depends on various factors including the height of eruption column, the strength and the direction of wind, and the size and density of the fragments.

The weight of the accumulated tephra (volcanic ash) caused failure and collapse of roofs of buildings around Rabaul Town and surrounding areas.

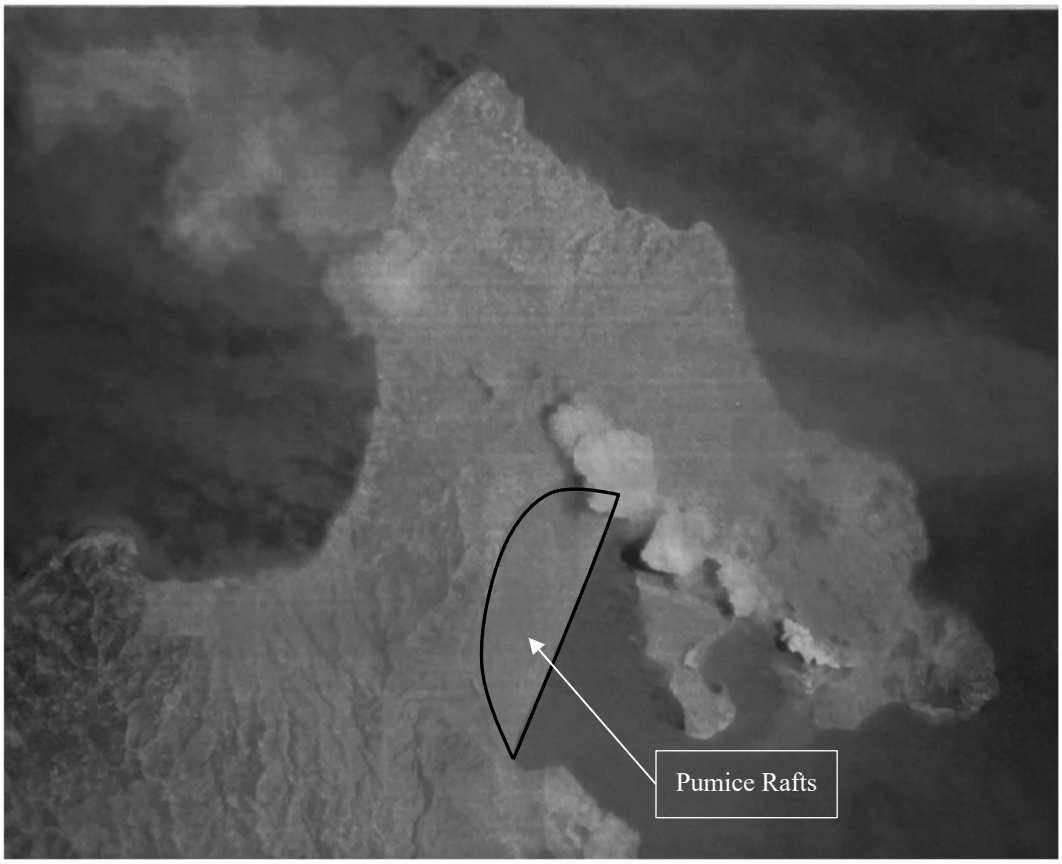
Ash also seriously damaged agriculture land and other vegetation. Ash in the atmosphere reduced visibility and hindered air traffic and road traffic. Ash also affected motor vehicles by clogging air filters and causing the rapid wearing out of moving spare parts. It also contaminated sources of water supply, especially the unprotected ones like uncovered water tanks and other water reservoirs.

2) Pumice Rafts

Pumice are light-coloured vesicular glassy rocks which often float on water. If they are deposited in water, they form “pumice rafts” which can be several metres thick, and/or can cover the entire bay or harbour. See the case of Simpson Harbour in 1994 eruptions in Figure 5.3. Pumice rafts can block waterways and harbours for months resulting in disturbance of water.

[4] Many of the geological analyses of hazards in Gazelle Peninsula were based on scientific contributions found in Lindley, I.D., 1988, Early Cainozoic Stratigraphy and Structure of the Gazelle Peninsula, East New Britain. An Example of Extensional Tectonics in the New Britain Arc-Trench Complex. Australian Journal of Earth Sciences 35, 231-244.

[5] PGK 300 million is equivalent to USD 300 million in 1994 exchange rate.



Source: GRA, 2001, Hazard Risk Report for ENBP 2001

Figure 5.3 Distribution of Pumice Rafts on Simpson Harbour After 1994 Volcanic Eruptions

3) Torrential Run-Offs (Mud Flow)

Mudflow is a slurry of volcanic debris and water that flow down in valleys of a volcano after heavy rain. Rainfall triggers mudflows even many months after the end of volcano eruptions.

It is different from the normal flood by the amount of rock debris included in the flow. During 1994 Rabaul eruptions, mudflows cut most roads around Rabaul, as shown in Figure 5.4.

Source: GRA, 2001, Hazard Risk Report for ENBP, 2001

Figure 5.4 Effect of Mudflow Along Namanula Road in Rabaul During 1994 Eruption

4) Lava Flows

The 1996 and 1997 lava flows from Tavurvur Volcano which cover a large land between Sulphur Point and Talvat Village, making a barren land for a long time.

5) Tsunami Due to Earthquake and Volcanic Activity

Approximately, 1937 tsunami killed 500 people in Vulcan.

(3) Earthquake Hazard

Seismic activities are very high in East New Britain. There are four types of sources of these seismic activities: subduction seismicity, transform seismicity, triple junction seismicity and active fault (intraplate) seismicity.

While high-density earthquakes of magnitude 6.0-8.0 are highest in Central Pomio and West Pomio/Mamusi, the probability of occurrence of high-intensity earthquakes within a 100-year period in Rabaul, Kokopo and Pomio Districts is high.

(4) Tsunami Hazard

ENBP's coastal areas have high tsunami risks due to their high seismicity and volcanism.

Earthquakes cause coastal landslides, submarine slumps, and possible undersea explosions (submerged volcanoes, such as Tavui Caldera) that can significantly disturb sea levels.

No major tsunamis similar to the size of the event in Aitape have occurred yet in East New Britain. However, danger is imminent if the population of coastal communities continues to grow.

- At least 12 damage-causing tsunamis hit Rabaul Harbour, Kokopo and Pomio since 1900 due to magnitude 7.0-8.0 earthquakes.
- Mortality was recorded during the 1937 eruption of Vulcan.
- During other events, damages to properties, shorelines, the harbour and houses along the coasts were caused by tsunamis.
- The magnitude 8.1 earthquake in New Ireland in November 2000 caused a tsunami that hit Duke of York Islands, Kokopo, Vunapope and Takubar, and inundation of over 100 metres inland.

This report of hazard assessment recommended that the province should maintain 500 metres in flat land as a coastal buffer zone against tsunami, and 300 metres for areas higher than 3 metres.

(5) Coastal Erosion Hazard

Shoreline loss or coastal erosion is alarmingly high in Kokopo, Rabaul and Pomio Districts. In Kokopo District, shorelines have been observed to have moved 10-15 metres inland in just 5-8 years. Factors for this coastal erosion include loss of mangrove forests and faster surface run-off due to loss of ground cover.

It is highly recommended that coastal development be controlled by establishing safe inundation zones of 300-500 metres in all coastal areas for mangrove afforestation and public parks.

(6) Floods Hazard

Flooding is critical in Kerevat and Warangoi areas mainly because of the loss of upland forests, which have reduced water retention capacities in upland areas, and increased soil deposits in natural drainage lines.

Kokopo has experienced isolated flooding due to the loss of natural drainage areas caused by land use change brought about by development. Rabaul Town's natural drainage paths are also vulnerable to seasonal flooding.

(7) Drought Hazard

There has been no disaster incidence of drought in Northeast Gazelle Peninsula. On the other hand, the problem of drought has been found in inland Melkoi, Pomio District. It is caused by lower rainfall and the inability to hold surface water of the localities partly due to the prevalence of limestone in Pomio District.

5.4 Review of "Integrating Hazard and Exposure for East New Britain, 2013"

(1) Strengthening Natural Hazard Risk Assessment Capacity in Papua New Guinea

In 2010, the Government of PNG and Geoscience Australia started a project for "Strengthening Natural Hazard Risk Assessment Capacity in PNG." This project was supported by AusAID and developed in collaboration with Government of PNG's technical agencies.

The project was designed to strengthen the technical capacity of PNG agencies to develop natural hazard and exposure information.

(2) Research Report "Integrating Hazard and Exposure for East New Britain, 2013"

A research report entitled "Integrating Hazard and Exposure for ENBP" was prepared and published in 2013 as a professional opinion. The report was prepared by experts and officers of PNG's Department of Mineral Policy and Geohazards Management, ENBPA, and Geoscience Australia, based on the findings of the ENBP study.

The report elaborates the information on integration of hazard and exposure for ENBP so that town planners and scientists make use of them in decision-making process related to disaster risk reduction.

(3) Earthquake Hazard

PNG is located in one of the most seismically active regions in the world. A historical database of seismicity includes 63 earthquakes of magnitude 7.0-8.0 and 4 earthquakes of magnitude 8.0 along the Bismarck arc (Mori, et al., 1987).

Northeast Gazelle Peninsula is less prone to seismic hazards than the other areas in the New Britain Island.

(4) Tsunami Hazard

The hazard assessment included in the Disaster Risk Assessment Report, 2001, for ENBP was based on consultations with communities affected by tsunami, literature reviews, and correlation studies of occurrence of earthquakes and volcanic eruptions.

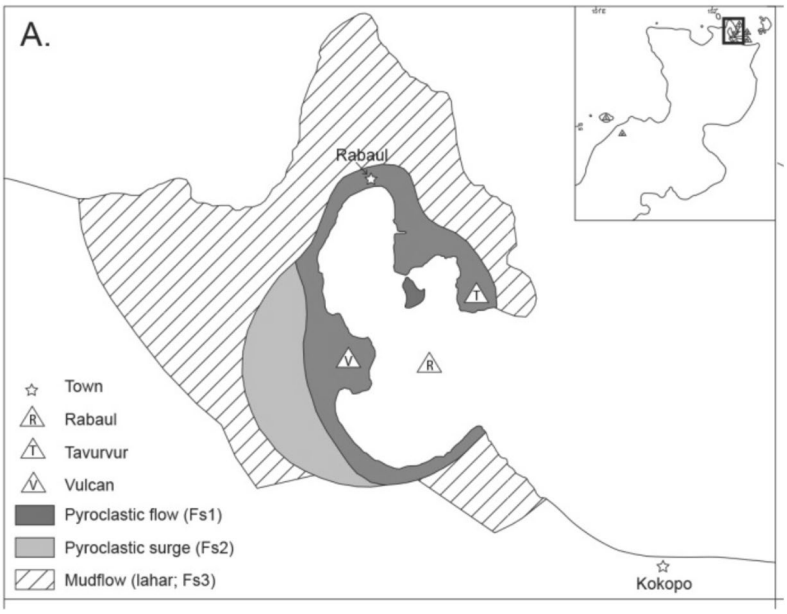
East New Britain is considerably vulnerable to major tsunamis. Major factors making tsunamis include 1) high seismicity in the region, 2) the presence of active volcanoes in the region and 3) other factors such as coastal and submarine landslides and submarine volcanoes.

This assessment report suggested that the absence of necessary scientific data, such as detailed bathymetry maps covering the coast areas of ENBP, and such data insufficiency limited the satisfactoriness of the Hazard Assessment Report 2001 for ENBP.

(5) Volcanic Flow (Pyroclastic Mudflow) Hazard Assessment

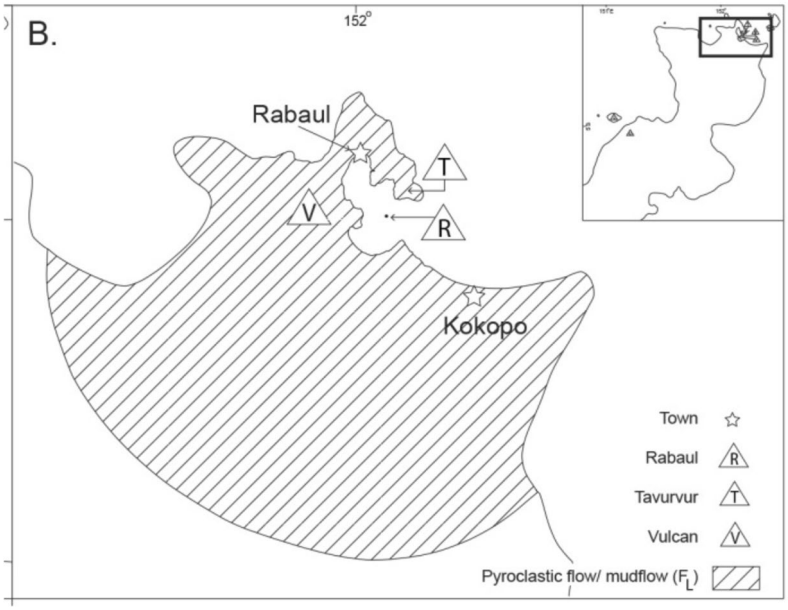
A local scale "volcanic flow" hazard (pyroclastic, mudflow) assessment was based on a GIS approach and previous eruptions focusing on the Gazelle Peninsula area.

Rabaul volcanoes' hazard maps on Pyroclastic Flow, Pyroclastic Surge and Mudflow are prepared for the two magnitudes of eruptions: small-moderate scale eruptions (SeeFigure 5.5) and moderate-large scale eruptions (See Figure 5.6).



Source: Moihoi et al., July 2013, "Integrating Hazard and Exposure for East New Britain," Geoscience Australia, Australian Government

Figure 5.5 Pyroclastic Flow, Pyroclastic Surge and Mudflow Hazard Zones for the Major Volcanic Centres of East New Britain Province: A. Flow Hazard Zones for Small-Moderate Scale Eruptions from Source Vents associated with Rabaul Caldera



Source: Moihoi et al., July 2013, "Integrating Hazard and Exposure for East New Britain," Geoscience Australia, Australian Government

Figure 5.6 Pyroclastic Flow, Pyroclastic Surge and Mudflow Hazard Zones for the Major Volcanic Centres of East New Britain Province: B. Flow Hazard Zone for Moderate-Large Scale Eruptions from Rabaul Caldera

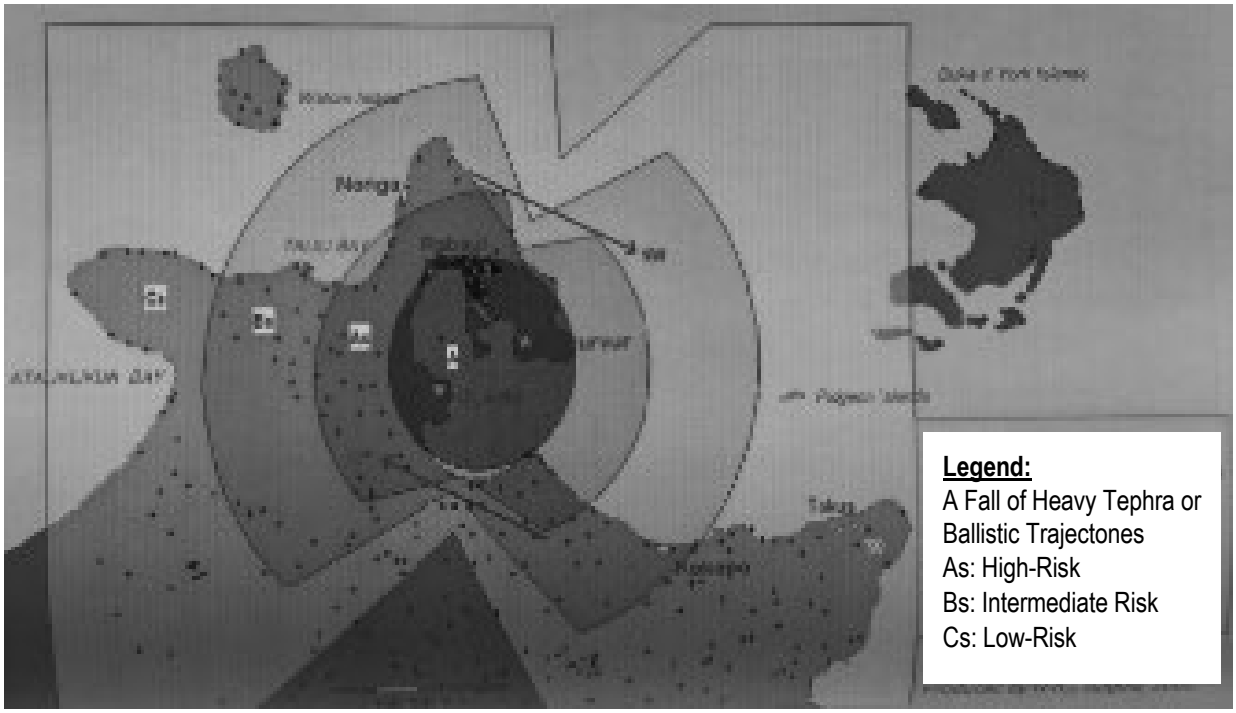
5.5 Volcanic Ash Hazard (Tephra[6] Fall Hazard)

After the 1994 eruption of twin volcanos in Rabaul, the following four hazard zones of Tephra Fall are considered in the Northeast Gazelle Peninsula as shown in Figure 5.7:

- A: Fall of Heavy Tephra or Ballistic Trajectones
- As: High-Risk

[6] The term 'Tephra' is used to describe all erupted clasts regardless of size, while the term 'ash' describes particles of less than 2 mm in size.

- Bs: Intermediate Risk
- Cs: Low-Risk



Source: Prepared by Rabaul Volcanic Observatory, August 2000

Figure 5.7 Rabaul Volcanic Ash Fall Hazard (Tephra Fall Hazard)

There are several kinds of hazard due to volcanic eruption, like lava flow, pyroclastic flow, ash fall and secondary hazard of ash-mad flow. Since lava and pyroclastic flows are devastating and limited to the close vicinity of caldera as shown in Figure 5.5 and Figure 5.6, volcanic ash hazard is considered for infrastructure plan.

From the simulated volcanic ash hazard results by a three-dimensional time-dependent model analysis, it is found out (as shown in Table 5.1) that Rabaul has a higher hazard than Kokopo and the other areas are lower than Rabaul and Kokopo in all wind conditions.

Table 5.1 Percentage Probability of Exceeding the Ash Load Thresholds

Ash Load	Wind	Rabaul (North)%	Kokopo (North)%	Western & Central Regions (%)
1kg/m^2	Apr-Sep	90-100	30-50	1-30
	Oct-Mar	90-100	60-90	10-80
10kg/m^2	Apr-Sep	90-100	20-40	1-20
	Oct-Mar	80-100	30-60	0-50
300kg/m^2	Apr-Sep	10-40	0-1	1-10
	Oct-Mar	0-30	0-10	0-10

Source: JICA Expert Team based on Moihoi et al., 2013, "Integrating Hazard and Exposure for East New Britain, "Geoscience Australia, Australian Governmen

5.6 East New Britain Provincial Disaster Management Plan 2022-2032

East New Britain Provincial Disaster Management Plan 2022-2032 (ENBP-DMP 2022-2032) is a general document based on a disaster risk reduction approach, as well as a multi-hazard risk approach.

The aim of this plan is to "enable ENBP to mitigate the effects of disaster events, prepare for these, respond to, recover from and build resilience to the disaster events."

The objectives of this plan are as follows:

- To develop and strengthen institutions, mechanisms and capacities at all levels, in particular at the community level, which can systematically contribute to building resilience to hazards.
- To foster effective integration of disaster and environmental risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis at the wards on disaster prevention, mitigation, and preparedness and vulnerability reduction; through mechanisms for coordinating DRR actions and budgetary assignation.
- To enhance systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programs in the reconstruction of affected communities.
- To describe the roles and responsibilities of disaster stakeholders to support disaster management as legislated in the Disaster Management Act 1984.

Disaster risks are summarised for each region of ENBP in Table 5.2.

Table 5.2 Summary of Disaster Risk Assessment in Six Regions in ENBP Based on Geology

REGIONS	GEOLOGICAL PARAMETERS	DEGREE OF STABILITY	RISK HIGH – 1 LOW – 4
1. Central Gazelle	Stanstone Hrd 3 Landslide Close vicinity of Baining Fault	WEAKLY STABLE TO MODERATELY UNSTABLE	3 – 2
2. Northwest Gazelle	Rx Hrd =>6 Close vicinity of Baining Fault	MODERATELY STABLE	4
3. Northeast Gazelle	Very soft rock Hrd => 1 Vicinity of active R volcano Amplification of shockwaves Landslide, Subsidence Soil Erosion, 50km from active Weitin Fault	UNSTABLE	1
4. Southeast Gazelle	Intense faulting, Landslide Deeper earthquakes Coast is high risk of tsunami 50km from active Weitin	UNSTABLE	1
5. Wide Bay	Complex block faulting, Landslide Subsidence, High risk of tsunami	UNSTABLE	1
6. Pomio	High earthquake density Subsidence and landslide due to weathering of limestone	CHEMICALLY UNSTABLE	1

Source: GRA, 2002, Disaster Risk Assessment Report 2002

5.7 Rabaul Volcanological Observatory (RVO)

Rabaul Volcanological Observatory (RVO) was established as a national institution in 1940 following the eruption of Tavurvur Volcano in Rabaul in 1937. RVO started its function with monitoring of volcanoes in Rabaul. It expanded its responsibilities under the Department of Mineral Policy and Geohazards Management to the monitoring of other volcanoes in PNG after the disastrous eruption of Lamington in 1951.

While there are 15 active and 22 potentially active volcanoes in Papua New Guinea, RVO is monitoring seven active volcanoes due to shortage of resources including funding, manpower and monitoring equipment.

RVO started its engagement with ENBP in Rabaul, in 1983 following the start of Rabaul volcanic crisis in March 1983. An Act of Parliament on establishment of Provincial Disaster Committees in Papua New Guinea. East New Britain Provincial Disaster Committee was established following the act in the first time.

The collaborative and coordinative work between RVO and the ENB Provincial Disaster Committee lead to the preparation of the first volcanic disaster-evacuation plan in Papua New Guinea.

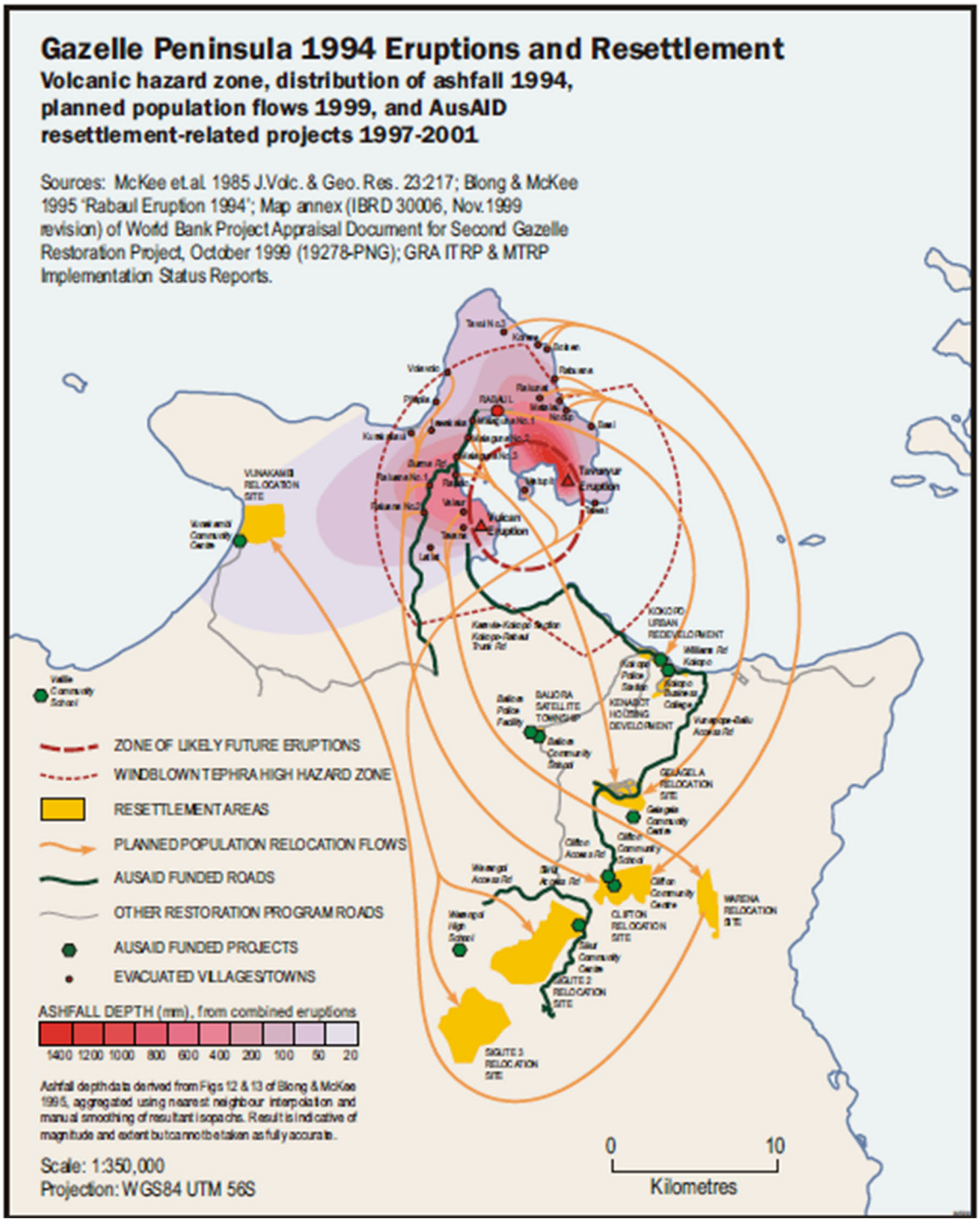
The completion and launching of the disaster/evacuation plan was followed by preparedness activities including evacuation exercises in coordination with the newly established Provincial Disaster Committee in anticipation for an eruption in Rabaul.

This kind of engagement and collaborative relationship between provincial authorities and RVO was later expanded to other provinces that have volcanoes.

5.8 Resettlement Areas for Affected Communities of 1994 Volcanic Eruptions in Northeast Gazelle Peninsula

With the external assistance of AusAID, ADB and WB, the Government of PNG had developed resettlement sites for affected communities, as shown in Figure 5.8.

Resettled people and households have kept lands in their original home villages, as well as provided lands in resettlement areas.



Source: Scales, Ian, April 2010, Roads in Gazelle Peninsula Development: Impact of Roads in the Post-Eruption Economic Landscape of East New Britain, AusAID, Canberra

Figure 5.8 Resettlement Areas for Resettlement-Related Projects, 1997-2001, After the 1994 Volcanic Eruptions in Northeast Gazelle Peninsula

PART IV Visions, Socio-Economic Framework, and Basic Development Strategies for Northeast Gazelle Peninsula

Chapter 6 Visions and Strategies for Regional Development of Northeast Gazelle Peninsula

6.1 Overall Issues

Based on the present situation, the following overall issues are identified for the region of Northeast Gazelle Peninsula:

- The land and other resources in Northeast Gazelle Peninsula region have not been fully and efficiently utilised for developing economic sectors due to ageing, deteriorated condition, or underdeveloped infrastructure.
- Since low-density population is spread over a wide area in the Northeast Gazelle Peninsula region, it is not possible to provide a dense and extensive road network to fully cover and efficiently utilise the region as a whole.
- The small population and economic agglomeration make it costly and inefficient to expand and upgrade the existing infrastructure.
- Growth potential of individual economic sectors is constrained by the relatively small population and economic agglomerations in the region, as well as by insufficient infrastructure.
- The area near Rabaul in the Northeast Gazelle Peninsula has a risk of being affected by volcanic eruptions and there is a landslide hazard due to weathering of volcanic rocks and ash fallout from volcanic eruptions.
- After the 1994 volcanic eruption, Rabaul Airport and the ENBP provincial capital functions were relocated to Kokopo area, but Rabaul Port, the province's primary port, was not relocated and remains at risk of damage from volcanic eruptions. (During the 1994 volcanic eruption, thick layers of volcanic ash that had fallen on the slopes caused landslides due to rainfall, resulting in damage such as the cutting off of access roads to Rabaul Port from surrounding areas.)
- Resilient spatial structure and infrastructure of the region have not been well prepared yet.
- As a result, it is not easy to attract public investment to infrastructure to support economic sectors in the region, despite having relatively good development potential endowment. Moreover, it is not easy to attract private investment to economic sectors in the region.

6.2 Visions, Objectives and Strategies for Regional Development of Northeast Gazelle Peninsula

6.2.1 Future Visions for Regional Development of Northeast Gazelle Peninsula

The following vision statement is adopted for Northeast Gazelle Peninsula: [7]

> Northeast Gazelle Peninsula will become “Nation's most liveable, resilient and enterprising region with sustainable infrastructure for economic growth.”

[7] In the course of the Project, Vision of NEGID-Plan has been discussed by PIU Core Members, the Joint Working Group and the Steering Committee.

6.2.2 Development Goals and Objectives for Regional Development of Northeast Gazelle Peninsula

(1) Goals for Development in the Region

To achieve the visions proposed above, the following set of goals is required:

- [Formal Economy] Development of prosperous economies for creating employments. Especially for the economic growth, it is necessary to develop diversified productive and export-oriented economies (agriculture, forestry, fishery, manufacturing, and tourism) based on land and marine resources, as well as rich cultures.
- [Subsistence and Informal Economy] Inclusive development should be promoted by paying attention to both subsistent agriculture and informal economies in addition to export-oriented economies in the region.
- [Resilience] Enhancement of resilience against various disasters in economic sectors, spatial structure and infrastructure.
- [Social Well-being] Maintaining social well-being based on family and community ties.
- [Environment] Sustainable management of natural environment and natural resources including lands and sea.

Based on these resources, the region's economic sectors have good potentialities to seek high-value addition by developing manufacturing and services industries. These development vision and goals will be supported by the Northeast Gazelle Peninsula's strong hub function of maritime and air transport (international and domestic).

(2) Overall Objectives of Development in the Region

The following overall development objectives are proposed for achieving the visions described above:

- To create a socioeconomic policy environment enabling the sustainability and prosperity of both export-oriented economies and family-based subsistence or informal economies
- To seek economic sectors development by widely and efficiently utilising regional products of land, marine and other natural resources, as well as cultural resources
- To make a challenging effort in developing new economic sectors, such as processing industries and upgrading tourism products, by using regionally available products and resources (including unprocessed materials of agricultural, forestry, and fisheries sectors) and by producing tourism products targeting diversified segments of international tourist market, including the high-end segment)
- To transform spatial structure for enhancing resilience against various disaster hazards and for promoting wide and efficient utilisation of land and other natural resources in the region
- To promote sustainable management of natural resources and natural environment of land and sea

6.2.3 Development Directions and Strategies for Northeast Gazelle Peninsula

(1) Formulation of Regional Development Strategies: How to Compose Regional Development Strategies for Northeast Gazelle Peninsula

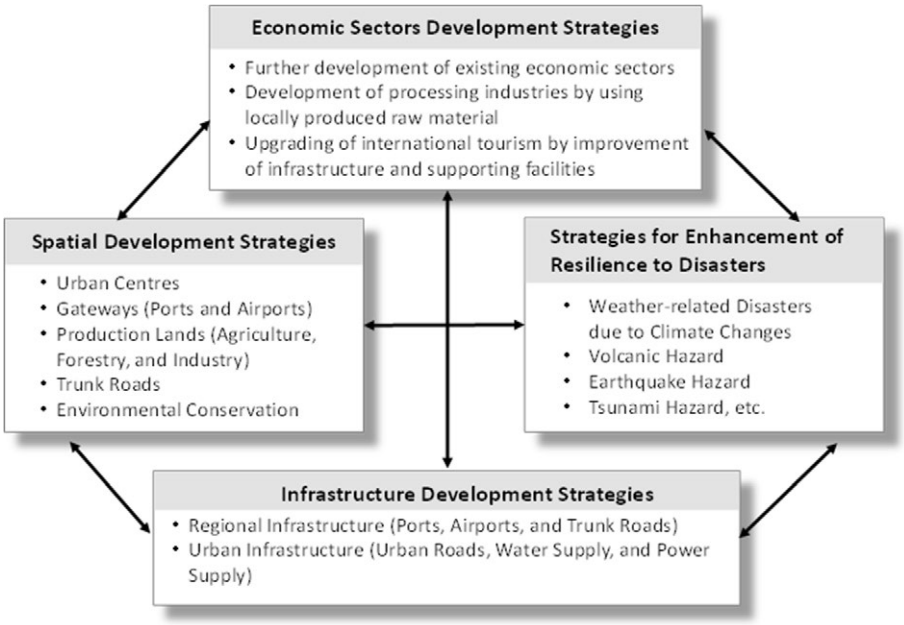
1) Aspects to Be Considered in the Formulation of Regional Development Strategies

Based on the understanding and recognition of the SWOT of the region, the following aspects will be considered in the process of composing/formulating components of regional development strategies:

- Basic Directions and Strategies for Development of **Economic Sectors** in the Region
- Basic Directions and Strategies for **Spatial Development** (including spatial utilization from viewpoints of natural environmental conservation) in the Region
- Basic Directions and Strategies for Enhancement of **Resilience to Disaster Hazards/Risks** (including considerations of intensification and increased frequency of weather-related disasters due to climate changes) in the Region
- Basic Directions and Strategies for **Phased Development** in Timeframe
- Basic Directions and Strategies for **Infrastructure Development** in the Region

The first 5 aspects, namely: (1) economic sectors, (2) space (including viewpoints of natural environmental conservation), (3) resilience against disasters (including viewpoints of climate change strategies), and (4) phased development, will guide the formulation of infrastructure development strategies.

The relationship among the major aspects to be considered in formulating regional development strategies is shown in Figure 6.1.



Source: JICA Expert Team

Figure 6.1 Major Aspects and Relations Considered in Formulating Regional Development Strategies in Northeast Gazelle Peninsula

(2) Basic Directions and Strategies for Development of the Economic Sectors in the Region

There are two basic development directions and strategies in economic sector development in the region:

- Development directions and strategies for promoting **further development (expansion) of existing economic sectors**, including the following production activities (by rehabilitating and upgrading existing infrastructures):
  - Production of export-oriented agricultural and forest products (copra, cacao, palm oil, balsa, etc.)
  - Fishing of tuna in Bismarck Sea
  - Cruise ship tourism targeting Rabaul volcanoes, cultural tourism, and war relic tourism
  - Marine nature tourism including dolphin watching, snorkeling, scuba diving and sport fishing

- Development directions and strategies for promoting processing industries by using locally produced raw materials and upgrading international tourism by improvement of urban infrastructure and supporting facilities
  - Agro-processing and forest processing industries by using locally produced copra, cacao, palm oil, balsa, tropical timber, etc. including the raw materials produced in surrounding island provinces
  - Fishery processing industries using tuna caught in Bismarck Sea
  - Upgrading of international tourism attractions and destinations by improving tourist infrastructure (hotels and conference centres) and supporting facilities (rest facilities, toilets and streets for walking)

It is easier to select and promote the basic directions and strategies of development in existing economic sectors, including production of export-oriented agricultural and forest products (copra, cacao, palm oil, balsa, etc.), than selecting and promoting other basic directions and strategies (e.g., promotion of attracting investments in processing industries of agricultural and forest products, as well as fisheries products). The impact of this development direction/strategy based on the existing economic sectors will gradually become lesser in the course of development.

On the other hand, it is more difficult or challenging to implement measures or strategies towards investment promotion to new economic sectors, especially to processing industries, than the efforts at further development of existing economic sectors. Once it is successful to attract investments to the processing industries, its impact on economic development is large and extensive in the region.

However, without any substantial intervention related to economic sector development, the gradual decline or stagnation in growth is expected to happen in the region. When either one direction of the above two directions/strategies is selected and implemented, it is uncertain if development results would be better.

Under such uncertain situations in the Northeast Gazelle Peninsula, it is wise and better to take actions in both directions. Fortunately, both of these directions and strategies are related to each other.

(3) Basic Strategies for Spatial Development in the Region

The spatial structure (spatial pattern) of the region is composed of the following things/functions:

- Urban Centres of Different Functions and Hierarchies (Primary Urban Centres, Secondary Urban Centres and Tertiary Urban Centres)
- Gateways for Inter-Regional Transportation (Ports and Airports)
- Agricultural Production Lands, Forestry Production Lands, and Industrial Parks
- Trunk Roads Connecting Important Functions, such as Urban Centres, Primary Gateways, and Productive Lands

Some of these functions are variable. It is possible to change the status of urban functions or gateways by changing hierarchical functions of different urban centres or location of ports or airports.

For example, the provincial capital of ENBP was relocated from Rabaul Town to Kokopo Town after the 1994 volcanic eruptions because Rabaul Town was heavily damaged and the provincial capital function needs to be reconstructed somewhere in a safe place.

Another example is the gateways (ports and airports) for inter-regional transportation which can be relocated for some reasons. Damaged by the 1994 volcanic eruptions, Rabaul Airport was relocated to Tokua Area. Now, the future location of Rabaul Port functions is under discussion/consideration among concerned agencies considering volcanic disaster hazards.

Depending on the spatial structure (spatial patterns) in the region, it is possible to put different service levels or development levels of trunk roads. With that, when urban centres and gateways are relocated, it will be necessary to change the function level of trunk roads. When some areas receive SEZs for processing industries, the function levels of some trunk roads connecting the SEZs and a regional gateway port or a regional gateway airport can be re-classified as different function levels of trunk roads.

Overall vision and goal of the region is to seek economic sector development, as well as social development, sustainably, inclusively and resiliently.

For seeking this vision and goal, given the limited lands and natural resources in the region, and considering the limited government budgets for infrastructure for the region, it is necessary to wisely and efficiently utilise not only available lands and natural resources, but also available/existing infrastructures of transportation and urban centres, including the existing spatial structure (spatial pattern) of the region.

The actual consideration of future spatial structure of the region will be discussed in Section 9.3.

(4) Basic Strategies for Enhancing Resilience Against Disasters in the Region

The Northeast Gazelle Peninsula is prone to various disaster hazards including the following:

- Geological Hazard (Subsidence and Landslides)
- Earthquake Hazard
- Volcanic Hazard (Pyroclastic Flow and Volcanic Ash)
- Sediment Disaster Hazard
- Flooding Hazard

To reduce disaster risks, it is essential to take the following three types of mitigation measures:

- Enhancing people's awareness of potential disaster hazards and risks, and preparing for responding to avoid disaster hazards and risks by emergency response (evacuation to safer places) and by selecting to reside in safer areas
- To strengthen the physical structure of infrastructure and residential buildings against disaster hazards (especially earthquake, volcanic ash, and sediment disaster)
- To transform the spatial structure (spatial pattern) of the region by relocating important functions to safer areas and for improving redundancy of infrastructure networks

The third aspect above is considered in spatial development strategies and future spatial structure of the region. The transformation of regional spatial structure for enhancing resilience against different disaster hazards is to be considered not only by relocation of important functions, such as urban centres and transport gateways (ports and airports), but also by restructuring the trunk road network in the region. Information and knowledge on disaster hazards and risks have been accumulated and ideas on mitigation measures to be taken have been regionally available. However, since port relocation and road network restructuring for regional spatial structure transformation require a lot of funds to be invested in infrastructure, it takes time for their realisation. Such spatial structural transformation should be incorporated in the spatial development strategies in the region.

(5) Time Framework: Phased Development

Under limited regional resources, including government budgets and private sectors' investment capacities, it is impossible to implement necessary projects (to do everything necessary) from public sector investment in infrastructure provision to private sector investment in economic sectors for driving development in the region. It is inevitable to select certain actions and a limited number of interventions under constraints of government budgets and private investments.

Taking advantage of any good opportunities for economic sector development in timely manner, it is essential for the region to be strategically prepared for selected infrastructure, by which to take a chance for economic sector development by receiving private investments in economic sectors.

Then, which infrastructure development or rehabilitation is more important or more strategic for promoting subsequent development of economic sectors should be considered and determined for infrastructure development planning.

Chapter 7 Future Socio-economic Framework for Northeast Gazelle Peninsula

7.1 Population of Northeast Gazelle Peninsula

(1) Population Data of Northeast Gazelle Peninsula and ENBP

The population data of Northeast Gazelle Peninsula and ENBP in 2000 and 2011 are shown in Table 7.1. The population of Northeast Gazelle Peninsula was 198,745 with an annual growth rate of 3.5% between 2000 and 2011. This growth rate was slightly lower than the growth rate of ENBP (3.7%), which had a population of 328,369 in 2011[8].

The growth rate of the population varied across the different districts. Between 2000 and 2011, Kokopo District showed a growth rate of 3.8%, Rabaul District had 3.5%, while Gazelle District had 3.4%.

Table 7.1 Population in Northeast Gazelle Peninsula and ENBP (2000 and 2011)

District/LLG	2000	2011	Annual Growth Rate (%) (2000-2011)	Share (%) in ENBP Population (2011)
East New Britain Province	220,133	328,369	3.70	100.0
Kokopo District	58,345	87,829	3.79	26.7
Bitapaka Rural LLG	14,766	23,116	4.16	7.0
Duke of York Rural LLG	10,292	14,009	2.84	4.3
Kokopo/Vunamami Urban LLG	19,933	31,965	4.39	9.7
Raluana Rural LLG	13,354	18,739	3.13	5.7
Rabaul District	27,048	39,387	3.48	12.0
Balanataman Rural LLG	12,869	19,621	3.91	6.0
Kombiu Rura LLG	8,044	11,583	3.37	3.5
Rabaul Urban LLG	3,907	4,785	1.86	1.5
Watom Island Rural LLG	2,228	3,398	3.91	1.0
Gazelle District	89,776	129,317	3.37	39.4
Central Gazelle Rural LLG	21,140	28,075	2.61	8.5
Inland Baining Rural LLG	18,628	26,826	3.37	8.2
Lasul Baining Rural LLG	8,195	13,555	4.68	4.1
Livuan Rural LLG	21,659	13,485	2.68	4.1
Reimber Rural LLG		15,488		4.7
Toma Rural LLG	20,154	17,080	4.26	5.2
Vunadidir Rural LLG		14,808		4.5
Pomio District	44,964	71,836	4.35	21.9
Northeast Gazelle Peninsula	135,826	198,745	3.52	60.5
Outside Northeast Gazelle Peninsula	84,307	129,624	3.99	39.5

Note: 11 LLGs with underline are included in the Study Area (Northeast Gazelle Peninsula). In 2022, Livuan/ Reimber Rural LLG and Vunadidir/Toma Rural LLG have been divided into Livuan Rural LLG, Reimber Rural LLG, Toma Rural LLG and Vunadidir Rural LLG. The population at 2000 could not be divided for these LLGs so the population by LLG prior to 2022 is used.
Source: National Statistical Office, 2013, National Population & Housing Census 2011

(2) Population Distribution in Northeast Gazelle Peninsula

In 2011, among the 11 LLGs in Northeast Gazelle Peninsula, Kokopo/Vunamami Urban LLG had the largest population (31,965 or 16.1% of the total Northeast Gazelle Peninsula population); followed by Central Gazelle Rural LLG, Gazelle District (28,075 or 14.1%); and Bitapaka Rural LLG, Kokopo District (23,116 or 11.6%). The 2011 population data of Vunadidir/Toma Rural LLG and Luvuan/Reimber Rural LLG, which have been divided into four LLGs, were as follows:

[8] The most recent population census in Papua New Guina is planned to take place in 2024. The result is not yet available when preparing this report.

17,080 for Toma Rural LLG; 15,488 for Reimber Rural LLG; 14,808 for Vunadidir Rural LLG; and 13,485 for Livuan Rural LLG.

7.2 Economy of Northeast Gazelle Peninsula

(1) Gross Regional Domestic Product

According to the National Accounts Branch, Economics Statistical Division of NSO, the Gross Regional Domestic Product (GRDP) or the Gross Provincial Domestic Product (GPDP) is not estimated in PNG.

The Survey of Business Activities (SBA) by NSO is an annual survey to collect economic information from selected legal companies operating in the country. This collection is done to compile national accounts, in particular those measuring the Gross Domestic Product (GDP), along with other statistics. For example, in 2019, SBA covered four industries, namely: manufacturing, construction, transport and storage, and administrative and support services. Locations covered were Port Moresby, Lae, and Madang. A sample comprising of 300 companies was surveyed to which 187 companies responded.

While SBA has been run annually since 2015, in the future, NSO plans to run a Census of Business Activities (CBA) to take account of the business population in operation in PNG. A CBA may also provide an opportunity to capture accurate economic benchmarks, help measure across all industries in the country, and contribute to the estimation of the GRDP or the GPDP.

(2) Economically Active Population

In 2011, 75.7% of the employed population in the industrial sector of ENBP worked in the primary sector. Since in Northeast Gazelle Peninsula, 68.8% worked for the primary sector, the shares of secondary sector and tertiary sector were larger than those outside Northeast Gazelle Peninsula. Notably, the primary sector had the largest share of employed population in the industrial sector.

Table 7.2 Employed Population by Industrial Sector in ENBP (2011)

		Primary Sector	Secondary Sector	Tertiary Sector	Total
East New Britain Province	Economically Active Population	93,527	4,965	25,085	123,577
	Share	75.7%	4.0%	20.3%	100.0%
Northeast Gazelle Peninsula	Economically Active Population	49,455	3,946	18,458	71,859
	Share	68.8%	5.5%	25.7%	100.0%
Outside Northeast Gazelle Peninsula	Economically Active Population	44,072	1,019	6,627	51,718
	Share	85.2%	2.0%	12.8%	100.0%

Source: National Statistical Office, 2013, National Population & Housing Census 2011

7.3 Future Socio-economic Framework for Northeast Gazelle Peninsula

(1) National Population Projection

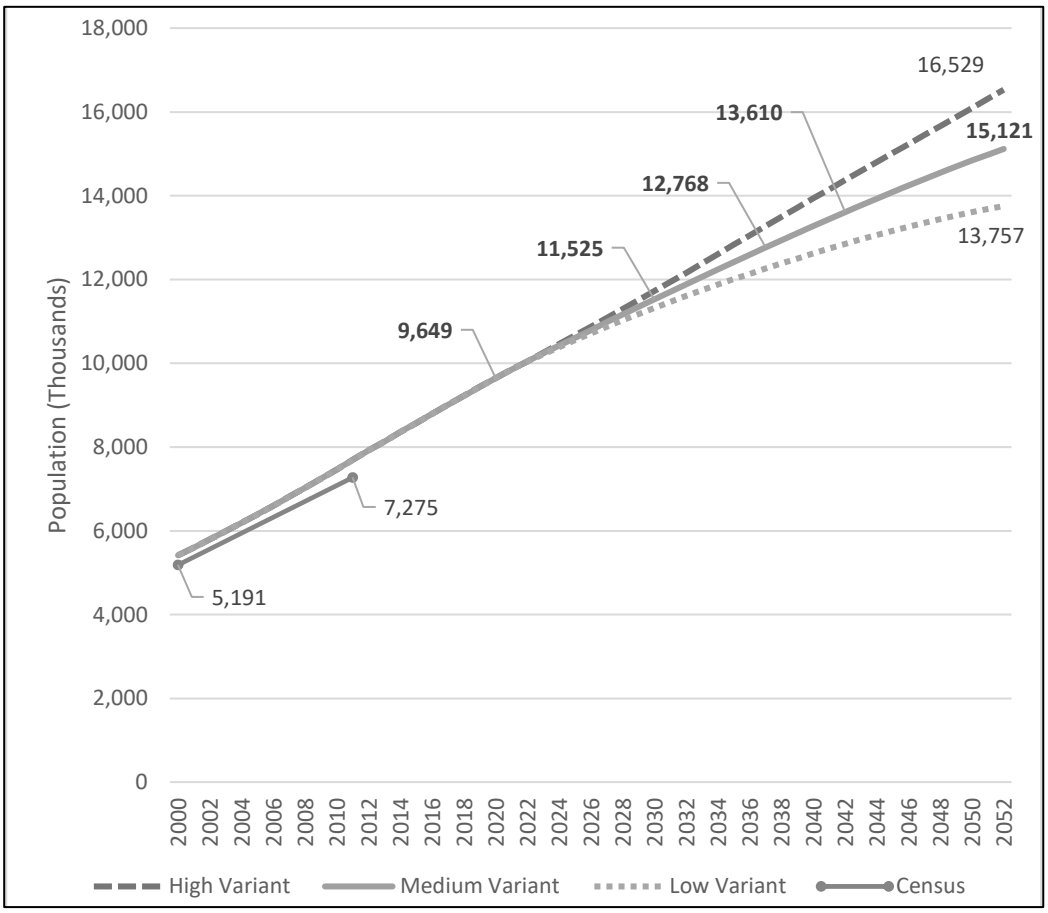
PNG's population reached 5,190 thousand in 2000 and 7,275 thousand in 2011 based on census data. The annual population growth rate was 3.1% between 2000 and 2011. According to the Papua New Guinea Development Strategic Plan (PNG DSP) 2020-2030 by the Ministry of National Planning and Monitoring, the population is projected to increase to 9.8 million in 2030. The PNG DSP states that the key to reducing population growth is to achieve reductions in the high fertility rate. Across the globe, developing countries that have educated their people and become prosperous middle-income countries have seen sharp reductions in fertility rates. This too will happen in PNG with fertility expected to fall in 2030 in line with the prosperity and education planned for under the PNG DSP, and with family planning.

On the other hand, the World Population Prospects 2022 of the United Nations shows three patterns of projections, namely: high-variant, medium-variant and low-variant between 2020-2100. The

population in 2022 is estimated to be 10,048 thousand with the annual growth rate of 2.45% between 2011 and 2022, using the population data in World Population Prospects.

According to the medium-variant projection, as shown in Figure 7.1, PNG's population will reach 11,525 thousand in 2030; 12,768 thousand in 2037; 13,610 thousand in 2042; and 15,121 thousand in 2052.

The population in 2052 reaches 16,529 thousand in high-variant projection and 13,757 thousand in low-variant projection.



Source: JICA Expert Team, based on World Population Prospects 2022 of the United Nations

Figure 7.1 Population Projections for PNG by UN between 2000-2052

By adopting the annual population growth rate used in World Population Prospects 2022, the population of PNG in 2022 is estimated to be 9,516,000, using the population of the 2011 population census result as the base population. The population in 2052 is projected to reach 15,971 thousand in high-variant projection; 14,635 thousand in medium-variant projection; and 13,315 thousand in low-variant projection, as shown in Table 7.3.

Table 7.3 Population Projection for PNG for NEGID-Plan (2000-2052)

	Population						Annual Growth Rate (%)				
	2000	2011	2022	2032	2042	2052	2000-2011	2011-2022	2022-2032	2032-2042	2042-2052
High Variant	5,190,786	7,275,324	9,516,000	11,634,000	13,827,000	15,971,000	3.12	2.47	2.03	1.74	1.45
Medium Variant	5,190,786	7,275,324	9,516,000	11,368,000	13,096,000	14,635,000	3.12	2.47	1.79	1.43	1.12
Low Variant	5,190,786	7,275,324	9,516,000	11,239,000	12,438,000	13,315,000	3.12	2.47	1.68	1.02	0.68

Note: Population data for the years 2000 and 2011, across three variants, are derived from the Census Data.
Source: JICA Expert Team

For the preparation of future population framework in NEGID-Plan, the medium-variant projection is adopted.

(2) Population Projection for Northeast Gazelle Peninsula

1) Current Population Projection

The ENBP Strategic Development Plan 2018-2022 states that the projected population in 2018 is 410,000. Thus, the annual growth rate between 2011 and 2018 is about 3.2%.

According to the NSO, the population of ENBP between 2011 and 2021 is projected to have an annual growth rate of 3.1% as shown in Table 7.4. The projected population will reach about 446,000 in 2021.

Table 7.4 NSO's Projected Current Population of ENBP

	2011	2016	2017	2018	2019	2020	2021	Annual Growth Rate 2011-2021
	Actual	Projection	Projection	Projection	Projection	Projection	Projection	
Population of ENBP	328,369	382,831	394,763	407,066	419,753	432,836	446,326	*3.1%*

Source: JICA Expert Team, based on NSO data

The 2022 population in each of the 11 LLGs is estimated in Table 7.5.

Table 7.5 Population by LLG in Northeast Gazelle Peninsula (2011 and 2022)

District	LLG	2011 (Census)	2022 (Projection)	Annual Growth Rate (2011-2022)	Share (%) of the Population in the Study Area (2011)	Share (%) of the Population in the Study Area (2022)
Kokopo	Bitapaka	23,116	30,400	2.52%	11.6	11.6
	Duke of York	14,009	15,800	1.10%	-	-
	Kokopo/Vunamami	31,965	43,300	2.80%	16.1	16.5
	Raluana	18,739	24,800	2.58%	9.4	9.4
Rabaul	Balanataman	19,621	25,900	2.56%	9.9	9.8
	Kombiu	11,583	15,100	2.44%	5.8	5.7
	Rabaul	4,785	6,400	2.68%	2.4	2.4
	Watom Island	3,398	4,300	2.16%	-	-
Gazelle	Central Gazelle	28,075	37,400	2.64%	14.1	14.2
	Inland Baining	26,826	31,900	1.59%	-	-
	Lasul Baining	13,555	18,500	2.87%	-	-
	Livuan	13,485	17,800	2.56%	6.8	6.8
	Reimber	15,488	20,400	2.54%	7.8	7.8
	Toma	17,080	22,300	2.45%	8.6	8.5
	Vunadidir	14,808	19,400	2.49%	7.5	7.4
Pomio	-	71,836	94,600	2.53%	-	-
East New Britain Province		328,369	428,300	2.44%	-	-
Northeast Gazelle Peninsula		198,745	263,100	2.58%	100.0	100.0

Sources 1 (Population 2011): National Statistical Office, 2013, National Population & Housing Census 2011; and JICA Expert Team, based on information from ENBPA and 2011 National Population & Housing Census Ward Population Profile
Sources 2 (Populaton 2022): JICA Expert Team, based on UN Population Prospects; and The National Research Institute Papua New Guinea, 2020, Provincial Estimates of Key Population Groups 2018-2022

2) Future Population Projection

The population by province is projected up to 2052 based on the population framework for PNG set above and considering the population trend in a long term.

The total projected population of ENBP is projected to become 524,500 in 2032; 618,600 in 2042; and 706,800 in 2052.

Based on the population census data in 2011, the future population of ENBP set above, considering the following aspects, the population of Northeast Gazelle Peninsula is projected by LLG between 2022 and 2052, as shown in Table 7.6. It is assumed that the total fertility rate will be gradually declining from 2022:

- Influences of demographic factors, such as the first-year single-age population
- Age-specific fertility rate, total fertility rate, and life expectancy
- Economic development planned in Northeast Gazelle Peninsula such as SEZ development

Table 7.6 Projected Population by LLG in Northeast Gazelle Peninsula (2032, 2037, 2042 and 2052)

District	LLG	Population						Annual Growth Rate		
		2011	2022	2027	2032	2042	2052	2022 -2032	2023-2042	2042-2052
Kokopo	Bitapaka	23,116	30,400	34,000	37,800	45,200	52,300	2.20%	1.80%	1.47%
Kokopo	Kokopo/Vunamami	31,965	43,300	49,000	55,300	67,900	80,700	2.48%	2.07%	1.74%
Kokopo	Raluana	18,739	24,800	27,800	31,000	37,300	43,400	2.26%	1.87%	1.53%
Rabaul	Balanataman	19,621	25,900	29,000	32,300	38,700	44,900	2.23%	1.82%	1.50%
Rabaul	Kombiu	11,583	15,100	16,800	18,600	22,000	25,200	2.11%	1.69%	1.37%
Rabaul	Rabaul	4,785	6,400	7,200	8,400	10,600	12,900	2.76%	2.35%	1.98%
Gazelle	Central Gazelle	28,075	37,400	42,000	47,100	57,000	66,800	2.33%	1.93%	1.60%
Gazelle	Livuan	13,485	17,800	19,900	22,700	28,300	33,600	2.46%	2.23%	1.73%
Gazelle	Reimber	15,488	20,400	22,800	25,900	32,100	37,900	2.42%	2.17%	1.67%
Gazelle	Toma	17,080	22,300	24,800	27,500	32,600	37,400	2.12%	1.72%	1.38%
Gazelle	Vunadidir	14,808	19,400	21,600	24,000	28,500	32,800	2.15%	1.73%	1.42%
Northeast Gazelle Peninsula		**198,745**	**263,100**	**294,900**	**330,600**	**400,200**	**467,900**	**2.31%**	**1.93%**	**1.58%**
Outside Northeast Gazelle Peninsula		198,745	165,200	181,900	193,900	218,300	239,000	1.61%	1.19%	0.91%
East New Britain Province		328,369	428,300	476,800	524,500	618,500	706,900	2.05%	1.66%	1.34%

Source: JICA Expert Team

The total projected population of Northeast Gazelle Peninsula is 330,600 in 2032; 400,200 in 2042 and 467,900 in 2052. This means that in 30 years, the population will have an increase of approximately 200 thousand.

In terms of LLG, by 2052, Kokopo / Vunamami is forecasted to have the largest population with 80,700; followed by Central Gazelle (Gazelle District) with 66,800; and Bitapala (Kokopo District) with 52,300.

(3) GDP Projections

Several GDP projections are seen in the existing plans as shown in Table 7.7. The projected figures may differ due to a variety of factors and conditions in the plans. According to the 2022 Budget Strategy Paper by the Department of Treasury, the annual growth rates from 2022 onwards are estimated at 3 or 4%.

Table 7.7 GDP Projections in the Existing Plans and Strategies

Plans/Strategies	Projected GDP growth rate	Remarks
PNG Vision 2050	Base-case: **4.5%** between 2010 and 2050, Base-case plus LNG development: **7.1%**	-
PNG National Strategic Plan (NSP) 2010-2030	**2.6%** between 2010 and 2020 without the implementation of NSP **8.4%** between 2010 and 2020 with the implementation of NSP	-
PNG Medium-Term Development Plan III 2018 -2022	GDP growth rate should be responded to the reduction of the population growth rate from 3.1% to 2.3%.	Sustained growth in the non-mining and petroleum sectors will be expected to grow GDP.
PNG 2022 Budget Strategy Paper, Department of Treasury	Estimated GDP growth rates are **-3.5%** in 2020, **1.7%** in 2021, **4.8%** in 2022, **2.7%** in 2025 and **3.7%** in 2027.	The growth rates between 2019 and 2023 are the same as those by IMF's World Economic Outlook, April 2022.

Source: JICA Expert Team based on various development plans

The GDP projections by IMF's World Economic Outlook. Estimates that the annual growth rate of GDP from 2024 onwards is at around 3%.

(4) Projection of Gross Regional Domestic Product (GRDP)

The result of the estimation is summarized in Table 7.8. According to this table, the GRDP of the study area amounted to about PGK 1,130 million (2013 constant prices) in 2011. This amount is 2.6% of the GDP of the whole country. This share is slightly lower than that of the population of the study area in PNG at 2.7% in 2011.

As for the broad economic sector, the share of the services sector is the highest at 57.3%, followed by the industry sector at 22.6%, the primary sector at 15.6%, and the mining & quarrying sector at 4.6%.

Table 7.8 Estimated GRDP of Northeast Gazelle Peninsula in 2011

Broad Economic Sector	GDP (2011) in the Whole Country		**Estimated GRDP of the Study Area (2011)**	
	PGK Million at Constant Prices	Share (%)	PGK Million at Constant Prices	Share (%)
Agriculture, Forestry and Fishing	8,503	*19.4*	**175**	***15.6***
Mining and Quarrying	7,068	*16.1*	**52**	***4.6***
Industry	5,966	*13.6*	**254**	***22.6***
Services and others	22,382	*51.0*	**646**	***57.3***
Gross Domestic Product	43,918	*100.0*	**1,128**	***100.0***

Source: JICA Expert Team

(5) Projection of the Future GRDP of Northeast Gazelle Peninsula

The future GRDP of Northeast Gazelle Peninsula is estimated by the economic growth rate of the broad economic sector. The estimation is based on the trend of the GDP in the whole country and the projections by the past plans and donor agencies. Also, the following analysis of Northeast Gazelle Peninsula is taken into account.

The agriculture sector still evolves around cocoa and copra although alternate crops such as vanilla, cardamon, and chillies, and garden food production for the local market is emerging rapidly. Steady progress on a medium or long-term basis will be expected. As for forestry, balsa is a fast-growing tree species, which suits the rich soil of the Northeast Gazelle. Growing and/or harvesting non-wood forest products have also potential. ENBP has extensive potential fisheries resources ranging from inland fisheries, aquaculture, large-scale deep-water tuna fisheries, and so on.

The manufacturing industry in the province is still small, but manufacturing finished products like coconut oil, cosmetic products and timber products are expected to grow. Also, the development of the Rabaul Tuna Export Processing Zone and the Gazelle Agro-Industry Special Economic Zone (SEZ) will become a driving force of the local economy on a mid-term basis. The mining industry in ENBP is mainly quarrying, which involves gathering sand, gravel, and rocks from rivers side and crushing them for road and building aggregation and construction. In recent years there have been some activities in the Wild Dog Gold Mine in the Baining area of the Gazelle Peninsula, but these activities are not counted for the future GRDP since the site is located outside Northeast Gazelle Peninsula.

Northeast Gazelle Peninsula has a unique and diversified tourism product with its natural, socioeconomic, political environment and its history. Thus, the growth of tourism services will be expected in the medium-term basis after the end of the COVID-19 pandemic.

In conclusion, as shown in Table 7.9, the total GRDP amounts to PGK 6,015 million (2013 constant prices) in 2052. In other words, the value of GRDP of the Northeast Gazelle Peninsula rises from PGK 1,508 million in 2022 to PGK 6,015 million (almost quadruple increase) in 2052 with an annual growth rate of 4.7%.

As for the composition of the broad economic sector in 2052, as shown in Table 7.9 and Figure 7.2, the services sector shows the highest share at 58.1%, followed by the industry sector at 27.5% and the agriculture, forestry, and fishing sector at 12.5%, respectively.

Table 7.9 GRDP Projection of Northeast Gazelle Peninsula by Broad Economic Sectors in 2022-2052

(1) Value of GRDP by Broad Economic Sector in Northeast Gazelle Peninsula

Unit: PGK Million at constant prices (2013 prices)

Sector	2011	2017	2022	2027	2032	2037	2042	2052	Share (%) of GRDP in 2052	Annual Growth Rate (%) 2022-52
Agriculture, Forestry and Fishing	175	209	243	288	342	417	507	750	12.5	3.83
Mining and Quarrying	52	59	65	71	79	87	96	117	1.9	2.00
Industry	254	287	332	404	516	690	924	1,654	27.5	5.50
Services and others	646	749	868	1,056	1,316	1,680	2,144	3,493	58.1	4.75
Gross Regional Domestic Product (GRDP)	1,128	1,303	1,508	1,820	2,253	2,874	3,671	6,015	100.0	4.72

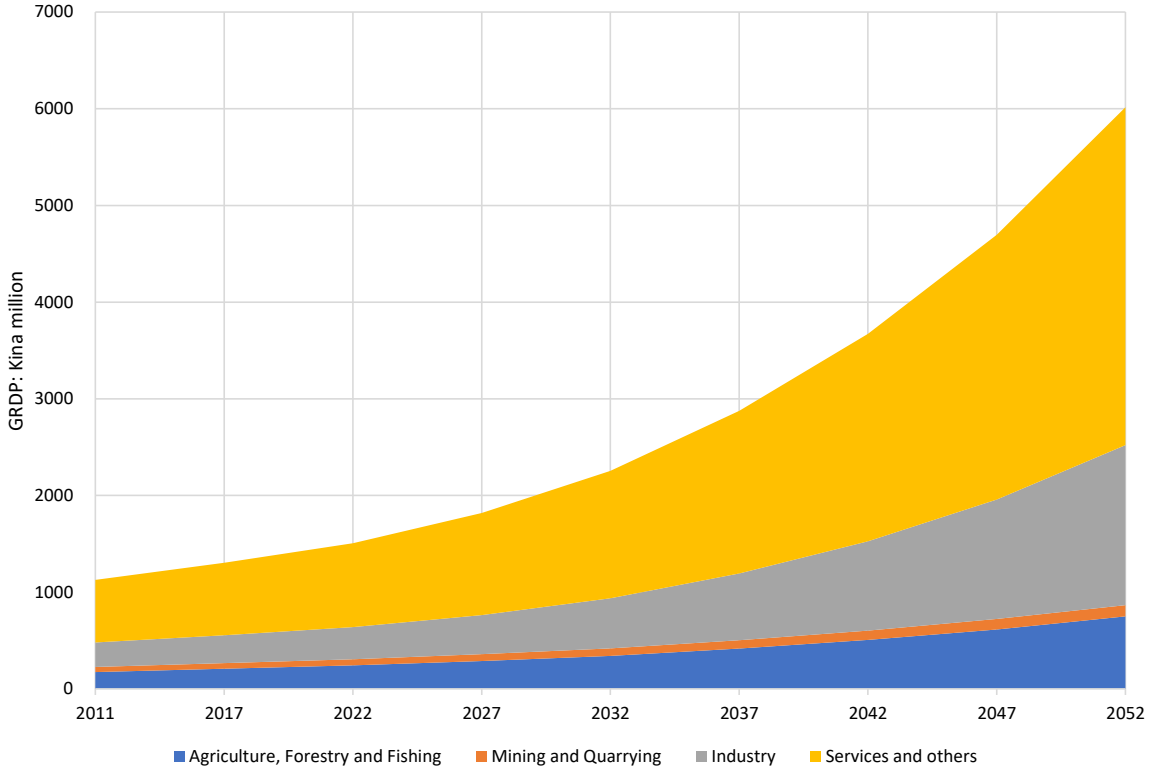
(2) Annual Growth Rate (%) of GRDP by Broad Economic Sector in Northeast Gazelle Peninsula

Sector	PNG 2011-2019	2011-2017	2017-2022	2022-2027	2027-2032	2032-2037	2037-2042	2042-2052
Agriculture, Forestry and Fishing	2.87	3.0	3.0	3.5	3.5	4.0	4.0	4.0
Mining and Quarrying	14.88	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Industry	-1.67	2.0	3.0	4.0	5.0	6.0	6.0	6.0
Services and Others	2.47	2.5	3.0	4.0	4.5	5.0	5.0	5.0
Gross Regional Domestic Product (GRDP)	5.17	2.4	3.0	3.8	4.4	5.0	5.0	5.1

(3) GRDP per Capita in Northeast Gazelle Peninsula

	Unit	2011	2022	2027	2032	2042	2052	Annual Growth Rate 2022-2052
Population	Persons	198,745	263,100	294,900	330,600	400,200	467,900	1.94%
GRDP	PGK Million at Constant Price	1,128	1,508	1,820	2,253	3,671	6,015	4.72%
GRDP per Capita	PGK at Constant Price 2013	5,676	5,732	6,172	6,815	9,173	12,855	2.73%

Source: JICA Expert Team



Source: JICA Expert Team

Figure 7.2 Projected GRDP by Broad Economic Sector in Northeast Gazelle Peninsula

PART V Development Strategies for Economic Sectors of Northeast Gazelle Peninsula

Chapter 8 Development Strategies for Economic Sectors of Northeast Gazelle Peninsula

8.1 Issues on Development of Economic Sectors

The issues and directions for individual economic sectors in Northeast Gazelle Peninsula are identified and summarised in the table below:

Table 8.1 Expected Directions of Economic Development by Subsector

Agriculture	
Cocoa	• Further recovery and increase of cocoa production through replanting of cocoa, introduction of disease-resistant varieties, and improved management of cultivation • Improving product quality by improving local drying processes • Increase income of cocoa farmers through promotion of intercropping with other cash crops, such as galip nuts. • Initiate business activities through the formation of cluster groups of cocoa producers (small-scale entry into the cocoa bean processing industry). • Attracting cocoa bean processing industry to Gazelle or Kokopo (cocoa butter, chocolate, etc.). • Collaboration with the Gazelle Agro-Industrial Special Economic Zone for the promotion of agro-processing.
Coconut	• Increase coconut production through improved seedling distribution and cultivation management. • Expansion of quality processing and white copra production through improved local drying processes. • Initiate business activities through the formation of cluster groups of copra producers (small-scale entry into agro-processing industry). • Attract coconut processing industry to Gazelle or Kokopo, support of existing SMEs including marketing support (virgin coconut oil, soap, shampoo, etc.). • Attract coconut oil mills (reconstruction). • Collaboration with the Gazelle Agro-Industrial Special Economic Zone in the promotion of agro-processing.
Coffee	• Expand coffee production through seedling distribution, technical assistance for cultivation, and improved access (construction of a feeder road). • Creation of added value through marketing development and grading by coffee factories in Kokopo. • Increase coffee bean collections for coffee factories by linking coffee farmers outside ENBP
Spices	• Quality improvement and market development through improved product processing such as drying, etc. • Development of agro-processing using spices (essential oils, etc.), support for SEM start-ups and market development. • Collaboration with the Gazelle Agro-Industrial Special Economic Zone concept in the promotion of agro-processing.
Palm Oil	• Facilitate the development of existing oil palm projects and mills in the province. • Expand production by developing oil palm plantations in harmony with local communities.
Small Livestock	• Expansion of small livestock production to improve local nutrition. • Development of the Gazelle hatchery and promotion of poultry meat production. • Development of the meat processing industry at the regional level.
Forestry	
Timber Production	• Ensure forest resource management and local community benefits through appropriate forest use agreements. • Promotion of downstream processing industries, such as sawn wood, other processed wood and furniture manufacturing.

Smallholder Balsa Growers and Balsa Plantations	• Establishment of a management system for smallholder balsa growers and balsa plantations (establishment of a Balsa Board and other administrative structures, establishment of private industry associations). • Coordination of farmland conflicts with traditional commodities, such as cocoa and coconut, as well as with food crops • Improvement of access through the development of road infrastructure.
Fisheries	
Tuna	• Creation of local fishery processing industries and employments ➢ Through the early realisation of the Rabaul Tuna Terminal Project (wharf and cold storage) ➢ By establishing the Rabaul Tuna Export Processing Zone adjacent to Rabaul Port ➢ By upgrading water supply and electricity supply to Rabaul Port • Efficient project implementation through coordination and collaboration of development initiatives and projects of related organisations.
Tourism	
Tourism	• Shift from a tourism destination that mainly focuses on volcanoes and cruise ship calls with supplementary tourism products, such as indigenous culture, military battlefield tourism, and marine nature tourism to a more diversified tourism destination • Upgrade tourism promotions and enhance the quality of tourism destinations by taking advantage of a variety of regional characteristics, such as volcano, culture, nature and history of the region.

Source: JICA Expert Team

8.2 Vision for Development of Economic Sectors

ENB Economic Development Plan 2003-2030 states that the vision for the economic sectors development is "for the creation of diversified economy, which is characterised by strong manufacturing and service industries including tourism, built upon a strong agricultural (other primary industries) foundation of the province and the New Guinea Islands."

ENBP Strategic Development Plan for 2011-2021 sets development goals for each subsector. The following is a listing of development goals for subsectors related to economic sectors.

- **Goal for Agriculture, Livestock and Forestry Subsectors:** Sustainably transform the Agriculture, Livestock and Forest Industries into vibrant and productive sector in preparation for downstream processing, manufacturing, and service industries. The establishment of which will be a means of growing the local economy.
- **Goal for Fisheries and Marine Resources Subsectors:** To develop the fisheries sector as an emerging industry capable of helping to grow the ENB economy.
- **Goal for Tourism Subsector**: Promote tourism as an alternative socioeconomic activity that has the potential to assist the local economy grow, improve living standards, and reduce poverty without negatively impacting culture and the environment.

8.3 Objectives for Economic Sectors Development

In the economic sector, the following two development objectives are set with a view to creating to a diversified economy, which is characterized by strong manufacturing and service industries including tourism, built upon a strong agricultural (other primary industries) foundation, and with a view to achieving sustainable development of both an export-oriented economy and a family-based subsistence farming or informal economy.

- To seek the expansion of economic sectors' production by widely and efficiently utilizing lands and other natural resources including marine and forestry resources
- To make a challenging effort at developing new economic sectors, such as processing industries and upgrading tourism products, by using regionally available products and resources (including unprocessed materials of agricultural, forestry, and fisheries sectors) and

by producing tourism products targeting diversified segments of international tourist market (including the high-end segment).

8.4 Strategies for Economic Sectors Development

The development strategies for the economic sectors are set out below, with two directions: the development and expansion of existing economic activities in the region, and the fostering new economic activities through the promotion of processing industries and the upgrading of international tourism.

(1) Development directions and strategies for promoting further development (expansion) of existing economic sectors, including the following production activities:

- Production of export-oriented agricultural products (copra, cacao, palm oil, balsa, etc.)
- Fishing of tuna in Bismarck Sea
- Cruise ship tourism targeting Rabaul volcanoes, cultural tourism, and war tourism
- Marine nature tourism including dolphin watching

(2) Development directions and strategies for promoting processing industries by using locally produced raw material and upgrading international tourism by improvement of infrastructure and supporting facilities:

- Agro-processing industries by using locally produced copra, cacao, palm oil, balsa, etc. including the raw materials produced in surrounding island provinces
  - By establishing an Agro-Industrial SEZ along Ataliklikun Bay in Gazelle District
  - By strategically providing access roads, water supply infrastructure, and power supply infrastructure to the prospective Agro-Industrial SEZ
  - By relocating part of port functions of Rabaul Port to Ataliklikun Bay
- Fishery processing industries using tuna caught in Bismarck Sea
  - By establishing a Tuna Processing SEZ near Rabaul Port
  - By strategically improving access roads, water supply infrastructure, and power supply infrastructure to the prospective Tuna Processing SEZ
  - By rehabilitating the existing infrastructure of Rabaul Port
- Upgrading of international tourism attractions and destinations by improving tourist infrastructure (hotels and conference centres) and supporting facilities (rest facilities, toilets and streets for walking)
  - By upgrading the current Tokua Airport to an international airport not only serving ENBP but also its surrounding island provinces
  - By promoting the development of airport city surrounding the prospective international airport of Tokua.

(3) Promotiong of foreign investment by designating and developing SEZs for the promotion of processing industries and upgrading international tourism

- To designate and develop strategic economic zones (SEZs) and promote the development of industrial infrastructure and facilities in order to promote the agro-processing, forestry and fish processing industries and international tourism, as noted in (2) above, by promoting investment from both domestic and foreign sources.

At the same time, to promote infrastructure development in urban areas where processing industries and tourist accommodation facilities are located

PART VI Present and Future Regional Spatial Structures and Urban Areas of Northeast Gazelle Peninsula

Chapter 9 Present and Future Regional Spatial Structure of Northeast Gazelle Peninsula

9.1 Objectives for Transforming the Regional Spatial Structure of Northeast Gazelle Peninsula

The objectives for transforming the regional spatial structure of Northeast Gazelle Peninsula region are as follows:

- To enhance disaster resilience of wide areas of the region by strategically selecting a location of a central port for Northeast Gazelle Peninsula and implementing the port relocation in a phased manner for reducing disaster risks, and by upgrading trunk roads in accordance with the transformed regional spatial structure
- To fully utilise wide areas of the territory and marine resources for strategically promoting the development of economic sectors in the region by establishing an extensive and upgraded network of trunk roads
- To establish growth areas consisting of government administrative functions, commercial and service functions, and manufacturing functions by providing urban infrastructures (urban roads, power supply and water supply facilities)
- To develop service centres to provide public services in a balanced way covering wide areas of the region

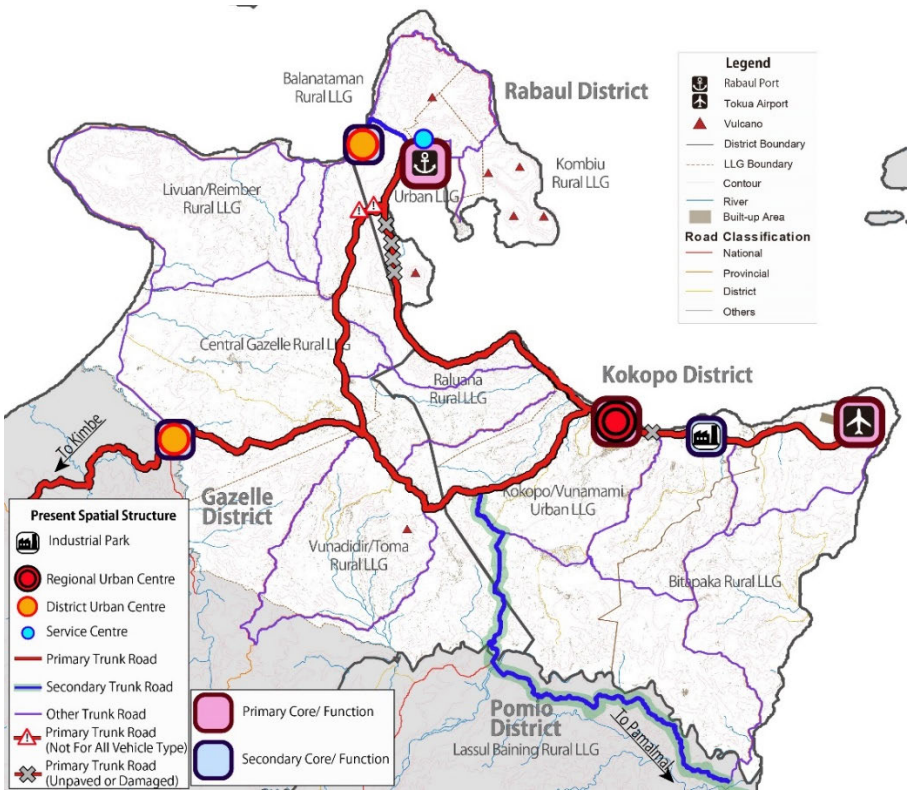
In this chapter, the future regional spatial structure is presented for the super long term. Moreover, the phased transformation plan for regional spatial structure is also discussed and presented. This plan is essential to guide the phased development of regional and urban infrastructures in Northeast Gazelle Peninsula.

9.2 Future Regional Spatial Structure of Northeast Gazelle Peninsula

9.2.1 Factors in Preparing Regional Spatial Structure

The present regional spatial structure (spatial pattern) of Northeast Gazelle Peninsula is drawn in Figure 9.1 by using regional gateways (port and airport), urban centres, as well as trunk roads.

Since Kokopo is not only the provincial capital of ENBP, but also the regional capital of Islands Region, it is a primary-level urban centre in Northeast Gazelle Peninsula. Rabaul Port and Tokua Airport are major inter-regional gateways with primary functions for serving the surrounding island provinces in Islands Region. Therefore, they should be considered as of the same grade as primary-level centres. These primary centres should be connected by primary trunk roads. However, the coastal road connecting Rabaul Port and Kokopo Town is partly not paved and damaged. Moreover, although an alternative road to the Kokopo-Rabaul Coastal Road was constructed, with the support of AusAID, inland to connect Rabaul Port and Kokopo Town, the inland road has a narrow and winding portion of steep slope.



Source: JICA Expert Team

Figure 9.1 Present Regional Spatial Structure of Northeast Gazelle Peninsula

The locations of inter-regional gateways (port and airport) and primary urban centres are also important factors in formulating the future regional spatial structure of Northeast Gazelle Peninsula. The location and the grade of these primary gateways and primary urban centres are important factors to determine the present and future regional spatial structure.

The grades of urban centres used in the future regional spatial structure are the following:

- Primary Urban Centre: Urban centre functioning as the regional and provincial administration capital with main commercial function
- Secondary Urban Centre: Urban centre with the function of district administration centre and some commercial functions
- Commercial Centre: Urban centre with major commercial function
- Service Centre: Centre with markets, shops, and other public facilities (schools and clinics)

In order to select the locations and grades of gateways (ports and airports) and urban centres, other factors such as redundancy, utilisation of land, and natural environment protection as tourism resources should be considered due to the characteristics of the region described in Section 4.1.

The regional spatial structure for Northeast Gazelle Peninsula for the target year 2032 was done, by first preparing regional spatial structure targeting 2052 as a super long-term spatial structure. This is because, a 10-year period is not long enough to consider changes in the spatial structure.

The super long-term regional spatial structure is prepared by assuming that necessary strategies for achieving the above development vision will be implemented in order. Therefore, the regional spatial structures for 2032 and 2042 are important milestones for achieving the regional future vision.

The future spatial structure is also formulated by considering the development of new planned SEZs, Gazelle Agro-Industry SEZ and Rabaul Tuna Export Processing Zone (or SEZ). The development of these SEZs will enable three regional growth areas to develop in Northeast Gazelle Peninsula: Kokopo Growth Area, Rabaul Growth Area and Kerevat Growth Area.

9.2.2 Future Regional Spatial Structures for Super Long Term

(1) Three Alternative Spatial Structures for Super Long Term

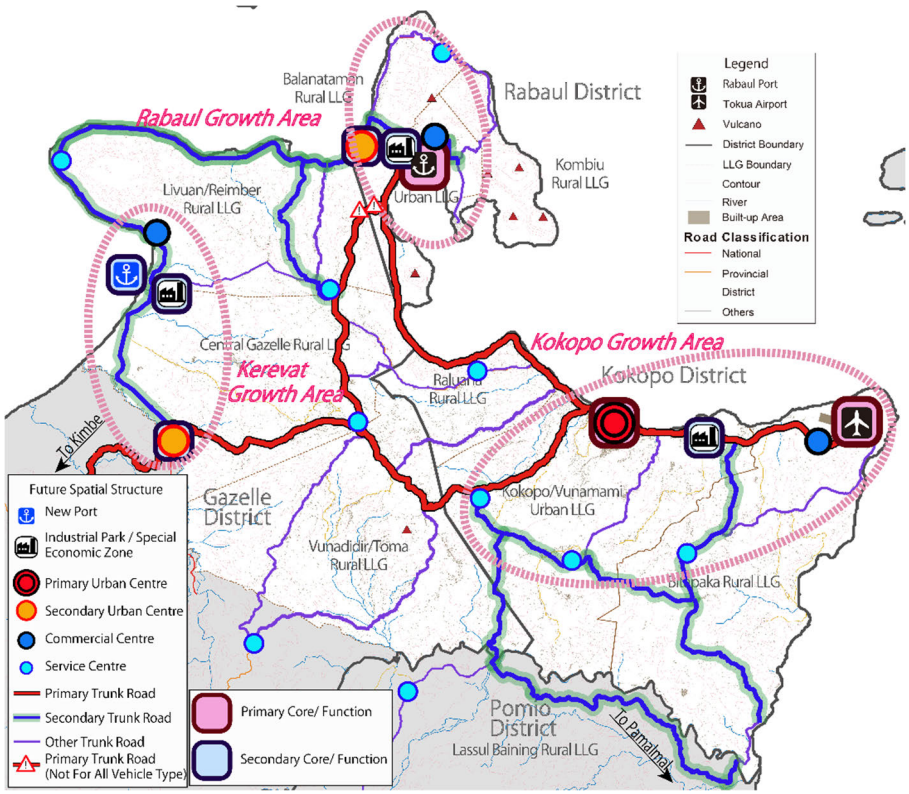
Three alternative spatial structures are prepared for the super long term for Northeast Gazelle Peninsula. How inter-provincial gateways (port and airport), urban centres and growth areas are laid out in each spatial structure are described in Table 9.1.

Table 9.1 Infrastructure, Gateways and Urban Centres in Alternative Regional Spatial Structures for the Super Long Term (2052)

	Regional Spatial Structure 1	Regional Spatial Structure 2	Regional Spatial Structure 3
Ports	• Rabaul Port will be rehabilitated and upgraded and continue to function as the main regional port. • A new port is developed at Ataliklikun Bay (in Gazelle District) as an alternative port of Rabaul Port. The new port will function as a port for SEZ and alternative port while Rabaul Port is not functional (due to volcanic eruptions, etc.)	• Rabaul Port will be rehabilitated, and part of the port function (handling bulk fuel, cruise ship calls, and fishing reefer ship calls) will remain in Rabaul. However, the main port function of handling container cargo and bulk cargo will be shifted to a new port. • A new container port will be developed at Kabakaul in Kokopo District.	• Rabaul Port will be rehabilitated, but its main port function will be shifted to a new port, while it will continue to function as the cruise ship terminal and fishing port. • The new port will be developed at Ataliklikun Bay (in Gazelle District) as an alternative port of Rabaul Port by 2042 and will be used as the port for SEZ and alternative port while Rabaul Port is not functional. However, Rabaul Port will continue to have the risk of being affected by volcanic eruptions. Therefore, the new port will be further developed to become the main port, with the main port function of handling container cargo, bulk cargo and bulk fuel will be shifted to Ataliklikun Bay.
Airports	• Tokua Airport will be upgraded and continue to function both as international and domestic airport.	• Tokua Airport will be upgraded and continue to function both as international and domestic airport.	• Tokua Airport will be upgraded and continue to function both as international and domestic airport.
Trunk Roads	• The coastal road between Kokopo and Rabaul will be rehabilitated by putting proper drainage, and necessary structure will be constructed in the road side slopes to reduce risks of landslide. • The road between Kurakakaul and Tokarongon Junction is upgraded to a secondary trunk road so that Rabaul Port is accessible from all areas of the region, even immediately after volcanic eruptions. • The road between Kerevat and a new port at Ataliklikun Bay will be upgraded to a secondary trunk road to access the new port. • The North Coast Road between Kurakakaul and Kabaira (in Ataliklikun Bay) will be upgraded to a secondary trunk road. • The road from Toma Junction to Tokua Airport via Bitapaka will be upgraded to a secondary trunk road.	• The road between Kerevat and new port at Ataliklikun Bay will be upgraded to a secondary trunk road. • The road from Toma Junction to Tokua Airport via Bitapaka is upgraded to a secondary trunk road. • The road between Bitapaka and Ulaveo is upgraded to a secondary trunk road. • The road between Gelagela and Vunapope is upgraded to a secondary trunk road. • The coastal road between Kokopo and Rabaul will become a secondary trunk road. It is because Rabaul Port is classified as the Secondary Gateway. In response, the main port function is shifted to the new port in Kokopo Area.	• The road between Kurakakaul and Tokarongon Junction is upgraded to a secondary trunk road so that Rabaul Town is accessible during volcanic eruptions. • The road between Kerevat and new port at Ataliklikun Bay will be upgraded to a primary trunk road to access the new container port. • The coastal road between Kurakakaul and new port at Ataliklikun Bay will be upgraded to a secondary trunk road. The road between Tokarongon Junction and new port will be upgraded to a secondary trunk road. • The road from Toma Junction to Tokua Airport via Bitapaka is upgraded to a secondary trunk road. • The coastal road between Kokopo and Rabaul will become a secondary trunk road.
Primary Urban Centre, Secondary Urban Centre, Commercial Centre and Growth Area	• Kokopo Town is a Primary Urban Centre since it is the provincial capital town. Kurakakaul and Kerevat Town are Secondary Urban Centres. • Commercial centres will be developed at Rabaul, Tokua and Kabaira, one in each growth area. • In each Growth Area, there will be an airport or seaport.	• Kokopo Town is a Primary Urban Centre since it is the provincial capital town. Kurakakaul and Kerevat Town are Secondary Urban Centres. • Commercial centres will be developed at Rabaul, Tokua and Ulaveo. • Commercialcentres will be developed at Rabaul, Tokua, and Kabaira. • The regional port and airport are concentrated in Kopopo Growth Area.	• Kokopo Town is a Primary Urban Centre. Kurakakaul and Kerevat Town are Secondary Urban Centres. • Commercial centres will be developed at Rabaul, Tokua and Kabaira, one in each growth area. • In each Growth Area, there will be an airport or seaport.

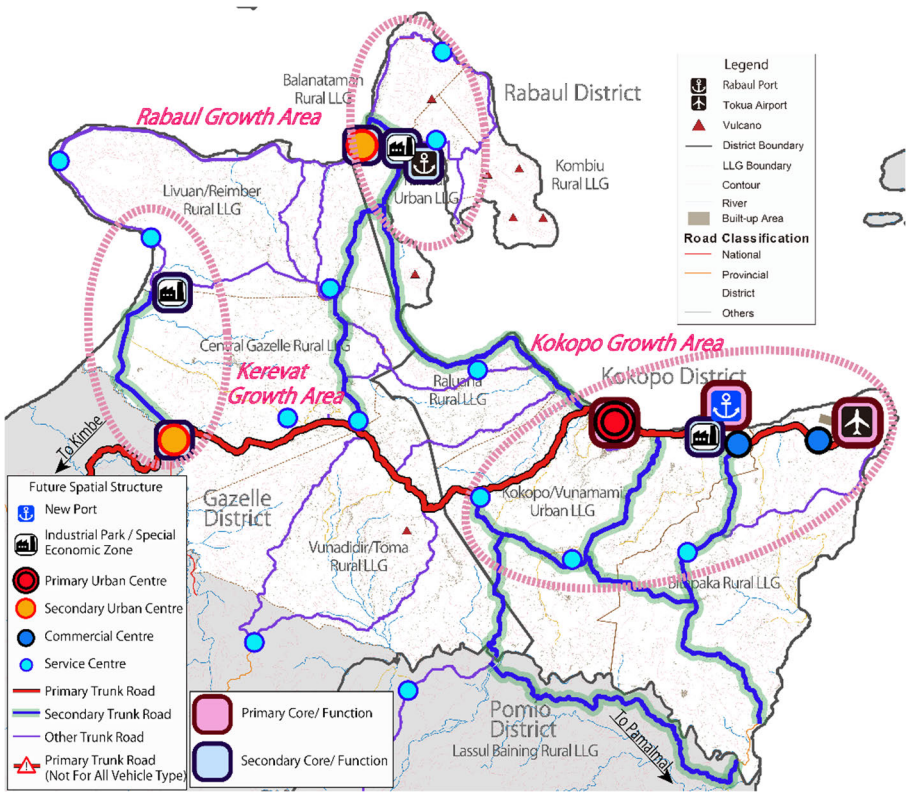
Source: JICA Expert Team

The alternative future regional spatial structures for super long term are shown in Figure 9.2, Figure 9.3 and Figure 9.4.



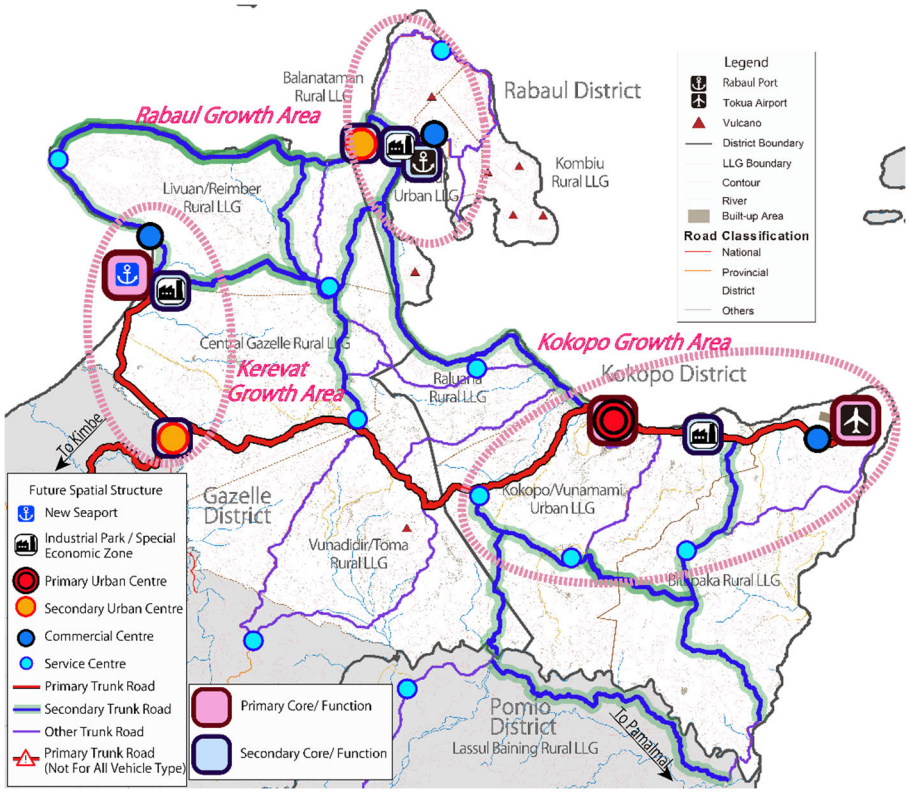
Source: JICA Expert Team

Figure 9.2 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 1



Source: JICA Expert Team

Figure 9.3 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 2



Source: JICA Expert Team

Figure 9.4 Future Regional Spatial Structure (2052) of Northeast Gazelle Peninsula for the Super Long Term: Regional Spatial Structure 3

(2) Selected Spatial Structure for the Super Long Term (2052): Spatial Structure 3

Among the three alternatives of regional spatial structures, Regional Spatial Structure 3 is proposed as the best option for Regional Spatial Structure 2052.

The NEGID-Plan formulation project is conducting an SEA study in parallel with the planning process, which is a comparative evaluation of three very long-term regional spatial development scenario alternatives from economic, spatial, social and environmental perspectives. See Table 20.4.1, 'Evaluation of regional spatial development scenario alternatives'.

Regional Spatial Structure 3 was selected for the following reasons:

- The three growth areas will be developed in a well-balanced way compared to the other two structures and will help the region to grow most efficiently with the most secondary roads developed.
- The new port is in a quiet harbour and is safe from waves and wind and has less risk of being affected by volcanic eruptions. The new port for the industry will also be away from Kokopo, where resort hotels are located.

(3) Phased Development Plan for the Selected Regional Spatial Structure 3

The phased development plan of the selected and proposed future Regional Spatial Structure 2052 (Regional Spatial Structure 3) is shown in Figure 9.5.

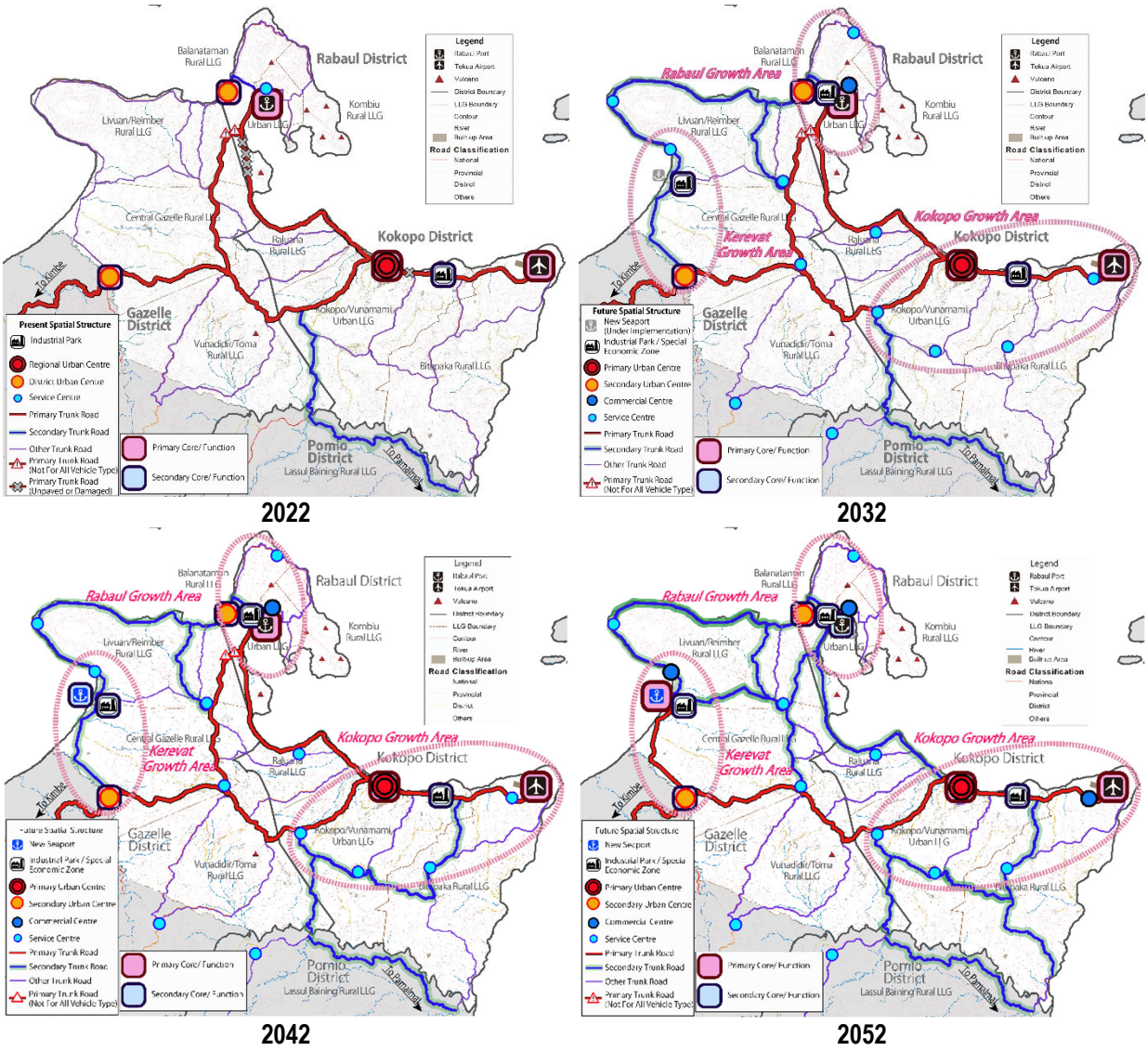
In 2032, Northeast Gazelle Peninsula is proposed to have the following new regional infrastructure:

- Rabaul Port will be upgraded to play the role as main port for the region at least for the next two decades.
- Preparation for the construction of the new port at Ataliklikun Bay will be conducted.
- Tokua Airport will be upgraded to accommodate international flights.

- Road connecting Kurakakaul- Tokarongon Junction will be upgraded as a Secondary Trunk Road.
- Road connecting Kabaira and Kerevat will be upgraded to a Secondary Trunk Road.
- Coastal road connecting Kokopo and Rabaul will be rehabilitated with proper drainage facilities.

Besides the above roads, the following centres and SEZs are proposed to be developed:

- Rabaul Town is developed as Commercial Centre.
- Tokua, Toma, Gelagela, Tokarongon, Kabaira and Rakuna will be developed as Service Centres.
- Rabaul Fish Export Processing Zone and Gazelle Agro-Industry SEZ will be developed.



Source: JICA Expert Team

Figure 9.5 Phased Development Plan of Regional Spatial Structures for Northeast Gazelle Peninsula (Regional Spatial Development Scenario): Selected Spatial Structure 3

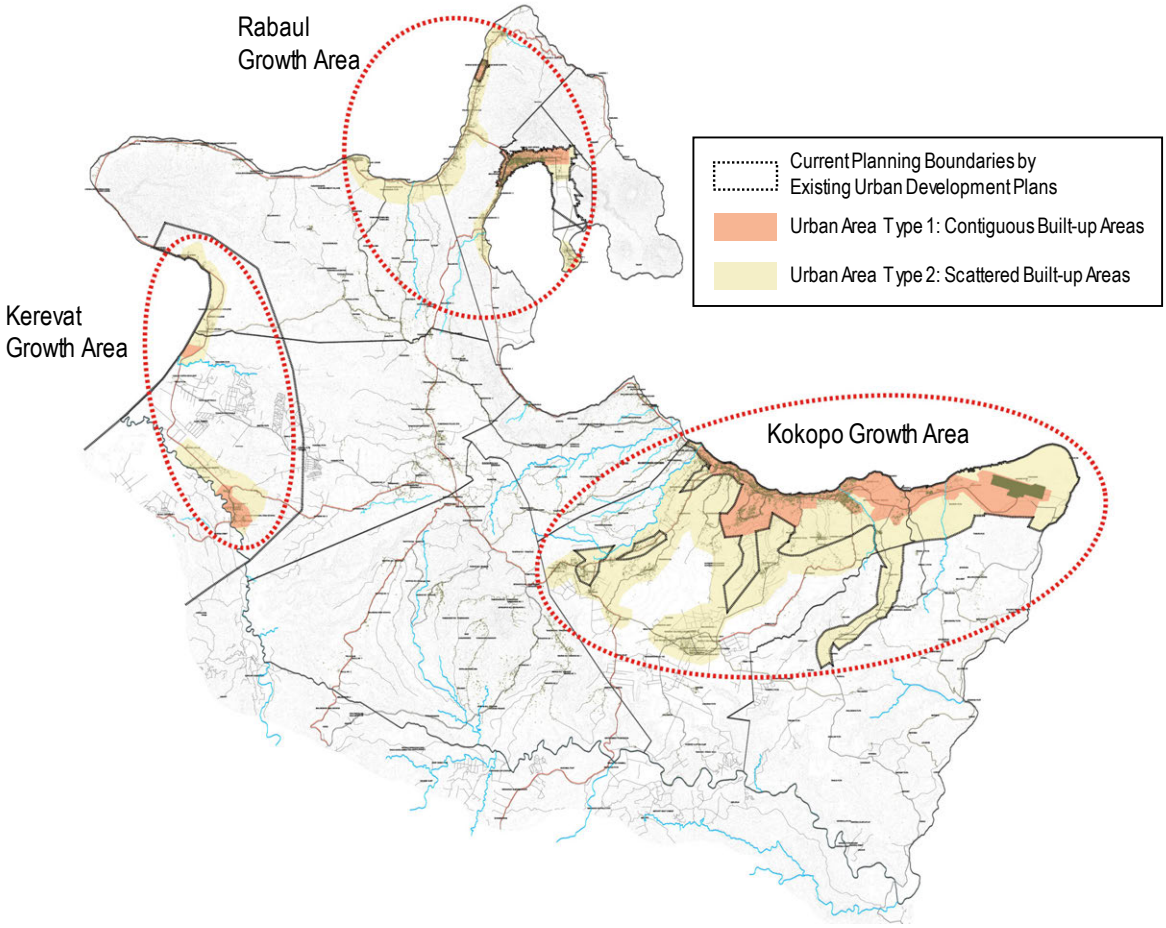
Chapter 10 Future Urban Areas in Northeast Gazelle Peninsula

10.1 Future Urban Areas for Northeast Gazelle Peninsula and Planning Areas for Urban Infrastructure

10.1.1 Growth Areas in Northeast Gazelle Peninsula and Future Urban Areas

(1) Criteria Considered for Future Urban Areas

The three growth areas proposed in the future regional spatial structure of Northeast Gazelle Peninsula are the areas where development should be promoted as shown in Figure 10.1.



Source: JICA Expert Team

Figure 10.1 Growth Areas and Proposed Future Urban Areas in Northeast Gazelle Peninsula

To determine the areas of future urban areas in these growth areas, the following aspects were considered:

- Existing urban planning boundaries
- Present situation of urbanisation
- Proposed urban centres in the future regional spatial structure
- Regional infrastructure to be upgraded in the future regional spatial structure
- Natural conditions, such as rivers and terrain

(2) Two Types of Urban Areas in Northeast Gazelle Peninsula

In Northeast Gazelle Peninsula, the major contiguous built-up areas are along the Kokopo-Tokua Corridor including Kokopo Town in Kokopo District, Rabaul Town in Rabaul District, and Kerevat Town in Gazelle District. The other built-up areas are scattered along the major roads. Therefore, two types of urban areas will be determined in Northeast Gazelle Peninsula. The first type is where the urban economic activities take place with functions such as business, commercial and administrative, and major facilities for education and health sectors. The residential areas in this type of urban area are built relatively close to each other compared with other areas in Northeast Gazelle Peninsula. This area will be called Urban Area Type 1. The second type is where citizens are engaged in urban economic activities as their main source of income, but living in low density areas where some agriculture activities also still remain. This area will be called Urban Area Type 2.

The urbanisation in Kokopo Growth Area is expected to become one contiguous area, while the urbanisation in Rabaul Growth Area and Kerevat Growth Area are to be promoted in separated areas mixed with non-development areas.

The proposed future urban areas are determined in alignment with the future regional spatial structure in 2032.

(3) Future Employed Population Engaged in Non-Agriculture Activities and Manufacturing

The future employed population engaged in non-agriculture activities and the manufacturing sector are assumed based on the future population framework set in Chapter 7.

In Northeast Gazelle Peninsula, approximately 35% of the population are the employed population in 2011 according to the population and housing census. Using this 35%, the employed population in 2022 and 2032 are assumed to be approximately 90 thousand in 2022 and 120 thousand in 2032.

The employed population in the non-agriculture sector is projected to become approximately 75 thousand in 2032. In 2011, there were only 22 thousand employed population engaged in the non-agriculture sector and it is projected there are 45 thousand employed population engaged in the non-agriculture sector, so there could be an increase of 30 thousand employed population engaged in the non-agriculture sector. The Urban Area Type 1 in Kokopo Urban Growth Area, Rabaul Urban Growth Area and Kerevat Urban Growth Area should accommodate jobs for the non-agriculture sector workers by increasing in the next decade.

In 2011, the employed population engaged in the manufacturing sector among the employed population in secondary sector was 30% with 1,181 persons.

Therefore, it can be assumed that there are currently approximately 2,000 workers engaged in the manufacturing sector and this will increase to 4,400 in 2032. Considering the size of the population, present development situation and developable land, 60% (approximately 2,600 jobs) of the manufacturing sector jobs shall be allocated in Kokopo Urban Growth Area and 20% (900 jobs) each in Rabaul and Kerevat Urban Growth Areas.

10.1.2 Planning Areas for Urban Infrastructure in NEGID-Plan

The planning areas for urban infrastructure in the NEGID-Plan will be considered for the future urban areas in the Kokopo Growth Area, Rabaul Growth Area and Kerevat Growth Area.

Although the formulation of the urban infrastructure plan for the Kerevat Growth Area is not included in the scope of the project of NEGID-Plan, the development direction and future demand of urban infrastructure will be proposed for Kerevat Urban Growth Area.

For water supply, Urban Area Type 1will be the planning area.

For urban roads and power supply, Urban Area Type 2 will be the planning area.

10.2 General Land Use Plan

10.2.1 General Land Use Plan for Kokopo Urban Growth Area

The general land use plan for Kokopo Urban Growth Area is prepared to guide the future development of the Kokopo-Tokua Corridor and the hinterland of the existing urban areas of Kokopo Town and Takubar.

The general land use plan is divided in two parts and the western part (Kokopo Town to Takubar) is shown in Figure 10.2 and the eastern part (Takubar to Tokua) is shown in Figure 10.3[9].

To develop the hinterland of the existing urban areas of Kokopo Town and Takubar industrial area, mixed-use development is proposed along the new bypass road and the ring road. The width of the mixed-use area is set as 50m from the edge of the road. In addition, Kinabot area is proposed to change its land use from residential to mixed use. This area was originally developed as residential area in Kokopo Town, but some companies are using the existing building as their offices and is now shifting to mixed use area.

For areas which are assumed to have the risk of landslide are proposed as Proposed Open Space to maintain its land use with trees. The areas which are designated as proposed open space are as follows:

- Upstream of rivers in Kokopo District
- Area along Karavi River as buffer

[9] There is an Airport City (Updated Master Plan 2023) planned next to Tokua Airport which is reflected to Figure 10.3.

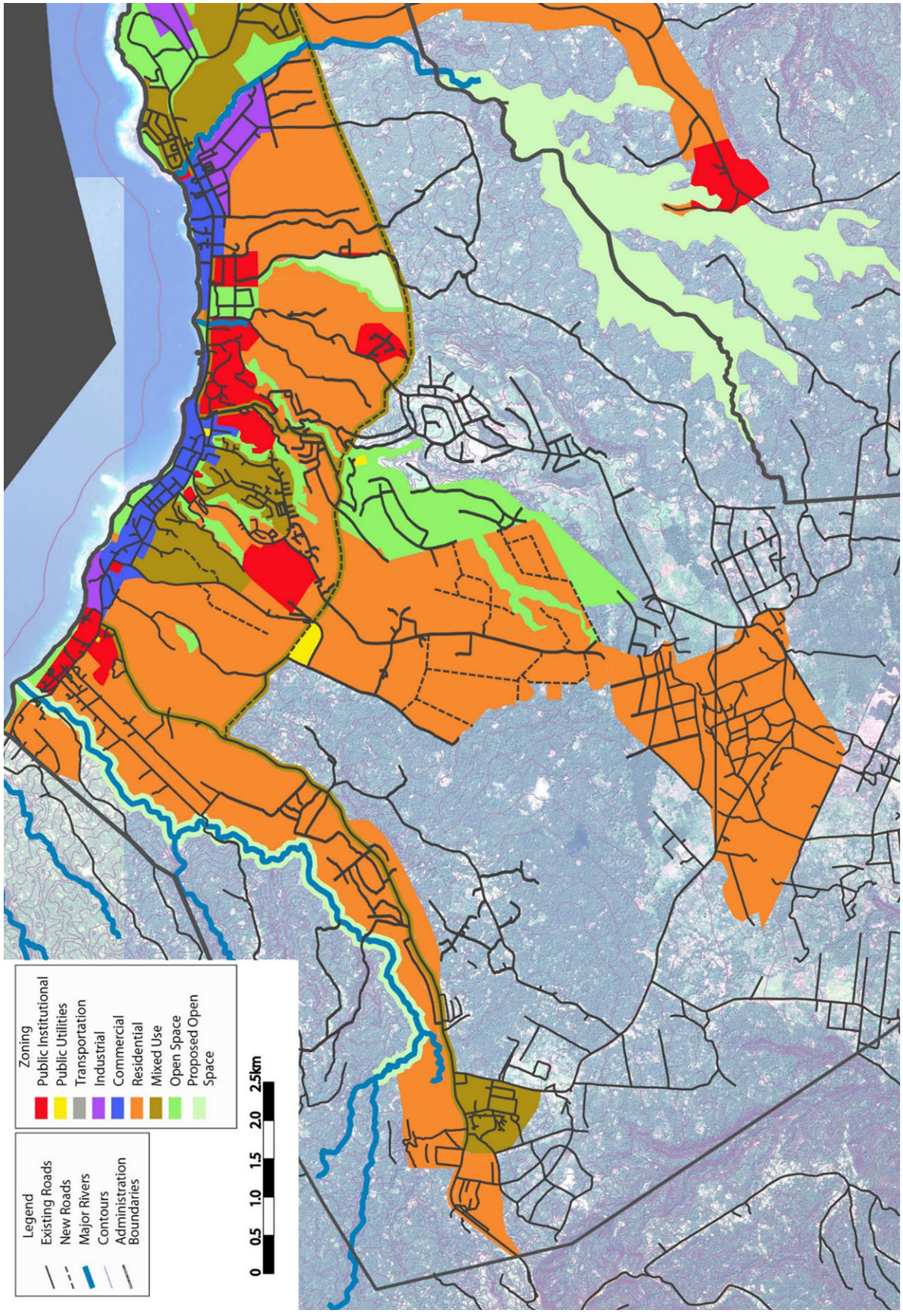


Figure 10.2 General Land Use Plan for Kokopo (Kokopo Town to Takubar)

Source: JICA Expert Team

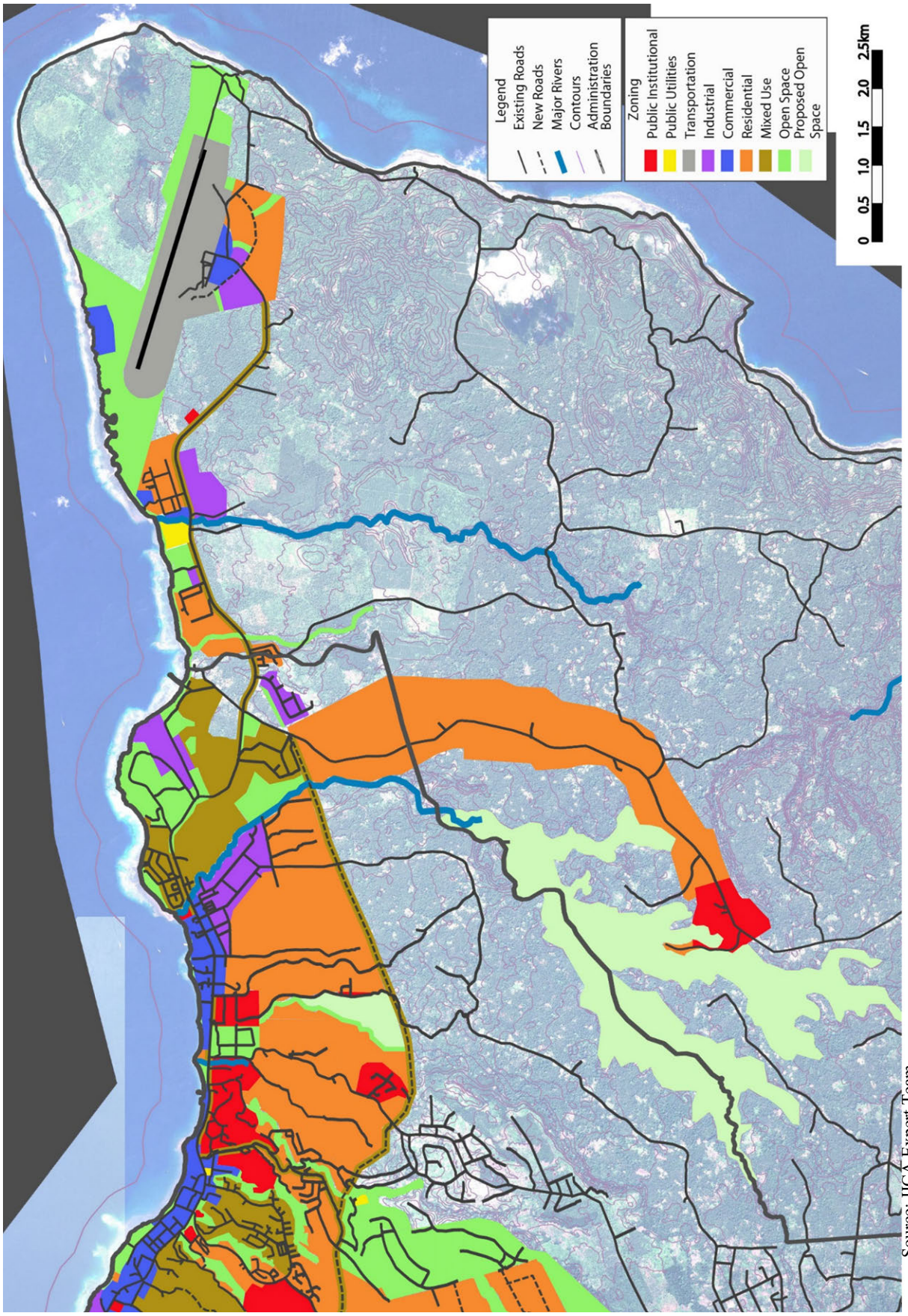


Figure 10.3 General Land Use Plan for Kokopo (Takubar to Tokua)

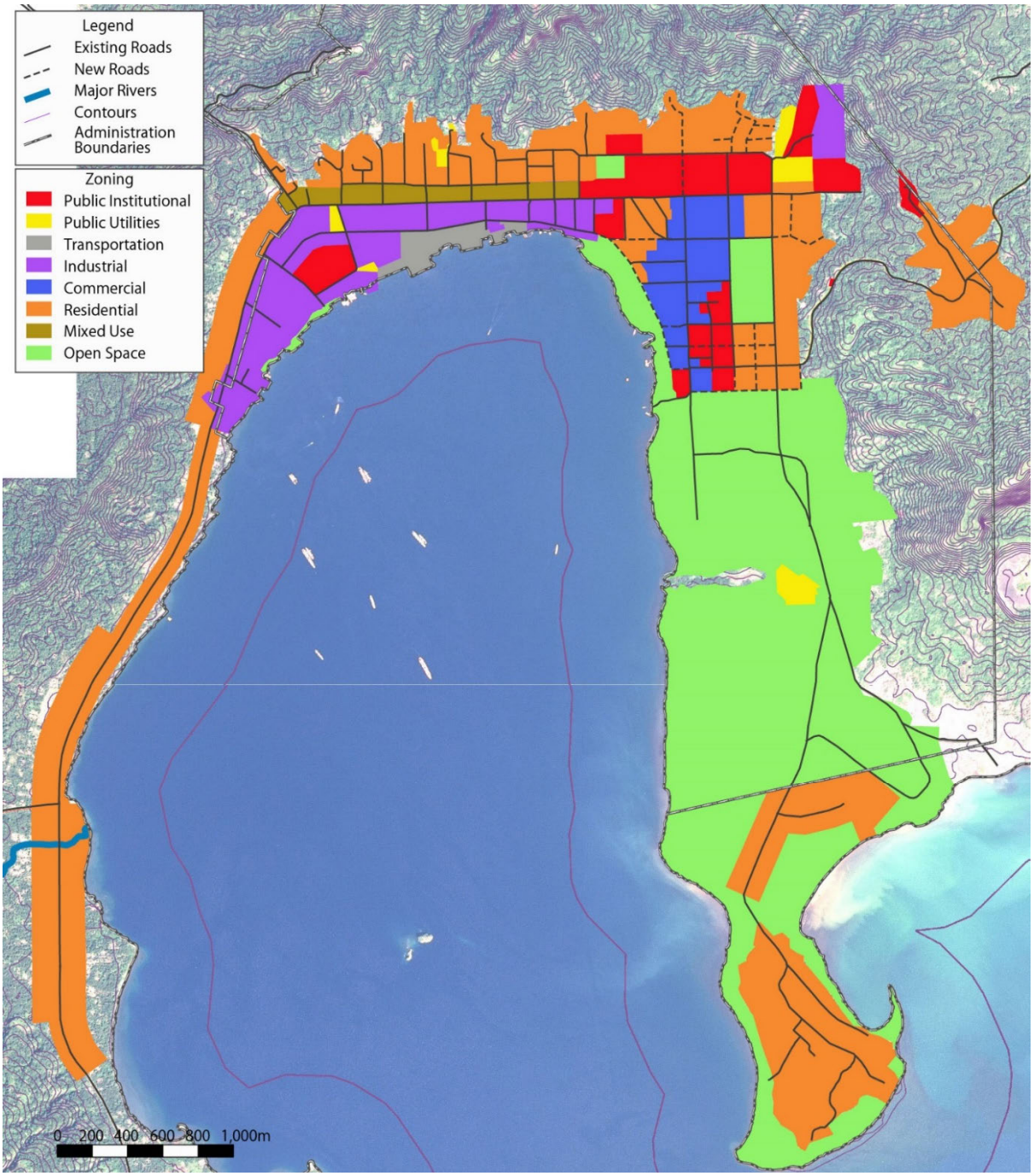
Source: JICA Expert Team

10.2.2 General Land Use Plan for Rabaul Urban Growth Area

The general land use plan for Rabaul Urban Growth Area is prepared to guide the future development of the existing urban area of Rabaul Town and the area along Kokopo Road to Burmah Junction, and the area along North Coast Road between Nonga and Kurakakaul.

The general land use plan is divided in two parts. The area covering Rabaul Town, and its surrounding areas are shown in Figure 10.4 and the area along North Coastal Road is shown in Figure 10.5.

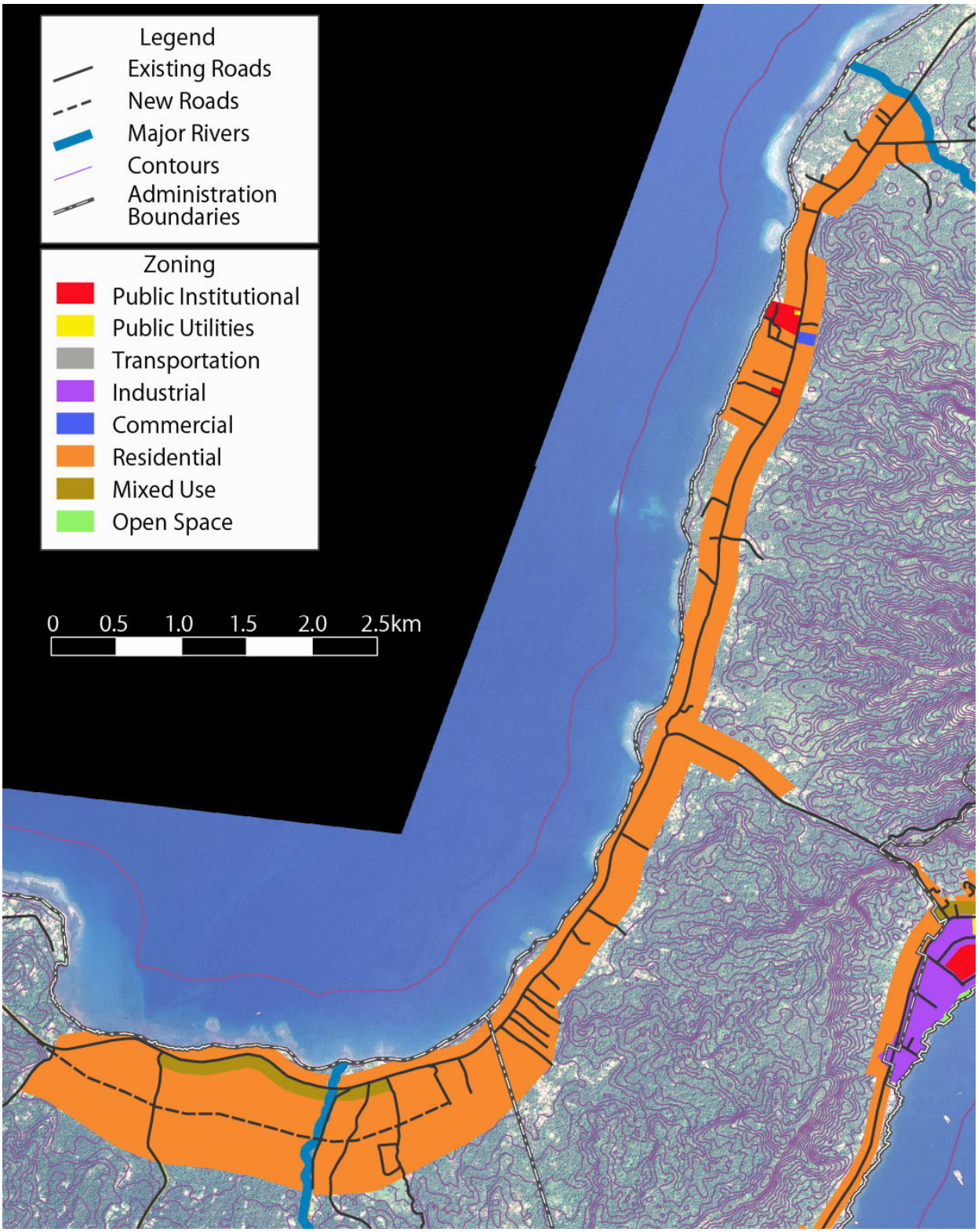
The area which was designated as Sector 3 (no development zone) in 1995 is suggested to remains as open space in the general land use plan. However, considering the current development in and around Matupit Island, certain area along the access road to Matupit and areas in Matupit Island are proposed as residential area.



Source: JICA Expert Team

Figure 10.4 General Land Use Plan for Rabaul Town

In Kurakakaul-Nonga areas the slopes are relatively steep. Therefore, the area possible for development is limited to along the North Coast Road. However, around Kurakakaul, where Rabaul District Government Office is located, the slope is gentle and urban development is possible. Therefore, a new road for urban development is proposed for residential development, and mixed use is proposed for the area along the North Coast Road.



Source: JICA Expert Team

Figure 10.5 General Land Use Plan for Kurakakaul-Nonga Area

PART VII Infrastructure Development Plan for Northeast Gazelle Peninsula

Chapter 11 Objectives for Infrastructure Development and Integrated Strategies for Regional Development in Northeast Gazelle Peninsula

11.1 Objectives for Infrastructure Development in Northeast Gazelle Peninsula

Considering the relationship between infrastructure development and other major aspects shown in Figure 6.1, the following objectives for infrastructure development in Northeast Gazelle Peninsula are identified:

- To support sustainability of socio-economic activities in the region by maintaining and rehabilitating infrastructures
- To promote development of economic sectors by expanding the coverage of infrastructures and by upgrading them for fully and efficiently utilising wide areas of the region
- To make infrastructures withstand disasters for enhancing resilience of wide areas and important functions of the region
- To provide infrastructures to induce socio-economic development in lower-hazardous areas against disasters
- To promote environmental conservation based on natural characteristics of different areas of the region through environmental consideration

11.2 Integrated Strategies for Regional Development with Emphasis of Infrastructure Development by Paying Attention to Different Areas in Northeast Gazelle Peninsula

In Chapters 12 through 17 of "Part VII: Infrastructure Development Plan for Northeast Gazelle Peninsula," a set of development plans for different infrastructure sectors is described sector by sector. On the other hand, this section shows **area-oriented integrated regional development strategies with emphasis of infrastructure development**, considering various aspects (economic sectors, spatial structure, and resilience against disasters) on regional development discussed in Chapter 6.

The following integrated regional development strategies are formulated by **paying attention to different areas of Northeast Gazelle Peninsula** for achieving the vision, goals, and development objectives:

These basic strategies for regional development are supported by development efforts at various infrastructures in different locations. Brief outline for each basic strategy is given below.

(1) Basic Strategy 1: Extension and Upgrading of Trunk Road Network for Expanding the Production of Export-Oriented Agriculture and Forestry Sectors and Improving Accessibility to Urban Centres

For promoting wider and more efficient utilisation of lands and other natural resources available in the region, the following kinds of road development are part of the road development strategies in the region:

- To extend the coverage of the trunk road network
- To upgrade backbone roads of the trunk road network

(2) Basic Strategy 2: Renovation of Rabaul Port and Revitalisation of Rabaul Town

1) Renovation of Rabaul Port

Relocation of part or all of Rabaul Port functions might be a choice for the future of the central port of Northeast Gazelle Peninsula (by starting relocation to a new port by 2042, and by establishing a prime port function at a new port by 2052, as proposed in Chapter 10 on Development Plan for Ports), considering the possible impact of a prospective volcanic eruption to Rabaul Town and access roads to Rabaul Port. However, currently the operators are not willing to move the fuel terminal adjacent to Rabaul Port to a new port site. Moreover, the cruise ships are also not pleased to move away from Rabaul because Tavurvur Volcano is their major target attraction for tourists.

Moreover, when it comes to the construction of a new port by relocating the whole function of Rabaul Port, it takes over 10 years to conduct a series of necessary actions for port relocation (not only a survey for environmental impact on the marine environment, regional consultative process, and basic design work for a new port, but also a detailed design work and actual construction of a new port in a new location). Therefore, it is a good option to maintain part of the existing port functions at the current location, to continue handle container cargos, bulk fuels and cruise ships, while implementing renovation works at Rabaul Port.

In order to respond to the increasing overseas container cargos for import and export and bulk fuels for the fuel terminal in Rabaul (not only for Northeast Gazelle Peninsula but also for surrounding island provinces), as well as to the increasing cruise ship arrivals, the following renovation works of the infrastructure of Rabaul Port are necessary in the short and medium terms:

- Rehabilitation (restoration) of ageing and deteriorated infrastructure (Berth 1, Berth 2 and other facilities) of Rabaul Port
- Upgrading of Berth 2 for increasing cargo handling capacities of overseas containers, break bulks and bulk fuels

2) Revitalisation of Rabaul Town in Relation to International Tourism

In the selected "Spatial Structure 3" discussed in Chapter 9, part of Rabaul Port functions including the berth for cruise ship calls, will remain in the current location. Taking advantage of this cruise ship tourism opportunity, the following measures should be taken for improvement and upgrading of international tourist destinations of Rabaul for the purpose of diversifying target tourist segments:

- To rehabilitate the water supply system of Rabaul Town for the purpose of providing stable water supply to cruise ships calling at Rabaul Port
- To conduct beautification and amenity improvement of streets, parks, and marketplaces in Rabaul Town as part of international tourist destinations (and to implement a pilot project for amenity improvement by installing street furniture in Rabaul Town)
- To diversify tourist market segments from the current narrow segment of cruise ship tourists to a wide range of international tourists seeking exotic tropical island resort experiences, eco-tourists, sun and beach tourists, and budget tourists
- To attract high-grade hotels for international tourists and business travelers, as well as budget tourist hotels and guesthouses in Rabaul Town

3) Development of Tuna Processing Industries in the Tuna Processing Special Economic Zone (SEZ) to Be Located Adjacent to the Rabaul Port

- To officially establish an area of SEZ adjacent to Rabaul Port

- To develop an industrial park with necessary infrastructure for attracting and enabling the operation of tuna processing industries in the SEZ
- To provide stable water supply by rehabilitating and upgrading the water supply system of Rabaul Town
- To provide stable power supply to the Tuna Processing SEZ by strengthening power generation and power transmission capacities of the Gazelle Power Grid

(3) Basic Strategy 3: Industrialisation and Port Gateway Development in Ataliklikun Bay

After the volcanic eruptions in Rabaul, ENBPA had sought alternative areas for urban centres and industrial centres away from Rabaul Town in the process of formulating the Urban and Regional Development Plan 2006, ENBP Economic Development Plan 2003-2033, and ENBP Strategic Development Plan 2011-2021. In the course of these planning studies and processes, ENBPA identified Ataliklikun Bay Area in Gazelle District as a potential alternative location of port and industrial park, which is considered safely away from Rabaul volcanos.

At the same time, the development of an Export Processing Zone (now a Special Economic Zone) for agro-processing industries has been considered and proposed at the area of Ataliklikun Bay in the last decade. In the beginning of 2022, the National Executive Council (NEC) approved the launching of a project for establishing the SEZ. ENBPA and Gazelle District's preference of Ataliklikun Bay as an alternative location for the port and SEZ is derived from the availability of a large tract of church lands along Ataliklikun Bay.

For locating the port function (by relocating part or all of Rabaul Port functions) and SEZ function, the following actions are necessary:

- Improvement of access road (Northern Coastal Road) to Ataliklikun Bay Area
- Provision of stable power supply to Ataliklikun Bay Area
- Provision of water supply to Ataliklikun Bay Area

(4) Basic Strategy 4: Upgrading of Kokopo-Tokua Urban Corridor as the Primary Centre not only of ENBP, but also of Islands Region

Since the relocation of the provincial capital from Rabaul Town after the 1994 volcanic eruptions, Kokopo Town has been playing functions of provincial capital for ENBP and regional capital for Islands Region. When Tokua Airport will be upgraded to an international airport, Kokopo will play an international gateway not only to Kokopo in Northeast Gazelle Peninsula, but also to surrounding island provinces.

Kokopo Town has a potentiality to be upgraded as a regional centre not only for regional administrative functions, export-import business functions, and regional headquarters for business corporations. For accommodating such expansion of urban areas and upgrading of urban functions, Kokopo Town and its surrounding areas (including Takubar and Tokua Areas) should be strongly connected by a town ring road. With this town ring road, urban areas will be expanded to accommodate the prospective expansion of CBD in Kokopo-Tokua Urban Corridor.

(5) Basic Strategy 5: Upgrading of Research and Higher Education Functions, with Focus on Volcanos and Marine Environment, and Hospitality Fields

The ENBP Economic Development Plan 2003-2033 and ENBP Strategic Development Plan 2011-2021 provide ideas on institutional development for research and higher education functions. Considering the potentials and constraints due to volcanos, marine environment and international tourism, Kokopo Town, Rabaul Town and Kerevat Town are potential sites for research and higher education, specifically:

- Kokopo Town for higher education on hospitality business and international tourism
- Rabaul Town for research and higher education on volcanos and thermal energy based on

Rabaul Volcanological Observatory

- Kerevat Town for marine environment research and higher education based on Papua New Guinea University of Natural Resources and Environment

(6) Basic Strategy 6: Strengthening of ICT Infrastructure and Services in Kokopo, Rabaul and Kerevat Growth Areas

In comparison with other developed provinces, ENBP has relatively poor telecommunication network and ICT infrastructure. The people and businesses in ENBP have less accessibility to ICT services. For advancement of more economic sectors, especially processing industries, upgraded international tourism, and regional business centre functions, ICT infrastructure and services should be upgraded, especially in the three growth areas (Kokopo, Rabaul and Kerevat Growth Areas).

(7) Basic Strategy 7: Strengthening of Disaster Risk Reduction in Emergency Response, Enhancement of Preparedness and Implementation of Mitigation Structural Measures

Since the 1980s, Rabaul Volcanological Observatory (RVO) has played an important role for monitoring and researching volcanic activities and volcanic hazards. At the same time, RVO put its effort at raising people's awareness of volcanic risks.

However, in recent years, RVO's assistance funding from international development partners has been decreasing. The technical equipment for volcano monitoring has become obsolete and deteriorated.

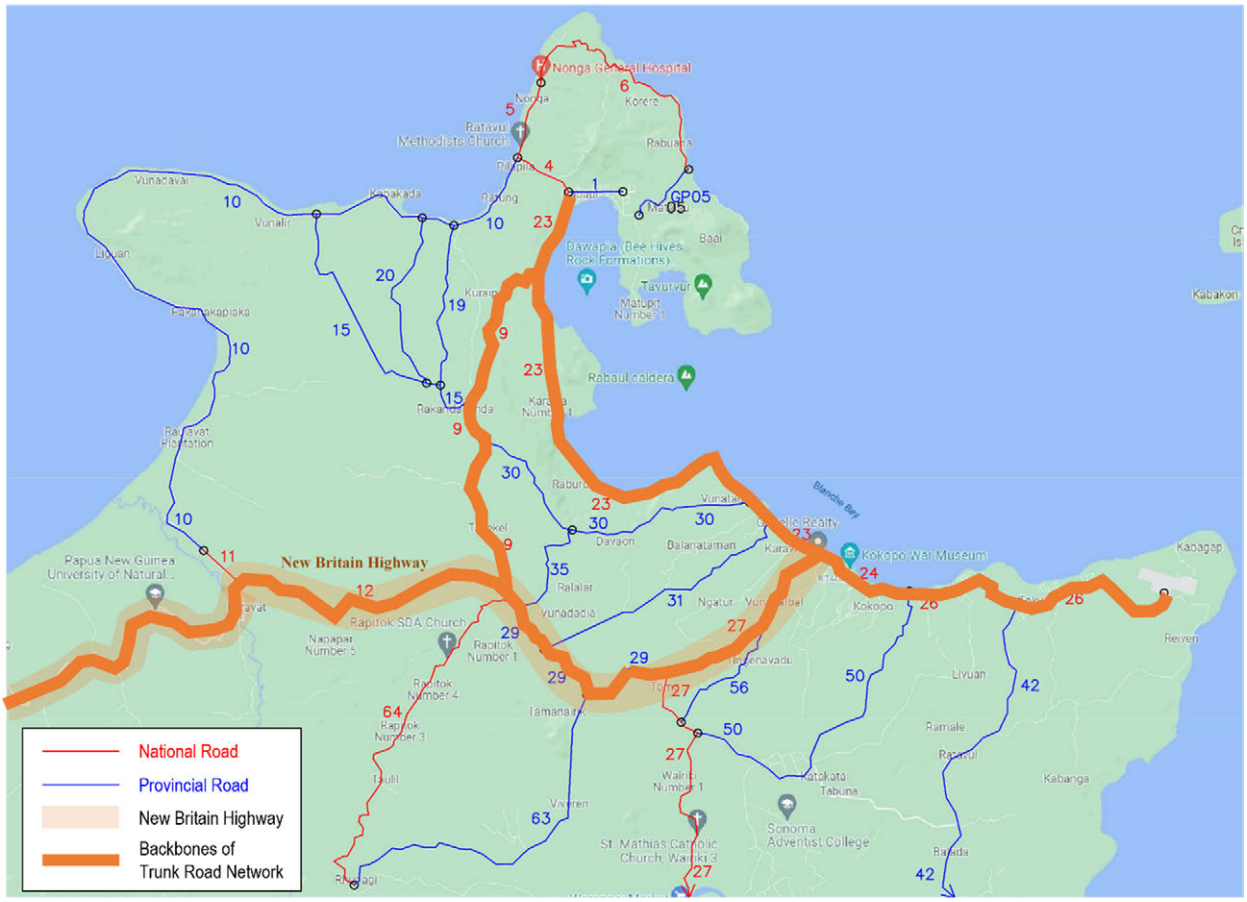
Monitoring and early warning, as well as analysis of volcanic hazard and risks, are essential for the region (Northeast Gazelle Peninsula) to be prepared for future potential volcanic eruptions and their disaster risks to the people, assets and economic activities. In this sense, it is necessary to update the technical equipment for volcanic monitoring and revitalise its research activities and functions in the context of sustainable and resilient development of the region.

Chapter 12 Development Plan for Trunk Roads

12.1 Issues on Development of Trunk Roads

The issues on development of trunk roads are summarised below. The trunk roads in Northeast Gazelle Peninsula are shown in Figure 12.1.

- Necessity of maintenance and rehabilitation of trunk roads
- Necessity of expansion of trunk roads
- Necessity of upgrading functions of trunk roads for primary centres in the regional spatial structure
- Disaster vulnerability and low transport functionality of current backbones of trunk roads



Source: JICA Expert Team

Figure 12.1 Backbones of Trunk Road Network in Northeast Gazelle Peninsula at Present and in the Next Decade until 2032

12.2 Objectives of Development of Trunk Roads

In response to the identified issues on development of trunk roads and the overall objectives of regional development for Northeast Gazelle Peninsula, the following objectives of development of trunk roads are identified:

- To support sustainability of socio-economic activities of people and economic sectors of the region by maintaining and rehabilitating the trunk roads
- To enhance the disaster resilience of wide areas of the region by improving the resilience of

trunk roads against disasters including redundancy of the trunk road network in the region

- To promote the development of economic sectors in the region by upgrading the primary routes and secondary routes of the trunk road network in the region
- To widely and efficiently utilise lands in the region for promoting the development of economic sectors by expanding the trunk road network in the region

12.3 Strategies for Development of Trunk Roads

In order to achieve the objectives of development of trunk roads described in the previous section, the following strategies are formulated:

(1) To Maintain and Rehabilitate Trunk Roads for Supporting Sustainability of Socio-Economic Activities of People and Economic Sectors of the Region

The 25 trunk roads identified by the ENBPA and Technical Working Group for Roads have a variety of problems as described in Appendix. It is necessary to maintain and rehabilitate the trunk roads to keep them in good condition.

(2) To Enhance the Resilience of Trunk Roads for Improving Disaster Resilience of Wide Areas of the Region

It is necessary to enhance the resilience of trunk roads against the two disasters described below and adopt the following measures:

1) Sediment Disaster by Improving Drainage Facilities and Vertical Alignment

In this aspect, it is necessary to pay attention to Kokopo-Rabaul Coastal Road.

2) Volcanic Ash Disaster by Improving the Redundancy of the Trunk Road Network in the Region for Enhancing the Disaster Resilience of Wide Areas of the Region

It is important to secure emergency road transport routes in the event of large-scale volcanic eruption. The risk of road closure caused by large volcanic ash deposits is high in some sections of the Kokopo-Rabaul Coastal Road near Vulcan Volcano. However, road sections with high risk have not been developed to increase resilience against such disaster.

At present, the trunk road network in this area is not well prepared in the event of large volcanic eruption in the future. Securing redundancy in the event of such disaster is necessary for roads that are important backbones of the region. For example, it is necessary to increase preparedness so that road connectivity from Rabaul Port to various parts of the region can be secured even in the event of future large-scale volcanic eruption. Relief supplies for disaster emergency response arrive at Rabaul Port. The region's fuel terminals (fuel depots) are also adjacent to Rabaul Port. It is important to develop alternative routes for transporting fuel from the fuel terminal adjacent to Rabaul Port to various parts of the region, as well as for transporting emergency supplies.

(3) To Expand and Upgrade Primary Routes and Secondary Routes of the Trunk Road Network not only for Promoting the Development of Economic Sectors in the Region, but also for Enhancing Disaster Resilience in the Region

A future regional spatial structure for Northeast Gazelle Peninsula has been proposed for year 2052 in “Chapter 9 Present and Future Regional Spatial Structure of Northeast Gazelle Peninsula”. A phased development plan has been also proposed for the regional spatial structure between 2022 and 2052

In each phase, the upgrading to secondary trunk roads or to primary trunk roads are recommended. Priority projects for development of trunk roads are proposed based on the phased transformation of the regional spatial structure.

12.4 Trunk Road Projects

12.4.1 Important Trunk Road Projects

To sustain the socio-economic activities, it is important to improve all trunk roads in the region. The current road conditions and proposed improvements are shown in Appendix D of the Main Text.

12.4.2 Priority Trunk Road Projects

(1) Priority Trunk Road Projects for Year 2025 to 2032

The following three projects are selected as the priority projects for Year 2025 to 2032 based on the phased development plan in 2032.

1) [TR-01] Strengthening of Kokopo-Rabaul Coastal Road

Primary trunk roads play a role as the backbone of the region. Among the backbone trunk roads, the most important trunk road is the coastal road between Kokopo and Rabaul (Kokopo Road, or Kokopo-Rabaul Coastal Road), which is not in good condition.

This road connects the central port of the region, Rabaul Port, and Kokopo Town CBD (which has functions of provincial capital and central commercial and service functions) in the shortest distance. However, there are many road portions where drainage for rainwater is not well installed. There is also a section in a low-lying area that is prone to sediment disaster. This section has not been paved.

The mountain side road (locally called Top Road, or Kokopo-Rabaul Top Road), which serves as an alternative road (from the viewpoint of redundancy) of the Kokopo-Rabaul Coastal Road, also has the status of national road, and is in good pavement condition. However, the section going up inland from Burmah Junction, which is the intersection with the coastal road, is a steep, narrow and winding road. Lorries carrying heavy containers or fuels from Rabaul Port or Rabaul Fuel Terminal to Kokopo Tow cannot pass it.

Therefore, it is important to strengthen Kokopo-Rabaul Coastal Road, Primary Trunk Road in 2032, as the most important trunk road in the region.

2) [TR-02] Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)

It is necessary to secure emergency road transport routes in the event of large-scale volcanic eruption. The risk of road closures caused by large volcanic ash deposits is high on the sections of the Kokopo-Rabaul Coastal Road near Vulcan Volcano. However, road sections with high risk have not been developed to increase resilience against such disaster.

Therefore, it is important to upgrade Rabaul-Kurakakaul-Rakunai Road to a Secondary Trunk Road in 2032, as an alternative road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road.

3) [TR-03] Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town

It is planned to develop Agro-Industry SEZ at Kabaira (Ataliklikun Bay) in the phased development plan 2032. It is proposed that North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town is upgraded to Secondary Trunk Road.

This road also has a role as an alternative road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road, as well as to Rabaul-Kurakakaul-Rakunai Road, in the event of large volcanic eruption.

(4) Priority Trunk Road Projects for Year 2033 to 2042

The following 3 projects are selected as the priority projects for Year 2033 to 2042 based on the phased development plan in 2042.

1) [TR-04] Upgrading of Kurakakaul-Kabaira (Ataliklikun Bay) Section of North Coast Road

Together with [TR-03], this road is upgraded to Secondary Trunk Road by 2042 as an access road from/to Agro-Industry SEZ at Kabaira (Ataliklikun Bay).

This road also has a role as an alternative road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road in the event of large volcanic eruption.

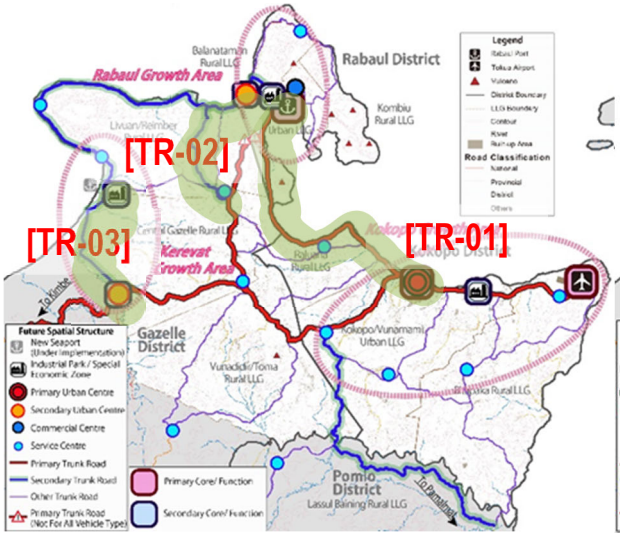
2) [TR-05] Upgrading of Malakuna-Putput Road

This road is a trunk road connecting Malakuna and Putput. This priority project will upgrade this road to a Secondary Trunk Road for improving the connectivity between Kokopo and the Southern Coastal Corridor of the ENBP.

It is planned that this road is upgraded to Secondary Trunk Road by 2032. However, it will be utilised without any upgrade by 2032, as the road condition is kept fair at present. This road will be upgraded by 2042.

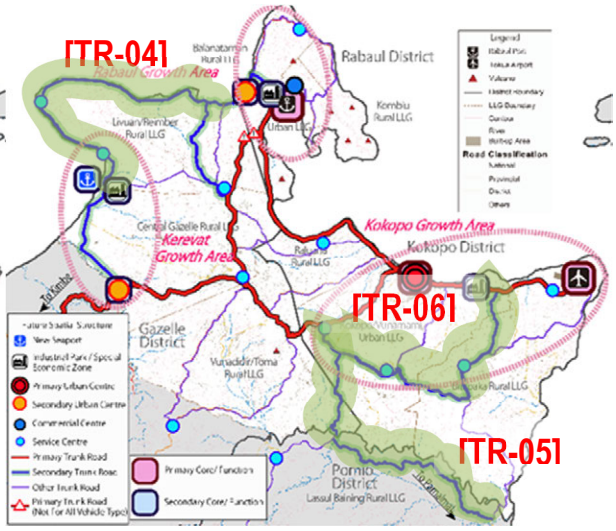
3) [TR-06] Upgrading of Kabakaul-Toma Road

This road is a trunk road connecting Kabakaul and Toma. This road is upgraded to a Secondary Trunk Road based on the Phased Development Plan 2042.



Source: JICA Expert Team

Figure 12.2 Priority Trunk Road Projects for Year 2025 to 2032



Source: JICA Expert Team

Figure 12.3 Priority Trunk Road Projects for Year 2033 to 2042

(5) Priority Trunk Road Projects for Year 2043 to 2052

Other primary trunk roads and secondary trunk roads shown in Figure 12.1 should be upgraded by 2052.

(6) Other Priority Projects for Year 2023 to 2032

Other than priority trunk roads projects, it is proposed to implement the following projects by 2032.

- Rehabilitation of Roundabout between Tokua Road (No. 26) and Bailu Road (No. 50)
- Construction of Sidewalk Near the School in Warongoi Road (No. 27)

Chapter 13 Development Plan for Port

13.1 Issues on Development of Ports

The issues on development of ports are summarised as follows:

- Ageing and deteriorated port infrastructure of Rabaul Port
- Low productivity of cargo handling at Rabaul Port
- Burden on berth occupancy due to fishing vessels

The issues related to relocation of port function from Rabaul Port are summarised as follows:

- Consideration of Disaster Risks in Determining the Necessity of Relocating Rabaul Port to a Safer Place
- Limited Cargo Handling Capacity Despite Increasing Cargo Throughputs Handled at Rabaul Port
- Problematic Access to Rabaul Port Within Northeast Gazelle Peninsula
  - Unpaved Section of Rabaul-Kokopo Coastal Road (Kokopo Road)
  - Steep-Slope Winding Section of Inland Road Between Rabaul Port and Kokopo Town
  - Possible Impact of Volcanic Ash Accumulation on the Road Section Near Vulcan Volcano
- Lower Commercial Viability of Rabaul Port

13.2 Objectives for Development of Ports

The objectives of the ports in this region, including Rabaul Port and other ports, are identified to conduct suitable development taking into account the following:

- The existing port should be properly maintained. Facilities are to be regularly inspected with maintenance record and sufficient repairing should be conducted with short/medium/long term maintenance plan.
- Port handling efficiency should be improved by introducing new equipment, operation systems, and by reorganisation of port operation.
- The port should be expanded in accordance with the increase in port demand.
- The port should provide uninterrupted services even upon occurrence of disaster due to volcanic eruption or tsunami. The existing Rabaul Port should be prepared for strengthening its resilience against such disasters.
- A new port should be planned to take into account risk of volcanic disaster and the future industrial development of the region.
- Rabaul is functioning as oil storage and distribution centre of the region. This function must be maintained and strengthened near a new port to be established in a low disaster risk area in the middle and long terms.
- Simpson Harbour is an attractive location for tourists. Rabaul Port should accommodate cruise ships and provide quality services to passengers and ships.
- Simpson Harbour should continue to play a role in the trading of tuna fish between fishing boats and reefer ships. At the same time, Rabaul Port and its surrounding area should accommodate the development of a tuna fish processing SEZ by utilising this existing advantageous condition.

13.3 Strategies for Development of Ports

13.3.1 Port Development Strategy in Overall Regional Development

(1) Port Development Strategy in the Regional Strategy for Enhancing Resilience against Disaster Risks of Volcanic Eruption

After the last large volcanic eruption in 1994, the ENBP's provincial capital was relocated to Kokopo Town, the Rabaul Airport was relocated to Tokua Area, and the Rabaul District's headquarters was relocated to Kurakakaul Area. In response to these relocations, necessary trunk roads have been developed. However, even after the 1994 volcanic eruption, the Rabaul Port and fuel depots have remained at their original places.

In the last 28 years (after 1994 volcanic eruption), the region's infrastructure has been restored and the regional economies have largely expanded. For this reason, prospective physical and financial losses due to possible damage to Rabaul Port by future volcanic eruption could be huge in comparison to 1994 eruption. Therefore, it is necessary to take necessary mitigation measures for ports in Northeast Gazelle Peninsula, including the relocation of some functions of Rabaul Port to a lower disaster risk area.

(2) Long-Term Relocation Strategy of Some Functions of Rabaul Port to a Lower Disaster Risk Area

The necessity of relocating Rabaul Port to an area safer from volcanic hazard has been considered and the subject of debates for many years, especially after each volcanic eruption in Rabaul. The relocation of Rabaul Port was discussed in the Rabaul Port Master Plan Report (November 2014) by PNG Ports, in which the Kokopo area was proposed as the new port location. The same relocation plan was updated by Detailed Infrastructure Master Plan of Rabaul Port (February 2021). As another alternative port location, the west side of Gazelle peninsula (Ataliklikun Bay) is proposed in this report considering a future industrial development potential of the region such as SEZ.

However, it is necessary to consider the commercial viability of Rabaul Port relocation or its expansion and upgrading. For instance, the volume of cargo handling in 2020 showed that Rabaul Port had cargo throughputs consisting of 203,000 tons of coastal cargo, and 365,000 tons of overseas cargo including container cargoes of only 20,000 TEU. The cargo volume seems to be too small to make the expansion and upgrading of Rabaul Port commercially viable, the same point which the PNG's Medium Term Transport Plan (MTTP) 2014-2018 mentioned.

Moreover, aside from the insufficient volume of cargoes handled by Rabaul Port, the scale of the economy in this region is also not large enough. Furthermore, it is considered that "regional economic benefits" brought about by the relocation of all functions of Rabaul Port are not sufficiently large to make the full port relocation economically feasible.

Therefore, it would take 20 or more years for Rabaul Port's cargo volume and the regional economy to become sufficiently large to make the regional economic benefits from the full-scale port relocation. Even so, preparation is needed for the risk of volcanic disaster, which is said to occur in 40 or 50 years after the last eruption in 1994. Assuming that the disaster might come in around 2032 - 2042, the scale of cargo volume as well as the regional economy would not reach sufficient level for the full-scale port relocation to be feasible.

(3) Strategy of Developing a New Primary Port in a Lower Disaster Risk Area and Remaining Some Functions in Rabaul Port

Instead of relocating the whole function of Rabaul Port to a disaster safer area, it is necessary to formulate an alternative combined strategy to reduce volcanic disaster risks by maintaining part of Rabaul Port functions in Rabaul with the establishment of a new port in a hazard safer area. That means, some measures will be adopted to keep partial function of the Rabaul Port at the current

site while rehabilitating and upgrading its ageing and deteriorated infrastructure in a disaster safer area.

For realising this alternative strategy for the port sector development in Northeast Gazelle Peninsula, it is also necessary to conduct rehabilitation and upgrading of the existing infrastructure of Rabaul Port because the demand for export and import cargoes is somehow on the increase. Notably, the region of Northeast Gazelle Peninsula has depended on export-oriented economic sectors, including primary production of agricultural, forestry and fisheries products.

13.3.2 Phased Development of Port Facilities in Northeast Gazelle Peninsula

(1) Phased Development of Port Facilities due to Changes in Spatial Structure

The phased development of the port facilities according to the changes in spatial structure described in Chapter 10 is shown in Table 13.1.

Table 13.1 Phased Development of Spatial Structure and Port Facilities

Period	Port Facilities
2022: At Present	The existing Rabaul Port is performing all functions of cargo import/export, as well as those of coastal cargo. Liquid cargo, such as fuel, is also handled at Rabaul Port. The main consumers and shippers are in Kokopo Town to /from where cargoes are transported by trucks. The present main issues to be tackled include 1) rehabilitation of aged and deteriorated port facilities, 2) upgrading of some port facilities to respond to a continuing port cargo demand, 3) strengthening of the coastal road between Kokopo and Rabaul, 4) strengthening of the access road (within Rabaul Town) to Rabaul Port.
By 2032: 10 Years from the Present	It is considered that development of tuna fish processing industry will commence at a SEZ established in the Rabaul Growth Area. Similarly, in Kerevat Growth Area, an Agro-Industry SEZ industrial will be started. Most of the port functions will still exist in Rabaul Port. However, small-scale port development should be completed in a new port location (highly probably in Ataliklikun Bay). By 2032, initial new port development will be aimed to support the emergency response to possible events of disasters due to volcanic eruption.
By 2042: 20 Years from the Present	By 2042, a new port will be developed to accommodate relocated port functions (general cargo handling function) from Rabaul Port. However, Rabaul Port will continue to be a prime port of the region in this phase.
By 2052: 30 Years from the Present	Two ports will handle regional cargoes. The new port will play the role of a prime port of the region. Industrial development will be fully operational, by which import/ export cargoes will be much increased.

Source: JICA Expert Team

(2) Port Functions Relocated to New Port

A proposed time schedule for phased development of ports, including relocation of selected functions of Rabaul Port to the new port, is shown in Table 13.2.

Table 13.2 Timeline for Division of Functions of Rabaul Port and New Port

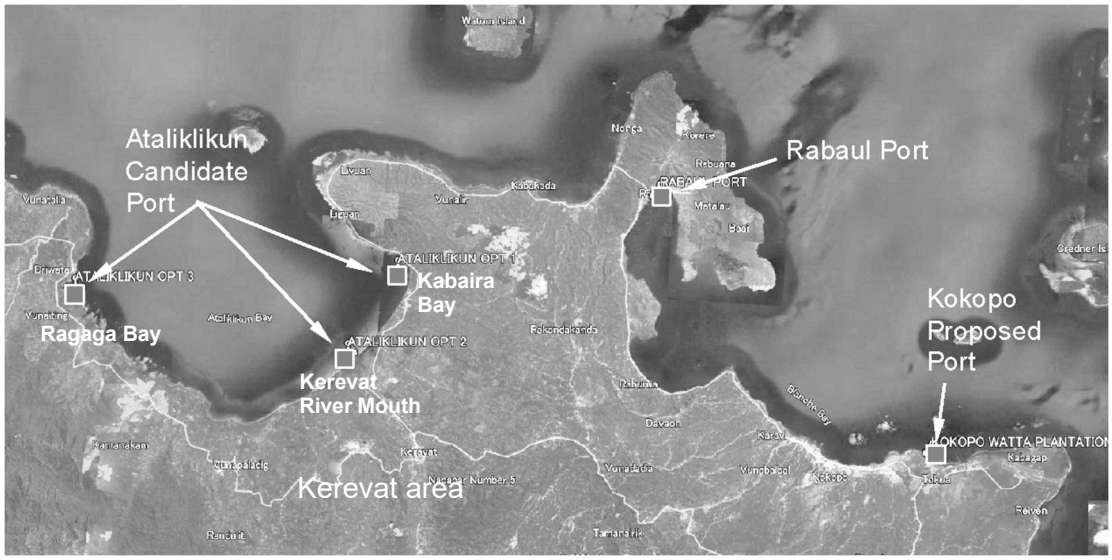
Year / Port Function	2025 - 2032	2032 - 2042	2042 - 2052	2052 -
Rabaul Port				
1) Container Cargo	★	★	★	
2) Bulk Cargo	★	★	★	
3) General Cargo	★	★	★	★
4) Liquid Cargo	★	★	★	
5) Tuna Fishing Boat	★	★	★	★
6) Cruise Ship Terminal	★	★	★	★
New Port				
1) Container Cargo			★	★
2) Bulk Cargo			★	★
3) General Cargo		★	★	★
4) Liquid Cargo (Fuel)			★	★
5) Tuna Fishing Boat				
6) Cruise Ship Terminal				
7) Emergency Response Purpose Jetty	★			

Source: JICA Expert Team

13.3.3 New Port Locations in Northeast Gazelle Peninsula

(1) Comparison of Alternative Port Location in Northeast Gazelle Peninsula

Figure 13.1 shows candidate port locations, as well as Rabaul Port, in Northeast Gazelle Peninsula.



Source: JICA Expert Team

Figure 13.1 Alternative Port Locations including Rabaul Port

Table 13.3 shows a summary of evaluation results among Kokopo, Ataliklikun Bay and Rabaul Port for the future primary port location. For each selected comparison criterion, a rating score is given on a three-point scale. Then, all the evaluation scores are simply added to form an overall evaluation of the three potential port sites. No weight is given to the rating score.

Table 13.3 Summary of Comparative Evaluation of Three Candidate Locations in Northeast Gazelle Peninsula

Comparison Factor	Kokopo	Ataliklikun Bay	Rabaul Port
1) Risk of Volcano Eruption	2	2	1
2) Risk of Tsunami	1	2	1
3) Seasonal Wave Condition	2	2	3
4) Depth of Water	3	3	3
5) Topography of Hinterland	3	3	1
6) Accessibility	2.3	2.0	2.3
6)-1 Accessibility to Import Goods Consumption Areas	3	2	2
6)-2 Accessibility to Export Goods Production Areas	3	3	2
6)-3 Accessibility to Fishery Products (Tuna and its Processed Food)	1	1	3
7) Existing and Planned Industrial Areas including SEZs	3	3	2
8) Ease of Land Acquisition	1	3	2
9) Development Cost	3	2	2
10) Existing Infrastructure	2.7	2.0	2.7
10)-1 Access Roads	3	2	3
10)-2 Power Supply	3	2	3
10)-3 Water Supply	2	2	2
11) Environment	1.0	2.7	2.0
11)-1 Noise, Pollution, Risk of Traffic Accidents	1	3	2
11)-2 Natural Environment	1	2	2
11)-3 Social Environment	1	3	2
Total	24.0	26.7	22.0

Source: JICA Expert Team

(2) Suitable New Port Location in Ataliklikun Bay Area

The following three candidate locations in Ataliklikun Bay were considered for further detailed comparison:

1. **Kabaira Bay**: Located at east side of the bay. The water area is sheltered by land stretch towards Cape Liguan. From sea chart, this water might have been used as an anchoring area in the past.
2. **Kerevat River Mouth**: Located at the middle of the bay and near the Kerevat river mouth. Here, deep water (>50m) is close to the shoreline. The site holds the advantage of proximity to Kerevat Town.
3. **Ragaga Bay**: Located at the west side of the bay. The water area is sheltered by land stretch along the west of the bay.

According to the summary of comparative evaluation (by simple numerical scoring) of the three candidate locations in Ataliklikun Bay, shown in Table 13.4, Kerevat River Mouth and Kabaira Bay are better than Ragaga Bay. However, at this moment, there is no corroborative information on land tenure of these three areas (whether they are customary lands or freehold lands).

Table 13.4 Summary of Comparative Evaluation of Three Candidate Locations in Ataliklikun Bay Area

Comparison Factor	Kabaira Bay	Kerevat River Mouth	Ragaga Bay
1) Risk of Volcano Eruption	2.0	3.0	3.0
2) Risk of Tsunami	2.0	2.0	2.0
3) Seasonal Wave Condition	2.0	2.0	3.0
4) Depth of Water	3.0	3.0	3.0
5) Topography of Hinterland	2.0	3.0	3.0
6) Accessibility	2.0	2.3	1.5
6)-1 Accessibility to Import Goods Consumption Areas	2.0	3.0	1.5
6)-2 Accessibility to Export Goods Production Areas	3.0	3.0	2.0
6)-3 Accessibility to Fishery Products (Tuna and its Processed Food)	1.0	1.0	1.0
7) Existing and Planned Industrial Areas including SEZs	2.0	2.0	1.0
8) Ease of Land Acquisition	2.0	2.0	2.0
9) Development Cost	3.0	1.0	1.5
10) Existing Infrastructure	1.7	1.7	1.2
10)-1 Access Roads	2.0	2.0	1.0
10)-2 Power Supply	2.0	2.0	1.5
10)-3 Water Supply	1.0	1.0	1.0
11) Environment	2.0	2.5	2.0
11)-1 Natural Environment	2.0	3.0	2.0
11)-2 Social Environment	2.0	2.0	2.0
Total	23.7	24.5	23.2

Source: JICA Expert Team

13.4 Projects for Development of Ports

13.4.1 Important Projects for Development of Ports

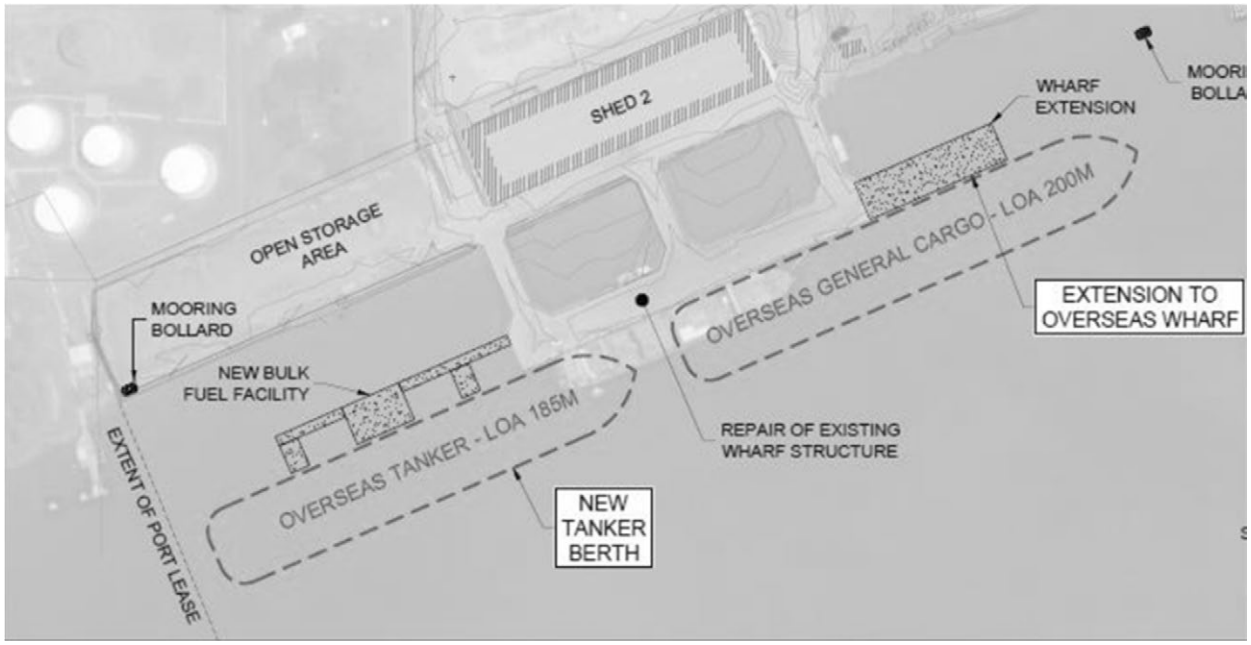
(1) [SP01] Rehabilitation of Rabaul Port Infrastructure

Following the discussion in Section 13.3, it should be considered that the existing Rabaul Port will continue to be utilised even if a new port will be developed in the future, probably after 2042. Overviewing the existing condition of the port facilities and increase of cargoes like demand

forecast, the aged and damaged facilities have to be repaired and properly maintained. Such rehabilitation should consider its lifetime to be more than 30 years.

(2) [SP-02] Upgrading of Rabaul Port Berth 2

As discussed in the Section13.3, the new port development will be realised by 2042, then its port operation will be started. According to the demand forecast, the port demand is estimated to increase by about 2.8 times of the present cargo volume. Considering the berth occupancy rate of Berth 1 and Berth 2 is about 50% at present, upgrading of port must be needed. In order to handle such increase of cargoes, one more berth will be required. However, it should be considered that the cargoes of Rabaul Port are assumed to decrease after new port development. Hence, it will not be necessary to invest large cost for this upgrading. It is recommended to implement the upgrading plan (Proposal-3) proposed in the Detailed Master Plan 2021 by PNG Ports as shown in Figure 13.2.



Source: PNG Ports, 2021, Rabaul Port Detailed Infrastructure Master Plan

Figure 13.2 Conceptual Plan for New Tanker Berth and Extension of Berth 2

(3) [SP-03] Basic Study on New Port Development in Ataliklikun Bay

A further detailed study is necessary to determine the location of the new port in a low-risk area within Ataliklikun Bay as the regional primary port. The basic study shall include the following:

- - Oceanographic Survey, Topographic Survey
- - Survey for Land Acquisition
- - Environmental Survey
- - Study of Fixing Port Location
- - Feasibility Study (Economic and Financial)

(4) [SP-04] Development of Berth specially for Fishing Vessels (for providing water, fuels and others)

For the efficient utilisation of Rabaul Port, it is necessary to avoid fishing vessels from occupying Berth 2 which is upgraded in [SP-02] for supplying water and fuel to the fishing vessels. Therefore, Berth 1 should be upgraded for the fishing vessels.

(5) [SP-05] New Port Development in Ataliklikun Bay

In this report, a new port development in Ataliklikun Bay Area is recommended. Discussion in Section 13.3.2 suggests that the development should start with the initial small-scale jetty and the improvement of road and utility infrastructures. This port will function as an emergency facility for probable volcanic disasters that will affect Rabaul Port and Rabaul Town.

Then the port should be expanded along with the regional economic growth and industrial development.

13.4.2 Priority Projects for Port Development in Northeast Gazelle Peninsula

The aforesaid (1) Rehabilitation of Rabaul Port Infrastructure has the highest priority, and (2) Upgrading of Rabaul Port is the next priority. Considering the required time for implementation and that the completion should be before the port demand will reach the port capacity, detailed design of facilities should commence immediately. For (3) New Port Development, the works have to start with oceanographic and topographic surveys to fix the port location. The presurvey of land acquisition and environmental survey should be done also in parallel. The conduct of feasibility study will be the next step.

The phased port development discussed in Section 13.3.2 is planned by implementing the three priority projects as shown in Table 13.5.

Table 13.5 Summary of Phased Implementation of Priority Projects for Port Development in Northeast Gazelle Peninsula

Timeline	Priority 1 **[SP-01] Rehabilitation of Rabaul Port Infrastructure**	Priority 2 **[SP-02] Upgrading of Rabaul Port Berth 2**	Priority 3 **[SP-05] Construction of New Port in Ataliklikun Bay**
2023~2032	Detailed Design Tendering for the Project Implementation of Rehabilitation Work	Detailed Design Tendering for the Project Implementation of Upgrading Work	**[SP-03] Basic Study on New Port Development in Ataliklikun Bay** Oceanographic Survey Topographic Survey Survey for Land Acquisition Environmental Survey Study of Fixing Port Location Feasibility Study (Economic and Financial) Small Scaled Initial Implementation
2033~2042			Detailed Design of Port Expansion Tendering for the Project Implementation of New Port Construction Work
2043~2052			New Port Operation

Source: JICA Expert Team

Chapter 14 Development Plan for Airports

14.1 Issues on Airports

The issues on airports are summarised as follows:

- Insufficient airport infrastructure and facilities for promoting international tourism and exporting business of fresh food
- Difficulties in association with super-long term (beyond 2050) development of Tokua Airport due to the surrounding conditions of the current site of Tokua Airport
- Consideration of an alternative airport in Gazelle District to be prepared from the perspective of disaster resilience.
- Necessityin promoting the development of international tourism and tuna processing industries in ENBP
- Necessity in promotion of Airport City Precincts by setting a Special Economic Zone

14.2 Objectives for Development of Airports

The objectives for development of airports are as follows:

- To strengthen the international air transport connectivity with major air transport hubs, such as those in Southeast Asia and Australia
  - For attracting international tourists and business travelers not only for ENBP, but also surrounding island provinces
  - For promoting international investments in Kokopo, Rabaul and Kerevat Growth Areas, especially in manufacturing sectors and business sectors by establishing strong international air connectivity
  - For promoting export of fresh fisheries and agricultural products
- To make a regional hub airport at Tokua Airport, the central airport not only of ENBP, but also of the Islands Region
- To enhance resilience of Tokua Airport, the central airport not only of ENBP, but also of the Islands Region
- To fulfill the function of alternative airport for Port Moresby and Lae International Airports
- To strengthen the air transportation function from the perspective of disaster resilient

14.3 Strategies for Development of Airports

In order to achieve the identified objectives for development of airports, the following strategies are to be implemented:

- To increase capacity and improve safety of Tokua Airport to meet the increasing demand for air traffic by constructing a new terminal building and extending the runway
- To promote the increase of frequency of flights for passengers and cargo by promoting international tourism and by promoting international investments in economic sectors, such as tourism and manufacturing
- To promote exporting fresh tuna and agricultural products by taking advantage of international flight connections
- To develop an airport city development, adjacent to Tokua Airport, including hotels,

convention centres, and shopping centres, by promoting private investments

- To prepare for development of an alternative emergency airport in Northeast Gazelle Peninsula

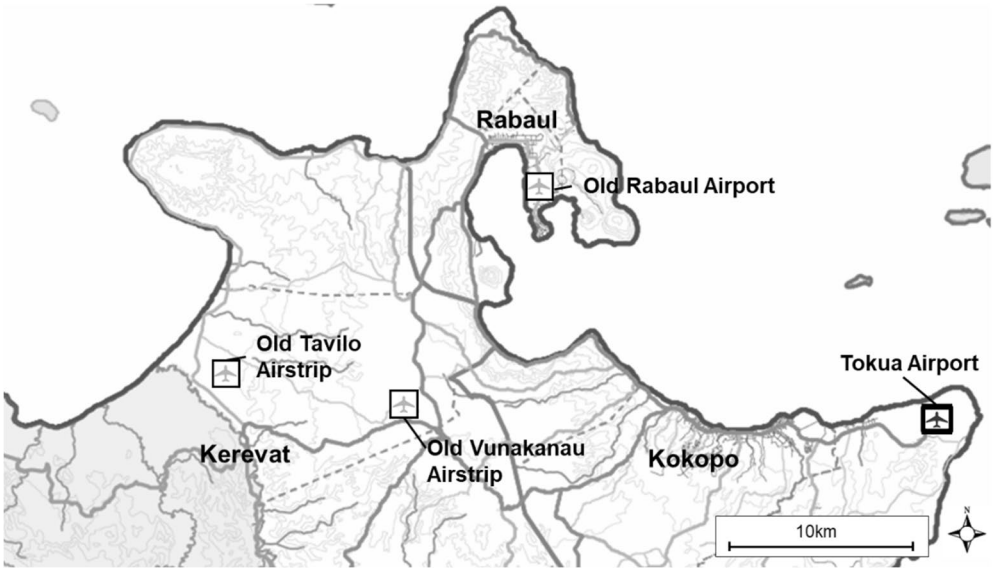
14.4 Projects for Development of Airports

14.4.1 Important Projects for Development of Airports

In accordance with the preliminarily considered development directions of the airport sector in Northeast Gazelle Peninsula, the following important projects are identified:

- [AP-01] Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)
- [AP-02] Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)
- [AP-03] Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport (in PPP Scheme)
- [AP-04] Feasibility Study for Development of Tavilo Emergency Airport

The location for the emergency airport is considered as Tavilo which is located in Kerevat Growth Area with less risk of volcanic ash fall. However, it is recommended that other possibilities should be considered in the feasibility study.



Source: JICA Expert Team

Figure 14.1 Locations of Old Airstrips and Tokua Airport

The first project above [AP-01] is selected as the priority project of the port sector.

Chapter 15 Development Plan for Urban Roads

15.1 Issues on Urban Roads

(1) Issues of Urban Roads in Kokopo Town

Considering that Kokopo Town is a primary business, commercial and service centre not only of ENBP but also of the Islands Region, it will be necessary to upgrade the urban functions of the Kokopo Town and to expand urban areas for accommodating more urban facilities (including office buildings and tourist/business hotels) and residences. For satisfying these needs, urban road development is necessary.

(2) Issues of Urban Roads in Rabaul Town

In Sector 1 of Rabaul Town, "Kokopo - Rabaul Road (Malaguna Road)" and "Port Access Road (Blanche Street)" are major urban roads in the currently urbanized area. Malaguna Road keeps good to fair condition, but some parts require rehabilitation. On the other hand, the condition of Blanche Street is very poor due to drainage problems. This road should be rehabilitated by solving sediments from the northern hill of the town.

In Sector 2 external support had not come after 1994. As most roads in Sector 2 have not functioned after the volcanic eruption in1994, the roads should be rehabilitated according to the expansion of urbanized area.

15.2 Objectives for Development of Urban Roads

Roads are fundamental infrastructures in urban areas. Roads compose the spatial structure of urban areas. Urban roads should serve existing urban areas and future urban areas. Urban roads should be properly developed to provide necessary mobility and connectivity for peoples and goods.

Urban road development has the following objectives:

- To provide accessibility and mobility with primary centres / primary functions in urban areas not only by extending and upgrading urban roads, but also by connecting urban roads with trunk roads
- To provide accessibility and mobility with secondary centres / functions in urban areas not only by extending and upgrading urban roads, but also connecting urban roads with trunk roads
- To support the expansion of urban areas in primary centres and secondary centres by extending and upgrading urban roads
- To improve the resilience of urban roads against disasters by providing disaster risk reduction measures

15.3 Strategies for Development of Urban Roads

(1) Strategies for Development of Urban Roads in Kokopo

There are three strategies for road development in Kokopo-Tokua Urban Areas, namely, CBD Ring Road Strategy, Town Bypass Strategy, and Corridor Strategy.

In order to make Kokopo-Tokua Urban Areas (Urban Corridor) a primary centre for government, business and manufacturing in Northeast Gazelle Peninsula, ENBP, but also for surrounding island provinces, urban roads should be strengthened by connecting with the regional trunk road network.

(2) Strategies for Development of Urban Roads in Rabaul Towns

In order to provide necessary access not only for the existing urban area, but also for restored and expanded urban areas, all roads in Sector 1 and Sector 2 should be rehabilitated. By doing so, the function of Rabaul Port could be well functioning and tourist attractions in Rabaul Town could be accessed easily by tourists.

(3) Strategies for Development of Urban Roads in Kerevat Town and Ataliklikun Bay

In the Kerevat Growth Area consisting of Kerevat Town and Ataliklikun Bay Area, the development of urban facilities, pot facilities and SEZ facilities are proposed. For supporting these development, road rehabilitation and upgrading is required. Such roads are categorized as trunk roads in the region.

15.4 Projects for Development of Urban Roads

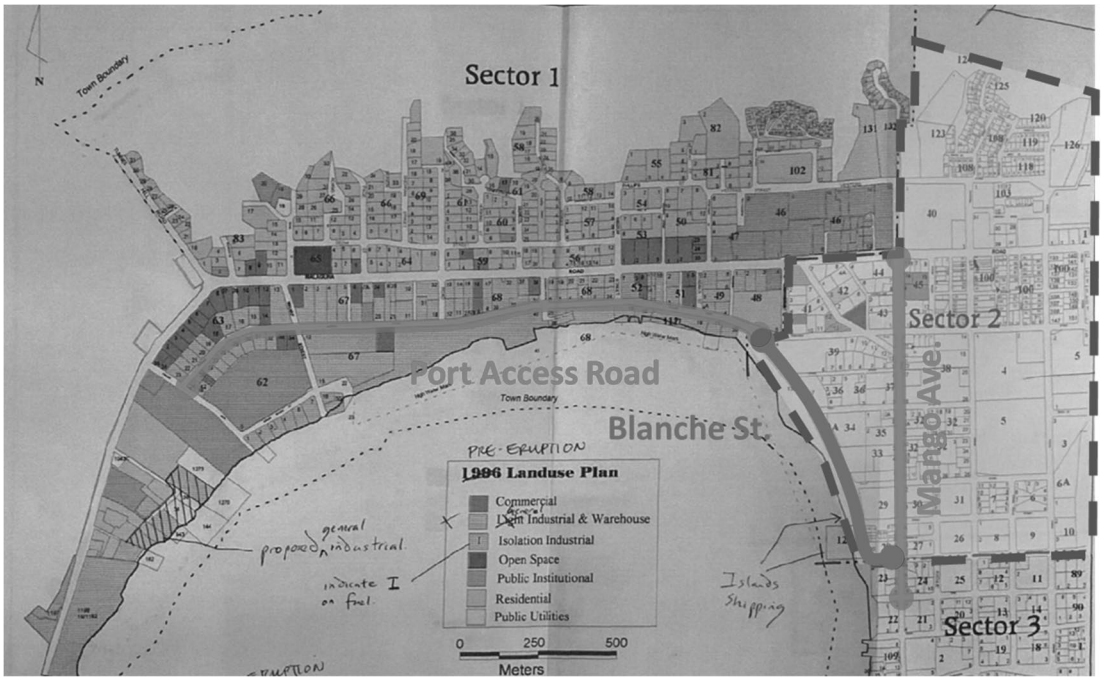
15.4.1 Important Projects for Development of Urban Roads

(1) Rehabilitation of Port Access Road in Rabaul Town (1.8 km) (including Improvement of Drainage Network in Rabaul Town) [UR-01]

It is essential not only in enhancing the port's function, but also in reduction of vehicle operation costs for transporting cargo to and from the port. The rehabilitation of the port access road requires the improvement of Rabaul Town's drainage network for managing sediments from the small hill behind Rabaul Town away from the Rabaul Port area.

(2) Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town [UR-02]

Mango Avenue and Blanche Street are major roads in Sector 2 of Rabaul Town, the seaside area, and Matupit Island. The rehabilitation of these roads could create the urban environment conducing to revitalisation of Rabaul Town.

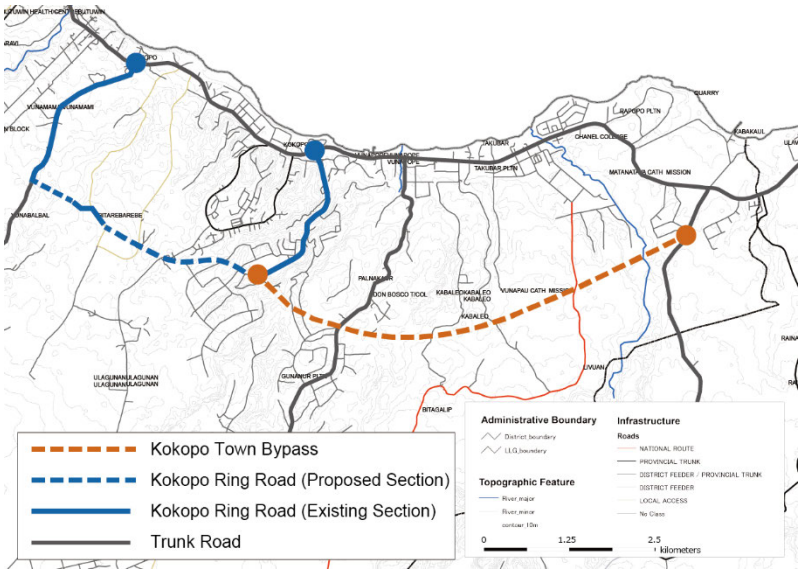


Source: JICA Expert Team

Figure 15.1 Important Urban Road Project in Rabaul Town

(3) Development of Southern Section (3.7 km) of Kokopo Town Ring Road [UR-03]

The southern section of the Kokopo Town Ring Road is part of the Kokopo Town Bypass Road. The development of the southern section of the Kokopo Town Ring Road is intended not only to provide road access to southern part of the Kokopo Town, but also to compose the part of the Kokopo Town Bypass Road connecting Kabakaul and Top Road, as shown in Figure 15.2.



Source: JICA Expert Team, based on Kokopo - Tokua Corridor Subject Development Plan 2016

Figure 15.2 Integrated Kokopo Ring Road and Kokopo Town Bypass in Kokopo-Tokua Urban Corridor: Proposed Urban Road Plan by NEGID-Plan

(4) Development of Kokopo Town Bypass Road (6.5 km) [UR-04]

In accordance with Town Bypass Strategy, it is proposed that short (6.5km) town bypass, connecting east of the Vunapope-Gelagela Road and Kokopo Ring Road will be constructed.

15.4.2 Priority Projects for Development of Urban Roads

All the important projects discussed in the previous section are considered priority roads for urban roads. A phased implementation plan for the identified priority projects is as follows:

Between 2024-2032

[UR-01] Rehabilitation of Port Access Road (1.8 km) in Rabaul Town including Improvement of Drainage Network in Rabaul Town

[UR-02] Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town

[UR-03] Development of Southern Section (3.7 km) of Kokopo Town Ring Road

Between 2033-2042

[UR-04] Development of Kokopo Town Bypass Road (6.5 km)

Chapter 16 Development Plan for Water Supply

16.1 Issues on Water Supply

The issues of water supply in Northeast Gazelle Peninsula are as follows:

- There are very limited public water supply systems in Northeast Gazelle Peninsula and those living outside supply areas usually use stored rainwater that falls from the roof of their housing. It is necessary to expand the service area, so the future urbanising area is included in the water supply service area.
- Water supply systems serving Kokopo and Rabaul Areas were constructed or reconstructed after the volcanic eruption in 1994. Therefore the. expansion to surrounding areas is impossible without refurbishing and improvement of the existing systems.
- Since there are fundamental problems for the water supply systems, the service level to users is low, and incur a high cost. There are also abundant groundwater resources in Northeast Gazelle Peninsula, and the water can be withdrawn by borehole easily, but it is not well utilised. The actual issues of the existing water supply facilities are as follows:
  - The lifespan of the pumps is short
  - The cost of installation of boreholes are expensive
  - The lifespan of the water tanks is short
  - There are no spare pumps

16.2 Objectives for Development of Water Supply

The objectives for development of the water supply are as follows:

- To cover urbanised areas by water supply systems since it is desired that planned urbanised areas are covered by water supply systems as much as possible
- To rehabilitate and improve the existing water supply systems since the existing facilities are old and not efficient.
- To manage the systems properly to get satisfaction of users by improvements of current systems include automatic operations and monitoring systems,
- To save the costs for water supply for the welfare of the people.

16.3 Strategies for Development of Water Supply

1) To Cover Urbanised Areas by Water Supply System

Target urban areas are in the surrounding area of current water supply areas of Kokopo Town, Rabaul Town and Nonga Area except for Kerevat Growth Area. Therefore, expansions from the existing water supply system have a great advantage to cover these areas. In addition, it is better for Water PNG to manage the expanded areas.

For Kerevat Town, since a water supply project to Kerevat Town is underway by WB, the project will contribute to this purpose. The project of expansion of water supply area for Nonga Northern Area will also contribute to this purpose.

On the other hand, Kokopo-Tokua Corridor shall be included as a coverage area by the water supply system, but a new intake and supply system may be required due to the wide area. For the

inland urbanised areas to Kokopo Town, the Baliora water supply system may be expanded for this purpose.

2) To Rehabilitate and Improve Existing Water Supply Systems

There are many problems that require rehabilitation and improvement, which are the preconditions of the expansion of supply areas.

Accordingly, rehabilitations and improvement must be included in the project as the first priority.

3) To Manage the Systems Properly to Get User Satisfaction

The staff of Water PNG will be able to control/manage facilities properly and obtain operation records easily because the above-mentioned improvements will include the introduction of automatic operation, monitoring systems and stand-by machines.

Because of the above, the staff can manage the facilities efficiently and properly, and cope with requests from users.

4) To Save the Costs

Saving costs is a fundamental requirement for almost all organizations, but it is not easy to attain the request, especially for a well-managed organization.

For Water PNG, some cost reduction can be achieved only by implementation of the improvements shown in this report. In addition, some changes are recommended, such as selection of durable equipment/facilities, negotiation of some installation cost and staff arrangement.

For Water PNG, some changes of design and procurement are recommended as follows:

- Introduction of automatic operation for pumps and other machines in order to save operation costs and to expand the lifespan of the machines.
- To avoid installation of galvanised steel tanks due to the short lifespan.
- To reduce the installation costs of boreholes because it is 10 times more expensive compared to international levels.

16.4 Projects for Development of Water Supply

As short-term projects, rehabilitation and improvement for Kokopo Town, Rabaul Town and Nonga area should be conducted as a precondition of the expansion of surrounding areas. In addition, current concrete plans for water supply in target areas should be included.

Such current concrete plans are a water supply project for Kerevat area and an expansion project of water supply area for southern area of Nonga.

The short term projects for the water supply sector are as follows:

- [WS-01] Project for Rehabilitation and Improvement for Kokopo Borehole Field
- [WS-02] Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area
- [WS-03] Project for Rehabilitation and Improvement of Water Supply System for Nonga Area
- [WS-04] Project for Development of Water Supply System for Kerevat Area
- [WS-05] Project for Expansion of Water Supply System for Nonga Northern Area

As middle-term expansion, the future urbanised areas in the Kokopo-Tokua Corridor Subject Development Plan 2016 should be considered.

For Rabaul Town, because expansion of the water supply areas is possible due to the increase of water intake capacity and installation of high elevation reservoir by the short-term works, the water supply area will be expanded as much as possible.

For Nonga area, an expansion of southern coastal areas is possible by the aforementioned rehabilitation and improvement and thus, this expansion should be done.

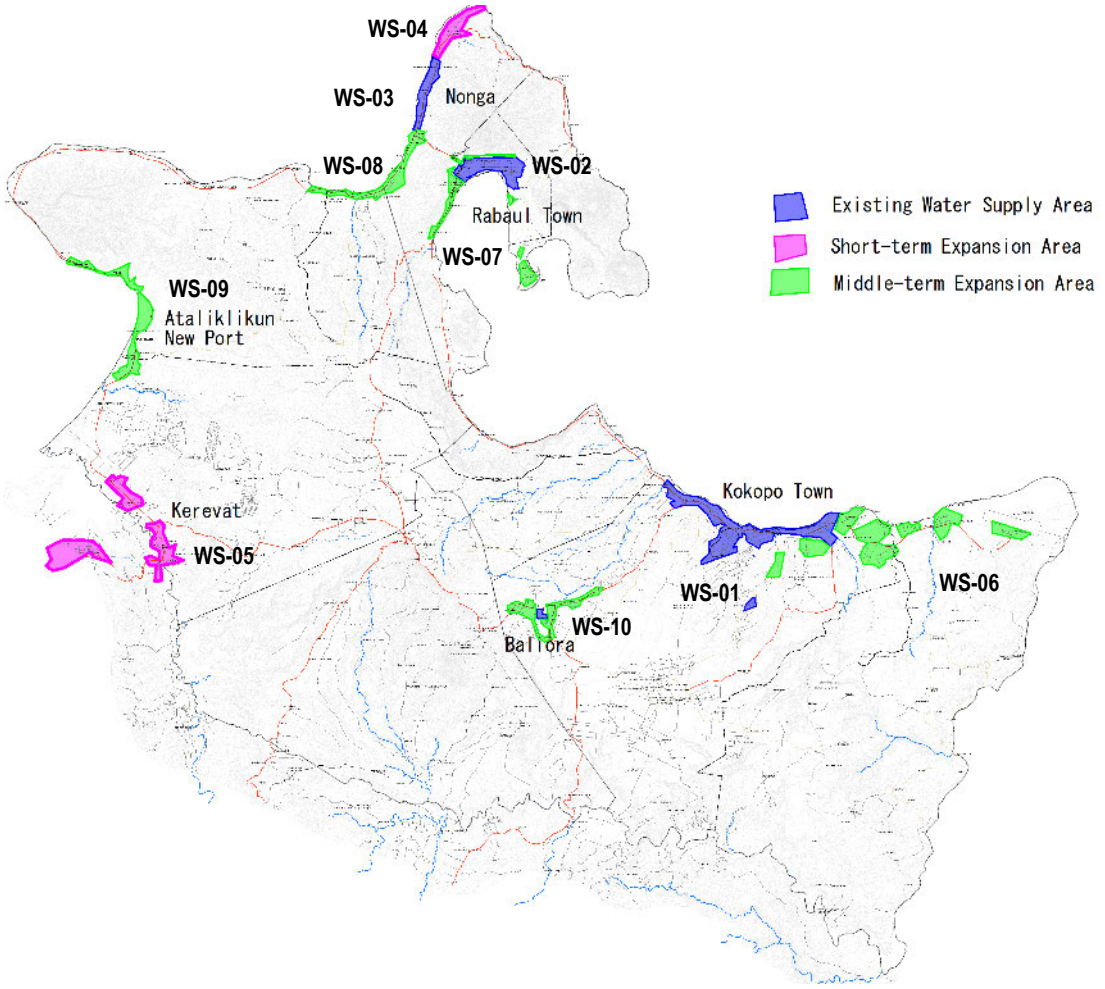
Currently, a port facing Ataliklikun Bay is planned and the water supply system for the port should be planned to include the surrounding residential areas.

Apart from these, a water supply system with a borehole for a police housing complex in Baliora Area is operated, but the capacity of the facilities is apparently excessive for the current supply area. There are many housing units nearby the system and the elevation of this area is 260-340 m. Accordingly, an expansion of the supply area will be planned as an example of water supply systems for high-elevation areas.

The medium term projects for the water supply sector are as follows:

- [WS-06] Project for Development of Water Supply System for Kokopo Eastern Area
- [WS-07] Project for Expansion of Water Supply System for Rabaul Town Surrounding Area
- [WS-08] Project for Expansion of Water Supply System for Southern Nonga Coastal Areas
- [WS-09] Project for Development of Water Supply System for Kerevat Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas
- [WS-10] Project for Expansion of Water Supply System for Baliora Area

The locations of these projects are shown in Figure 16.1.



Source: JICA Expert Team

Figure 16.1 Water Supply Expansion Areas by Short-Term and Middle-Term Project

Chapter 17 Development Plan for Power Supply

17.1 Issues on Power Supply

The issues in Northeast Gazelle Peninsula are identifies as follows:

- Frequent power outage
- Shortage of power output of Warangoi Hydro Power Station
- Shortage of power output of diesel generators
- Inadequate maintenance of power facilities
- Inadequate storage conditions for spare parts and equipment for replacement
- Environmental impact of diesel generators

17.2 Objectives for Development of Power Supply

The goal of development of power supply is to provide stable and reliable power required for sustainable socioeconomic activities in Northeast Gazelle Peninsula, as well as to contribute to the promotion of the development of the economic sectors.

In order to achieve a stable and reliable power supply for promoting social and economic development, reducing power outages is of the highest priority and strongly required for Northeast Gazelle Peninsula. In order to solve this problem, the following development directions should be sought:

- To rehabilitate existing power facilities including reinforcement of high priority transmission lines, substations, and distribution lines
- To satisfy short-term needs to provide supplemental power supply by strengthening diesel power generators at Kokopo S/S, Rabaul S/S, and Kerevat S/S in Kokopo Town, Rabaul Town, and Kerevat Town, in which economic sector development is promoted by establishing Special Economic Zones and industrial parks
- To satisfy medium and long-term needs, reduce dependence on diesel power generators, and develop alternative energy resources, such as geothermal and solar energy resources, to diversify power sources in response not only to the demand growth in urban areas but also to the need for rural electrification
- To reinforce the maintenance capability of power facilities of PNG Power

17.3 Strategies for Development of Power Supply

17.3.1 Strategy for Power Generation Development

If 5MW mega-solar power plant and 7MW Upper Warangoi Hydropower Plant are established in accordance with the said PDP, the total generation capacity will reach approximately 29MW and should be able to numerically cover the future peak demand forecasted. However, it is also predicted that several generation units might be shut down due to unforeseen technical problems and/or ageing facilities and equipment. Thus, the further addition of generation plants should be recommended in preparation for the future unforeseen reduction in supply capacity. It is also important to utilise carbon-neutral energy resources for generation development in accordance with the principles of NEP 2017-2027.

17.3.2 Strategy for Transmission, Substation, and Distribution Development

In the transmission and distribution sector in the Northeast Gazelle Peninsula, the development plan led by the Asian Development Bank (ADB) has a key role to improve Gazelle Grid.

- Rehabilitation of the existing 66kV transmission lines and substations not to be covered by ADB assistance: Since the power is supplied through the power network, the partial rehabilitation and reinforcement will be insufficient. Thus, the power facilities not covered by ADB assistance will require rehabilitation.
- Reinforcement of back-bone lines (66kV Transmission Lines 552 and 553): To promote the development of the Northeast Gazelle Peninsula, the reinforcement of these back-bone lines is essential.
- Duplexing of the existing 66kV transmission lines (From single circuit to double circuit): In order to improve supply reliability and to meet the N-1 rule, this duplexing of lines is required.

Rehabilitation of the existing 22kV distribution lines: The 22kV distribution lines are entirely facing ageing problems as well. Replacement and rehabilitation are required on a prioritisation basis.

17.4 Projects for Power Supply

17.4.1 Important Power Supply Projects

The Gazelle Grid entirely requires rehabilitation and replacement of each piece of equipment due to ageing. Therefore, all the important projects listed below will be required and it will be desirable to proceed with the replacement and rehabilitation work. Based on the present situation, the following important rehabilitation projects were recommended for implementation over the next approximately 10 years (by 2032):

(1) Power Generation

[PW-01] Ulagunan Diesel Generators Rehabilitation Project: As shown in Table J.3.1, the number of available units at Ulagunan S/S is two only out of six units. Furthermore, even available units cannot produce rated output due to technical problems. The remaining four units are facing difficulty in procuring spare parts due to their unavailability. It is recommended that these generators are replaced with new ones, of which spare parts are available.

(2) 66kV Transmission Line

[PW-02] 66kV Transmission Line 552 and 553 Rehabilitation Project: These lines are important called the "Back-bone Line" connecting Kokopo and Rabaul. It was observed that some of the transmission poles were inclined, and insulators were remarkably broken, in spite of the fact that these lines have an important role in power supply.

[PW-03] 66kV Transmission Line 554 Rehabilitation Project: Navunarum T-off line segment is supposed to be replaced by ADB's rehabilitation project. This line is connected to Vunakanau Switchyard which is to be constructed as well. However, 66kV transmission line 554 will not be covered. Therefore, it will be important to rehabilitate this line to ensure the power supply from Vnakanau Switchyard.

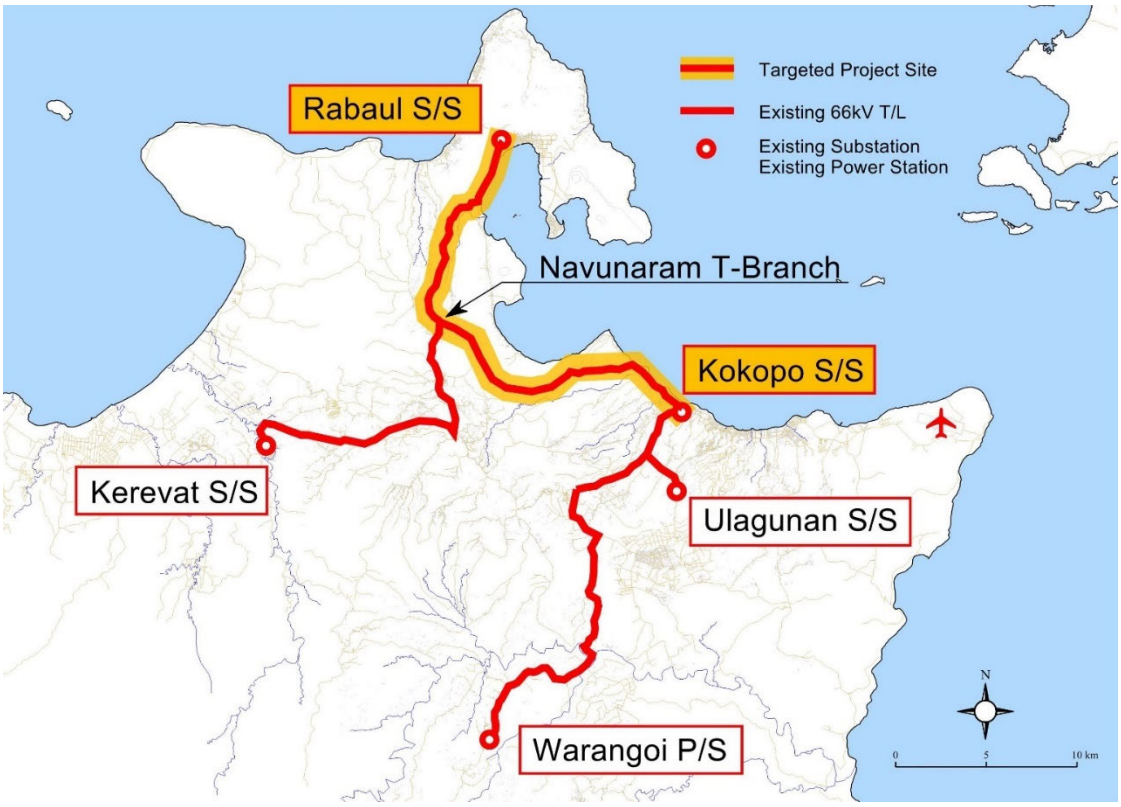
(3) 66/22 kV Substation

[PW-04] Kokopo Substation Rehabilitation Project: In this substation, the protection relay system does not work properly. Due to technical problems, power outages are caused frequently by malfunction and unnecessary functions of the system. In order to ensure the reliability of the power supply, this rehabilitation project will be essential.

[PW-05] Rabaul Substation Rehabilitation Project: Likewise, it seems that the protection relay system does not work properly at this substation. Also, disconnectors, bus-bar, etc. installed in the 1970s are still continuously being used. When a volcanic eruption occurred in 1994, most of this equipment was buried in volcanic ash and dust. However, they were washed and being used up to now. The only transformer is a second-hand unit removed from Kokopo S/S after the volcanic eruption in 1994. In preparation for probable volcanic eruption in the future, it will be important to rehabilitate this substation, and worth considering a shift to an indoor substation.

(4) 22kV Distribution Line

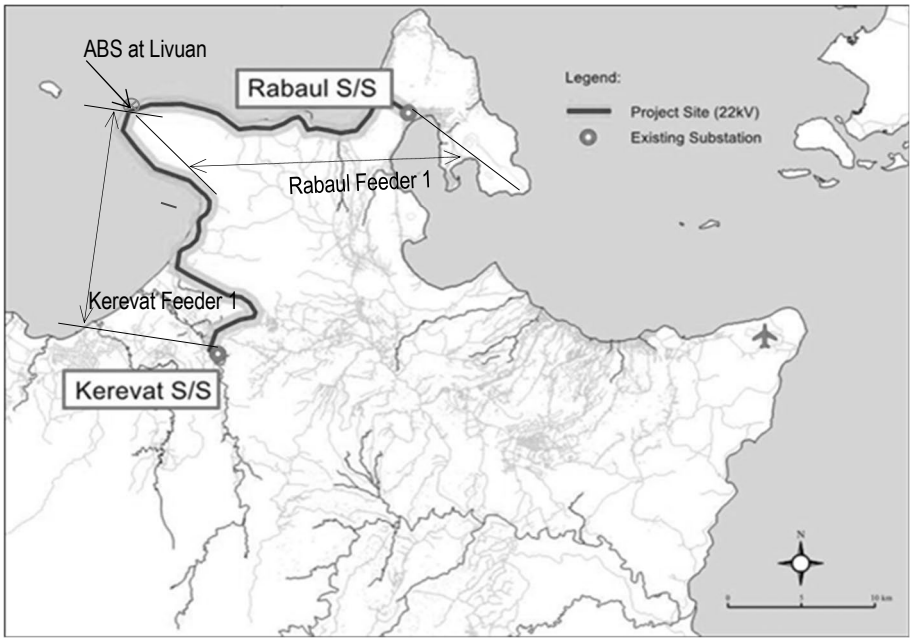
[PW-06] Kokopo Feeder 2 Rehabilitation Project: This feeder is the longest distribution line, and Tokua Airport is connected at the end of the line. Accordingly, the voltage drop might be one of the technical concerns. Also, it was frequently observed that ground clearance was not secured sufficiently at various locations. According to PPL, the clearance of HV and LV should be more than 6m and 5.5m in consideration of regulation. Since the insulation wires are adopted, they do not cause an electric shock to the objects and persons which directly touch them. However, this status should be improved from a safety point of view. Specifically, it will be recommended to shorten the span among poles, improve the line sag and lift the wire at the higher position by replacing existing poles by taller poles.



Note: Transmission Line 552: Kokopo Substation – Navunaram T-Branch, Transmission Line 553: Rabaul Substation – Navunaram T-Branch
Source: JICA Expert Team

Figure 17.1 Project Site of the Priority Project for 66kV Transmission Lines

[PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project: This distribution line has the role of supplying power along the North Coastal Road in the northern-west part of the Northeast Gazelle Peninsula, which is expected to become a more important line for regional development intending a shift of port function. (See Figure 17.2)



Source: JICA Expert Team

Figure 17.2 Project Site of Priority Project for 22kV Distribution Lines

(5) Development of Alternative Sources of Power

[PW-08] Projects to Promote the Development of Alternative Sources of Power through Both Private and Public Investments: This is an investment promotion activity for private investment and public investment in power generation by alternative sources of energy, such as solar and geothermal.

17.4.2 Priority Projects of Power Supply

(1) Policy to Select Priority Projects

Considering the fact that ADB's assistance will highly contribute to the improvement of Gazelle Grid, the following key points are considered to select priority projects:

- To contribute to the acceleration of regional development along coastal areas connecting Kokopo and Rabaul and around Ataliklikun Bay which is expected to be developed as a key alternative place that has a port function
- Not to overlap with ADB's projects
- Combining more than two important projects to form a priority project, where necessary, in order to achieve an effective implementation impact.

(2) Selected Priority Projects

Based on the above selection policy, one important project on transmission, one important project on electricity distribution, and one important project on power generation were selected as priority projects as follows:

- [PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations
- [PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project
- [PW-08] Projects to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Chapter 18 Phased Implementation Plan of High-Priority and Priority Projects for Infrastructure Development in Northeast Gazelle Peninsula

18.1 Identified Important Projects by Infrastructure Sector

In Northeast Gazelle Peninsula, a variety of projects or actions in infrastructure sectors have been proposed by the past and current provincial development plans as discussed in Appendix C. Those proposed projects are necessary and useful for sustaining socio-economic activities and promoting socio-economic development in the region.

In each infrastructure sector, the following types of projects are formulated in NEGID-Plan:

- Those projects for rehabilitating aged or deteriorated infrastructure to sustain socio-economic activities in the region,
- Those projects for increasing the capacity of infrastructure function in response to increased demand,
- Those projects for extending service areas of infrastructure in response to extended distribution of population distribution or economic activities, or
- Those projects for infrastructure provision to withstand disasters.

Table 18.1 Important Projects Identified for Each Infrastructure Sector

Infrastructure Sectors	Important Projects	
Regional Infrastructure		
Trunk Roads	[TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road [TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	[TR-03] Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town [TR-04] Project for Upgrading of Kurakakaul-Kabaira (Ataliklikun Bay) Section of North Coast Road [TR-05] Project for Upgrading of Malakuna-Putput Road [TR-06] Project for Upgrading of Kabakaul-Toma Road
Ports	[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure [SP-02] Project for Upgrading of Rabaul Port Berth 2 [SP-3] Project for Basic Study on New Port Development in Ataliklikun Bay including the following aspects: - Oceanographic Survey, Topographic Survey - Survey for Land Acquisition - Environmental Survey - Study of Fixing Port Location - Feasibility Study (Economic and Financial)	[SP-04] Project for Development of Berth specially for Fishing Vessels (for providing water, fuels and others) [SP-05] Project for Construction of New Port in Ataliklikun Bay
Airports	[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1) [AP-02] Project for Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)	[AP-03] Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport [AP-04] Project for Feasibility Study for Development of Tavilo Emergency Airport

Urban Infrastructure		
Urban Roads	[UR-01] Project for Rehabilitation of Port Access Road (1.8 km) in Rabaul Town including Improvement of Drainage Network in Rabaul Town [UR-02] Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town	[UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road [UR-04] Project for Development of Kokopo Town Bypass Road (6.5 km)
Water Supply	[WS-01] Project for Rehabilitation and Improvement for Kokopo Borehole Field [WS-02] Project for Rehabilitation and Improvement for Rabaul Town Area [WS-03] Project for Rehabilitation and Improvement for Nonga Area [WS-04] Project for Development of Water Supply System for Kerevat Area [WS-05] Project for Expansion of Water Supply Area for Nonga Northern Area [WS-06] Project of Development of Water Supply System for Kokopo Eastern Area	[WS-07] Project of Expansion of Water Supply System for Rabaul Town Surrounding Area [WS-08] Project of Expansion of Water Supply System for Southern Nonga Coastal Areas [WS-09] Project of Development of Water Supply System for Gazelle Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas [WS-10] Project for Expansion of Water Supply System for Baliora Area
Power Supply	[PW-01] Ulagunan Diesel Generators Rehabilitation Project [PW-02] 66kV Transmission Lines 552 and 553 Rehabilitation Project [PW-03] 66kV Transmission Lines 554 Rehabilitation Project [PW-04] Kokopo Substation Rehabilitation Project	[PW-05] Rabaul Substation Rehabilitation Project [PW-06] Kokopo Feeder 2 Rehabilitation Project [PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project [PW-08] Projects to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

18.2 Selection High Priority Projects and Priority Projects by Infrastructure Sector for NEGID-Plan

In the NEGID-Plan, among the important projects identified by infrastructure sector as shown in the previous section, "priority projects" for achieving the defined vision and for implementing regional development strategies clarified in Chapter 6 of this Final Report are selected by using the following criteria:

- Those infrastructure projects which are intended to promote regional development in respect of the following directions (one of the following conditions should be satisfied to be a priority projects):
  - To expanding the production of existing economic sectors,
  - To support the promotion of value-added economic sectors based on regionally available resources,
  - To contribute the enhancement of disaster resilience in the region, or
  - To contribute the transformation of regional spatial structure so as to promote the enhancement of disaster resilience and development of economic development.
- Moreover, while satisfying one of the above conditions, those infrastructure projects should be technically matured and well understood by relevant stakeholders.

The criteria to select "high-priority projects" out of such priority projects selected are as follows:

- Those priority projects which are highly critical in the following points in line with the formulated regional development strategies described in Chapter 6:
  - To initiate significant efforts at development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
  - To break through difficult problems on development of economic sectors, enhancement of

disaster resilience, or transformation of regional spatial structure

- To create synergies for development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure by implementing in conjunction with different infrastructure development

Table 18.2 Selected High-Priority Projects and Priority Projects for Infrastructure Development Plan in Northeast Gazelle Peninsula

Infrastructure Sectors	High Priority Projects	Priority Projects
Regional Infrastructure		
Trunk Roads	[TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road [TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	[TR-03] Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town
Ports	[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure [SP-02] Project for Upgrading of Rabaul Port Berth 2 [SP-03] Project for Basic Study on New Port Development in Ataliklikun Bay including the following aspects: - Oceanographic Survey, Topographic Survey - Survey for Land Acquisition - Environmental Survey - Study of Fixing Port Location - Feasibility Study (Economic and Financial)	[SP-04] Project for Development of Berth specially for Fishing Vessels (for providing water, fuels and others) [SP-05] Project for Construction of New Port in Ataliklikun Bay
Airports	[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)	[AP-03] Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport [AP-04] Project for Feasibility Study for Development of Tavilo Emergency Airport
Urban Infrastructure		
Urban Roads	[UR-01] Project for Rehabilitation of Port Access Road (1.8 km) in Rabaul Town including Improvement of Drainage Network in Rabaul Town [UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road	[UR-02] Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town
Water Supply	[WS-01] Project for Improvement and Rehabilitation for Kokopo Borehole Field [WS-02] Project for Improvement and Rehabilitation for Rabaul Town Area	[WS-03] Project for Improvement and Rehabilitation for Nonga Area [WS-04] Project for Water Supply Plan for Kerevat Area [WS-06] Project of Water Supply for Kokopo Eastern Area [WS-07] Project of Expansion for Rabaul Town Surrounding Area [WS-09] Project of Construction of Water Supply System for Ataliklikun New Port and Surrounding Areas
Power Supply	[PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations	[PW-02] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project [PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

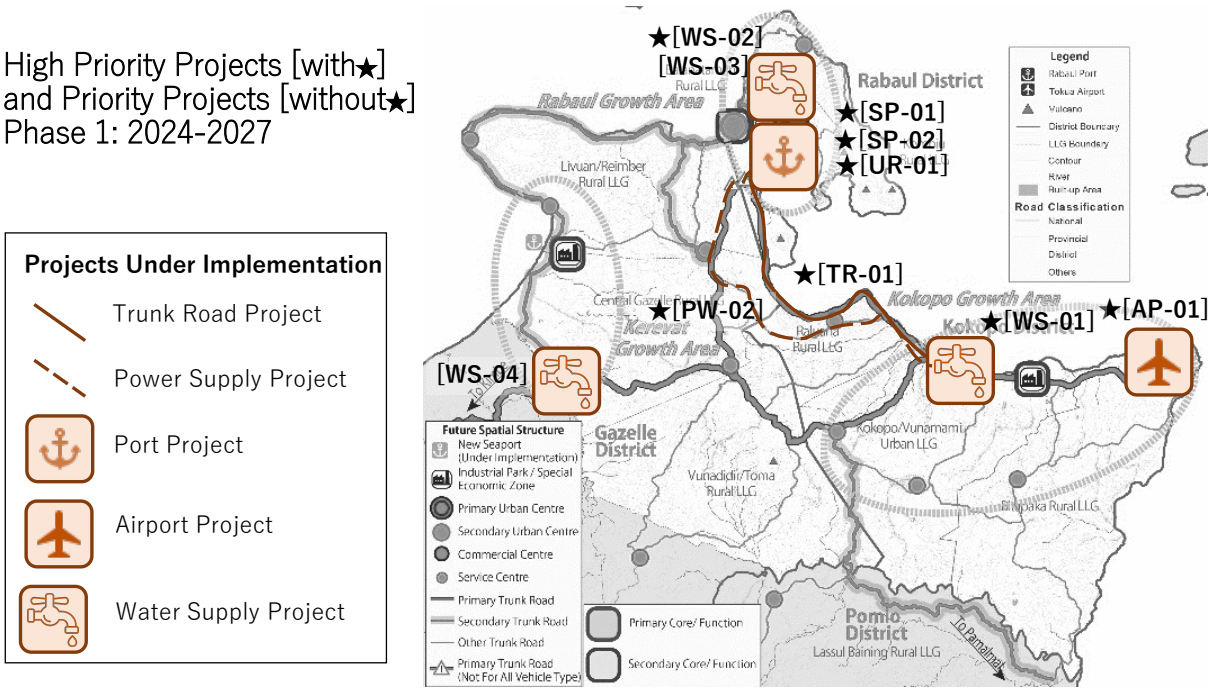
18.3 Phased Implementation Plan for High-Priority Projects and Priority Projects

As illustrated in the diagram of relationships among different aspects in regional development shown in Figure 6.1, the transformation of the spatial structure of the region needs to be promoted in order to develop the region's economic sectors and strengthen its disaster resilience. In other words, infrastructure development needs to be promoted for economic sectors development and disaster resilience strengthening, and at the same time for the transformation of the spatial structure.

A plan should be prepared to show how the High-Priority and Priority Projects selected in the previous section are to be implemented, in phases, within the timeframe.

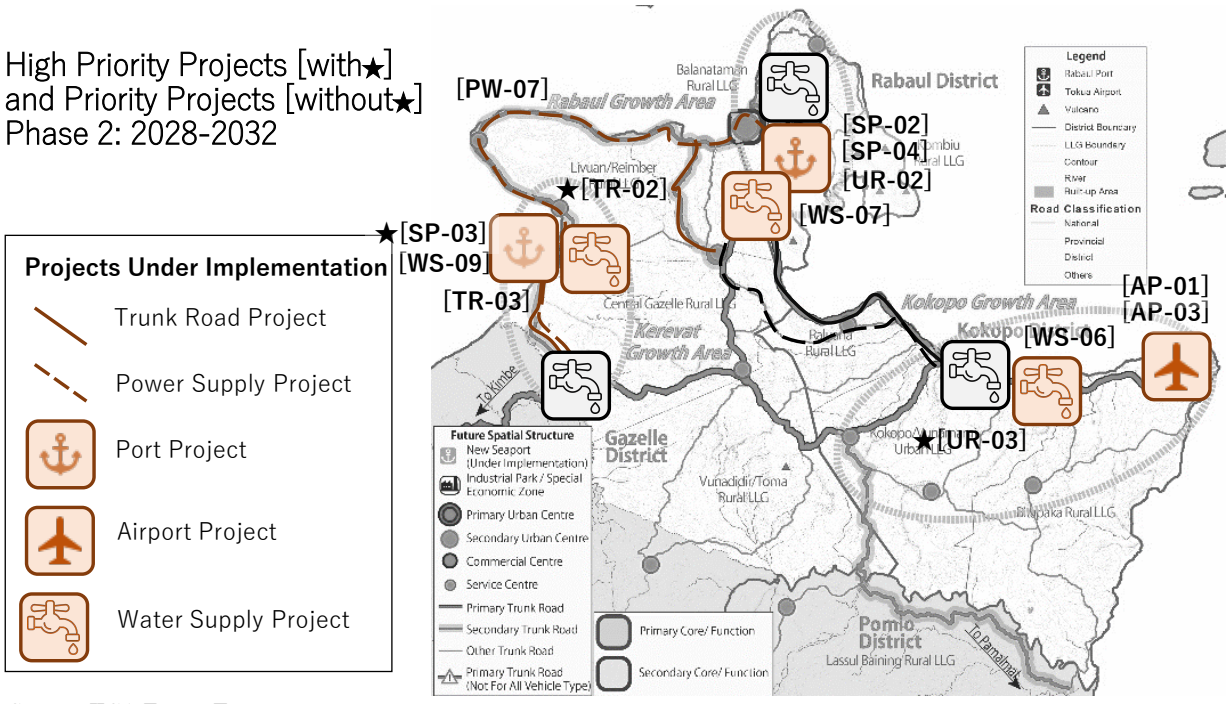
In preparation of such a phased implementation plan for high-priority and priority projects for infrastructure development, an integrated and multi-sectoral approach for infrastructure development is used rather than planning for individual infrastructure sectors.

A proposed phased implementation plan for high-priority and priority projects for infrastructure development is shown in Figure 18.1 and Figure 18.2. Furthermore, the high-priority and priority projects including the other important projects are listed by phase in Table 18.3, Table 18.4 and Table 18.5.



Source: JICA Expert Team

Figure 18.1 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 1: 2024-2027)



Source: JICA Expert Team

Figure 18.2 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 2: 2028-2032)

Table 18.3 List of Projects in Phase 1 (2024-2027)

No.	Priority	Trunk Road Projects
TR-01	High Priority	Project for Strengthening of Kokopo-Rabaul Coastal Road
No.	**Priority**	**Port Projects**
SP-01	High Priority	Project for Rehabilitation of Rabaul Port Infrastructu
SP-02	High Priority	Project for Upgrading of Rabaul Port Berth 2
No.	**Priority**	**Airport Projects**
AP-01	High Priority	Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)
No.	**Priority**	**Urban Road Projects**
UR-01	High Priority	Project for Rehabilitation of Port Access Road in Rabaul Town including Improvement of Drainage Network in Rabaul Town
No.	**Priority**	**Water Supply Projects**
WS-01	High Priority	Project for Rehabilitation and Improvement for Kokopo Borehole Field
WS-02	High Priority	Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area
WS-03	Priority	Project for Rehabilitation and Improvement of Water Supply System for Nonga Area
WS-04	Priority	Project for Development of Water Supply System for Kerevat Area
No.	**Priority**	**Power Supply**
PW-01	-	Ulagunan Diesel Generators Rehabilitation Project
PW-02A	High Priority	66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations
PW-03	-	66kV Transmission Line 554 Rehabilitation Project
PW-04	-	[Combined into PW-02A] Kokopo Substation Rehabilitation Project
PW-05	-	[Combined into PW-02A] Rabaul Substation Rehabilitation Project
PW-08	Priority	Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

Table 18.4 List of Projects in Phase 2 (2028-2032)

No.	Priority	Trunk Road Projects
TR-02	High Priority	Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road
TR-03	Priority	Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town
No.	**Priority**	**Port Projects**
SP-02	High Priority	Project for Upgrading of Rabaul Port Berth 2 (Continuing from Phase 1)
SP-03	High Priority	Project for Basic Study on New Port Development in Ataliklikun Bay
SP-04	Priority	Project for Development of Berth specially for Fishing Vessels (for providing water, fuel, and others)
No.	**Priority**	**Airport Projects**
AP-01	High Priority	Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1) (Continuing from Phase 1)
AP-03	Priority	Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport
AP-04	Priority	Project for Feasibility Study for Development of Tavilo Emergency Airport
No.	**Priority**	**Urban Road Projects**
UR-02	Priority	Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town
UR-03	High Priority	Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road
No.	**Priority**	**Water Supply Projects**
WS-05	-	Project for Expansion of Water Supply System for Nonga Northern Area
WS-06	Priority	Project for Development of Water Supply System for Kokopo Eastern Area
WS-07	Priority	Project for Expansion of Water Supply System for Rabaul Town Surrounding Area
WS-08	-	Project for Expansion of Water Supply System for Southern Nonga Coastal Areas
WS-09	Priority	Project for Development of Water Supply System for Gazelle Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas
WS-10	-	Project for Expansion of Water Supply System for Baliora Area
No.	**Priority**	**Power Supply Projects**
PW-06	-	Kokopo Feeder 2 Rehabilitation Project
PW-07	Priority	22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project
PW-08	Priority	Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

Table 18.5 List of Projects in Phases 3 and 4 (2033-2042)

No.	Priority	Trunk Road Projects
TR-04	-	Project for Upgrading of Kurakakaul-Kabaira (Ataliklikun Bay) Section of North Coast Road
TR-05	-	Project for Upgrading of Malakuna-Putput Road
TR-06	-	Project for Upgrading of Kabakaul-Toma Road
No.	**Priority**	**Port Projects**
SP-05	-	Project for Construction of New Port in a Ataliklikun Bay
No.	**Priority**	**Airport Projects**
AP-02	Priority	Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport (Continuing from Phase 2)
AP-03	-	Project for Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)
No.	**Priority**	**Urban Road Projects**
UR-04	-	Project for Development of Kokopo Town Bypass Road (6.5 km)

Source: JICA Expert Team

18.4 Selection of Candidates for Pre-Feasibility Studies in NEGID-Plan

(1) Selection Criteria for Candidates for Pre-Feasibility Studies

The selection of one candidate for pre-feasibility study is determined by the following criteria/factors:

- The candidate projects should be one of the high priority projects which satisfy the criteria for selecting the high priority projects as shown in Section 18.2.
- The candidate projects should not have any commitments for assistance from donors/development partners.
- The candidate projects should be one of the highest priority orders expressed by ENBPA.

(2) Donors' Commitment to the High Priority Projects

Considering the strategical importance of high priority projects in implementing the regional development strategies in Northeast Gazelle Peninsula, it is strongly recommended that pre-feasibility studies or full-scale feasibility studies should be conducted in a timely manner (without delay) for the all selected high-priority projects.

A feasibility study has been conducted for [AP-01] by JICA, and a financial assistance to [SP-01] and [SP-02] is under consideration by international donor agencies.[10]

[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)

[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure

[SP-02] Project for Upgrading of Rabaul Port Berth 2

The following urban road project consists of both road maintenance and Rabaul Town drainage network improvements, although the road maintenance (pavement portion) was funded by the ENBPA budget and Rabaul District budget in FY2023, while the rehabilitation work was delayed and implemented in May 2024:

[UR-01] Project for Rehabilitation of Port Access Road (1.8 km) in Rabaul Town including Improvement of Drainage Network in Rabaul Town

Therefore, it is considered that these four projects do not require any pre-feasibility studies or full-scale feasibility studies.

[10] It was under consideration by EU and AFD as of March 2024.

As a result, the following seven projects are candidate projects for pre-feasibility studies. The three candidate projects are for regional infrastructure. The other four projects are for urban infrastructure.

The following three candidate projects (regional infrastructure) for pre-feasibility studies are as follows:

★ [TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road (to be Implemented in Phase 1)

★[TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road) (to be Implemented in Phase 2)

★[SP-03] Project for Basic Study on New Port Development in Ataliklikun Bay (To be Implemented in Phase 2)

The following four candidate projects (urban infrastructure) for pre-feasibility studies are as follows:

★[UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road (to be Implemented in Phase 2)

★[WS-01] Project for Improvement and Rehabilitation for Kokopo Borehole Field (To be Implemented in Phase 1)

★[WS-02] Project for Improvement and Rehabilitation of Water Supply System for Rabaul Town Area (To be Implemented in Phase 1)

★[PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitatio of Kokopo and Rabaul Substaions (To be Implemented in Phase 1)

(3) ENBPA's Preference (Priority Orders) over Some High Priority Projects

Among these seven high-priority projects, four high-priority projects are to be implemented in Phase 1 (2024-2027), as shown in Table 18.3.

Moreover, through a discussion session with core members of PIU of ENBP, their priority orders among the high-priority projects have been identified as follows:

No.1 Urgency: [TR-01]: To be Implemented in Phase 1: No Donor's Commitment Yet

No.2 Urgency: [SP-01]: To be Implemented in Phase 1: Donor's Commitment

No.3 Urgency: [SP-03]: To be Implemented in Phase 2: No Donor's Commitment Yet

No.4 Urgency: [SP-02]: To be Implemented in Phase 1: Donor's Commitment

No.5 Urgency: [PW-02]: To be Implemented in Phase 1: No Donor's Commitment Yet

No.6 Urgency: [WS-02]: To be Implemented in Phase 1: No Donor's Commitment Yet

In consideration of all above factors, [TR-01] "**Project for Strengthening of Kokopo-Rabaul Coastal Road"** is considered the most suitable for conducting a pre-feasibility study.

Chapter 19 Profiles of Eleven High-Priority Projects for Northeast Gazelle Peninsula

Eleven high-priority projects for infrastructure development for Northeast Gazelle Peninsula are listed as shown Table 19.1.

Table 19.1 List of High Priority Projects

No.	Project Code	Project Name	Executing Agency	Project Costs (PGK million)
1	TR-01	Project for Strengthening of Kokopo-Rabaul Coastal Road	Department of Works and Highways	PGK 57 million
2	TR-02	Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	Division of Infrastructure Development, ENBPA	PGK 90 million
3	SP-01	Project for Rehabilitation of Rabaul Port Infrastructure	PNG Ports Corporation Ltd.	PGK 85 million
4	SP-02	Project for Upgrading of Rabaul Port Berth 2	PNG Ports Corporation Ltd.	PGK 80 million
5	SP-03	Project for Basic Study on New Port Development in Ataliklikun Bay	Department of Transport PNG Ports Corporation Ltd.	PGK 6 million
6	AP-01	Project for Redevelopment of Tokua Airport Phase 1	National Airport Corporation (NAC)	PGK 880 million
7	UR-01	Project for Rehabilitation of Port Access Road in Rabaul Town including Improvement of Drainage Network in Rabaul Town	Division of Infrastructure Development, ENBPA Rabaul District	PGK 42-55 million
8	UR-03	Project for Development of Southern Section of Kokopo Town Ring Road	Division of Infrastructure Development, ENBPA Kokopo City	PGK 26 million
9	WS-01	Project for Rehabilitation and Improvement for Kokopo Borehole Field	Water PNG Corporation Ltd.	PGK 5 million
10	WS-02	Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area	Water PNG Corporation Ltd.	PGK 8 million
11	PW-02A	66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations	PNG Power Corporation Ltd.	PGK 62 million
			Total	PGK 1,341 – 1,354 million

Note: The Project Codes in the above table are the same as those for the projects described in Part VII (Chapters 12 through Chapter 17).
Source: JICA Expert Team

PART VIII Strategic Environmental Assessment

Chapter 20 Strategic Environmental Assessment

20.1 SEA for NEGID-Plan

20.1.1 Background of SEA for NEGID-Plan

A Strategic Environmental Assessment (SEA) is an environmental study at policy, planning, and programme (PPP) levels. It has a profound significance in the plans for proactive environmental and social considerations at higher levels of decision-making processes by providing early warning on environmental and social impacts, and from broad and long-term perspectives. Therefore, SEA will be conducted in the process of the formulation of Infrastructure Development Plan for Northeast Gazelle Peninsula in the Project.

PNG has no act nor guidelines for SEA. Therefore, in this Planning Project, the SEA will be conducted based on JICA Guidelines for Environmental and Social Considerations. The SEA results will be reflected in the land use policy and infrastructure development plan to be formulated in the Planning Project.

20.1.2 Objectives of SEA for NEGID-Plan

The objectives of SEA for NEGID-Plan are as follows:

- To identify and assess potential impacts induced by implementing the Infrastructure Development Plan for Northeast Gazelle Peninsula
- To evaluate options from the technical, financial and environmental points of view taking into consideration views and comments from stakeholders
- To select an optimal option for the Project and propose mitigation measures to avoid, reduce and mitigate any impacts

20.2 Progress of SEA Study

(1) Screening

The legal framework and institution of the Government of PNG on environmental and social considerations and JICA's guidelines for environmental and social consideration have been reviewed, and the method for implementing the SEA in NEGID-Plan has been considered by the JICA Expert Team.

(2) The First Stakeholder Meeting for Pre-Scoping

The stakeholder meeting held on 5th April 2022 was utilised as an opportunity for pre-scoping.

In the group discussion, major concerns related to natural and social environment in Kokopo District, Rabaul District and Gazelle District were discussed among others. The main concerns raised by the participants are listed below.

- Due to climate change, the locals are experiencing higher rainfall which causes soil erosion and siltation in Rabaul Port.
- Siltation on the reefs and changes in the seabed impact the environment and marine ecosystem.

(3) Scoping

Scoping was conducted based on the environmental and social conditions of the study area, and the results of the First Stakeholder Consultation Meeting, the discussion among the participants.

Based on the scoping result, the major issues that have been selected that require further assessment are as follows:

- Marine environment including the flora and fauna
- Drainage management
- Waste management
- Land acquisition and land ownership of land for infrastructure development

Marine environment survey has been conducted to understand the current situation of the marine environment of the potential areas for port development, and disaster risk analysis has also been conducted to understand the risk of disaster in the three growth areas.

(4) The Second Stakeholder Meeting for Assessment

The stakeholder meeting held on 28th November 2022 was utilised as an opportunity for assessing the future and spatial development proposed for Northeast Gazelle Peninsula.

After the presentation about outline of the project, progress of the study, and SEA in the project from ENBPA Officer and JICA Expert Team, group discussion was held in two groups about likely impacts due to the spatial development options for Northeast Gazelle Peninsula.

Some environmental impacts such as natural resources and pollution were raised as concern for all scenarios. In Scenario 1 and Scenario 2, traffic congestion was also raised as possible negative impact. Regarding social environment and culture, possibility of affecting worship sites and religious sites were indicated by both groups for all scenarios. The necessity of increase in law-and-order issues were raised for Scenario 1 and Scenario 2, whereas there was opinion on Scenario 3 that the issues will improve if development is balanced in each growth area.

20.3 Impact Assessment for Alternative Scenarios

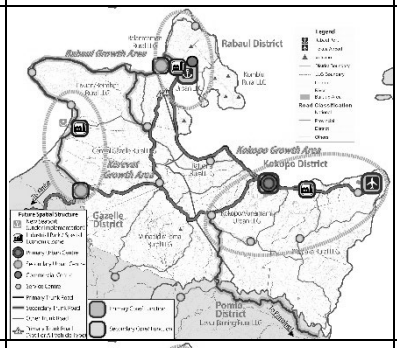
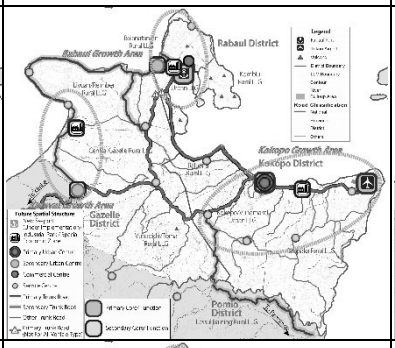
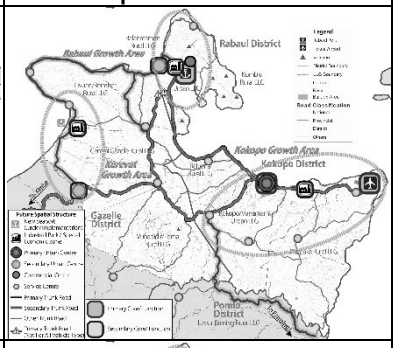
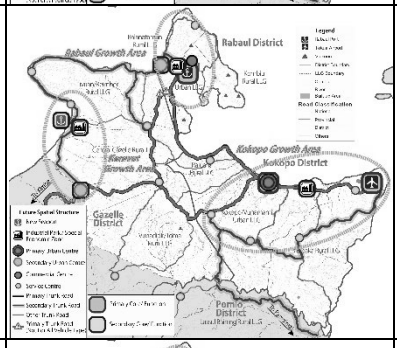
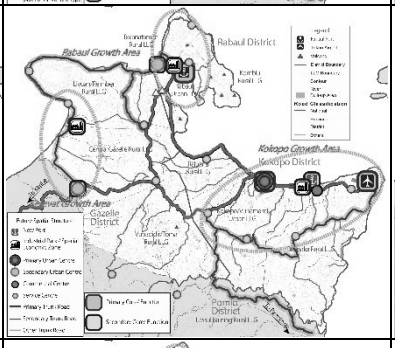
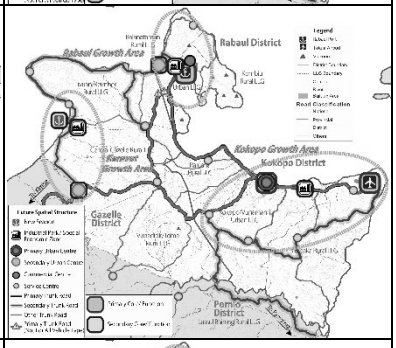
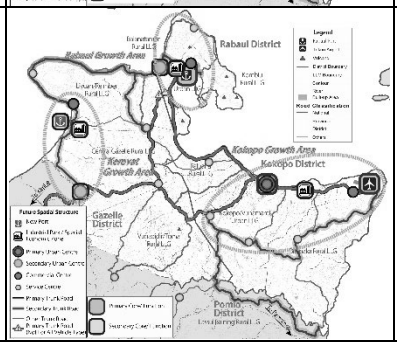
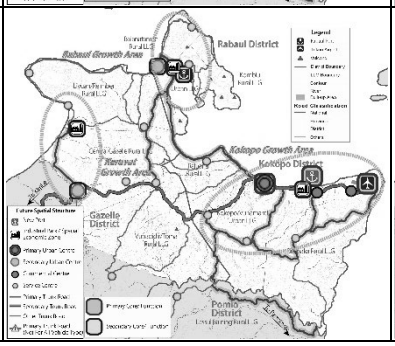
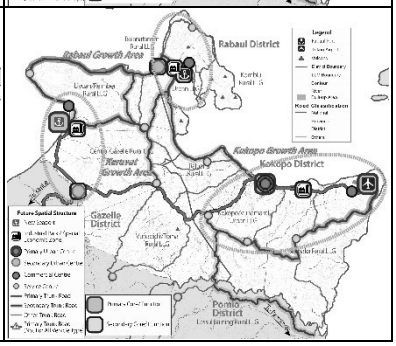
20.3.1 Three Alternative Scenarios for Regional Spatial Development

The spatial structures for years 2032, 2042 and 2052 of the three alternative scenarios for regional spatial development described in Section 9.2 are shown in **Figure** 20.1. Until 2032, these three alternative scenarios do not differ significantly, where the existing Rabaul Port will be rehabilitated, upgraded and used, but in alternative scenario 1 and 3, an alternative port for disaster response at Ataliklikun Bay will begin beyond 2032.

The alternative scenarios 1 and 3 are same in 2042, where a new port will be developed at Ataliklikun Bay, and some functions will begin to be transferred to the new port. On the other hand, in alternative scenario 2, a new port will be developed at Watta Plantation in Kokopo and some functions, such as container handling, will be transferred to the new port. There is no difference in road hierarchy among the three alternative scenarios, as Rabaul Port will continue to be the primary port in the region in all three alternative scenario until 2042.

In 2052, in alternative scenario 2 and 3, the new port will become the main port, and Rabaul Port will become a port for fishing ships and cruise ships. On the other hand, in alternative scenario 1, Rabaul Port will continue to function as the primary port. In scenarios 2 and 3, where the primary port functions are transferred to Ataliklikun Bay or Kokopo, the road between Kokopo and Rabaul, which has been maintained at high maintenance costs, will no longer need to be maintained as a primary trunk road and will become a secondary trunk road. Furthermore, in Scenario 2, the road between Rabaul and the Gazelle Agro-Industry SEZ, which is being considered for development along Ataliklikun Bay, will become a tertiary trunk road.

The location of the new port at Ataliklikun Bay will not be specified in this plan, as a more detailed survey will be required.

	Scenario 1: Ataliklikun Bay with Gazelle Agro-Processing SEZ and alternative port in case of disaster	Scenario 2: Concentrated development in Kokopo Growth Area with the new port in Kokopo	Scenario 3: Balanced development in each Growth Area with new industrial port at Ataliklikun Bay and cruise ship terminal at Rabaul Port
2032			
2042			
2052			

Source: JICA Expert Team

Figure 20.1 Alternative Scenarios for Regional Spatial Development

20.3.2 Risk Identification of Alternative Scenarios

Three development scenarios are assessed from the viewpoints of the economic and spatial, social and environmental aspects. Table 20.1 shows the results of the analysis.

Table 20.1 Evaluation of Alternative Development Scenarios

	Scenario 1: Ataliklikun Bay with Gazelle Agro-Processing SEZ and alternative port in case of disaster	Scenario 2: Concentrated development in Kokopo Growth Area with the new port in Kokopo	Scenario 3: Balanced development in each Growth Area with new industrial port at Ataliklikun Bay and cruise ship terminal at Rabaul Port
Economic and Spatial Benefit	• The port development at Ataliklikun Bay will contribute to the investment coming to the proposed Gazelle Agro-Industry SEZ in Gazelle District. • Northeast Gazelle Peninsula is prone to various disaster. By	• The location of the port will be close the existing industrial areas in Kokopo, namely Takbar and Ulaveo, as well as the regional capital Kokopo. Therefore, it will be efficient and convenience for the existing commercial and industrial industries in Kokopo.	• The three growth areas will have equal opportunities for economic growth. • The port development at Ataliklikun Bay will contribute to the investment coming to the proposed Gazelle Agro-Industry

	having an alternative port function in Ataliklikun Bay will ・ Improvement to water and power supply facilities following the trunk roads. ・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.	・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.	SEZ in Gazelle District. ・ Northeast Gazelle Peninsula is prone to various disaster. The land in Northeast Gazelle Peninsula is utilized widely and the risk of disaster can be dispersed, and the sustainability of local economies is expected to increase. ・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.
Social Impact	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector. ・ Since there will be people migrating to Kerevat area, there may be more risk of crimes and conflicts in Kerevat Growth Area. It will be necessary to increase the police service in Kerevat and along North Coast Road between Kerevat and Rabaul.	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector.	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector. ・ Since there will be people migrating to Kerevat area, there may be more risk of crimes and conflicts in Kerevat Growth Area. It will be necessary to increase the police service in Kerevat and along North Coast Road between Kerevat and Rabaul.
Environmental Impact	・ Dugongs are seen in Ataliklikun Bay, and they are feeding exclusively on seagrasses, which are observed in Kabaira Bay and Ragaga bay, Since the bay is large, depending on the location selected for the development of port within Ataliklikun Bay, it may not disturb the habitat of dugong, but careful study is necessary.	・ The new port development at Kokopo has the risk of polluting the sea around the dolphin's breading area. This will also impact the economy of Northeast Gazelle Peninsula which rely on tourism industry.	・ Dugongs are seen in Ataliklikun Bay, and they are feeding exclusively on seagrasses, which are observed in Kabaira Bay and Ragaga Bay, Since the bay is large, depending on the location selected for the development of port within Ataliklikun Bay, it may not disturb the habitat of dugong, but careful study is necessary.

Source: JICA Expert Team

20.3.3 Sustainable Tests of Alternative Scenarios

The sustainability of each scenario is assessed from the viewpoint of natural resources, social and cultural conditions and economic aspects. The results are shown in Table 20.2.

For the assessment of three alternative development scenarios, six scales of score (0 to 5) are created. The high score will show if three development scenarios support or are against the sustainability aims. The six scales of score are as follows:

- Scale 0: The scenario is not relevant.
- Scale 1: The scenario works strongly against the aims.
- Scale 2: The scenario works against the aims.
- Scale 3: The scenario on balance has neutral effect on the aims.
- Scale 4: The scenario supports the aims.
- Scale 5: The scenario strongly supports the aims.

The result of the sustainable test for alternative scenarios of regional spatial development is shown in Table 20.2. The result shows that alternative scenario 3 has the least number of scale 2 and the greatest number of scale 5. It can be said that alternative scenario 3 is the most sustainable scenario.

Table 20.2 Result of Sustainable Tests for Alternative Development Scenarios

	Performance																	
	Scenario 1						Scenario 2						Scenario 3					
Effect on Natural Resources																		
Protected areas and wildlife should be conserved, and these resources should be enhanced where practical.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Areas vulnerable to degradation should be avoided.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should encourage efficient energy use and maximize use of renewable energy rather than fossil fuels.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Discharges of pollutants and waste products to the atmosphere, water and land should be avoided or minimized.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Rivers and water bodies should retain their natural character	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Effect on Social and Cultural Conditions																		
Local character and cohesion of local communities should be enhanced where particular.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should benefit the work force, and local communities in terms of health and well-being, nutrition, shelter, education and cultural expression.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should empower women.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should create jobs for local people, particularly women and young people.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Active participation and involvement of local communities should be encouraged.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve access to water.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve access to transport.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve sanitation.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Adverse and beneficial impacts from development should be distributed equitably and should not discriminate against any groups, especially vulnerable and excluded people.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Vulnerability and risk of disasters, crises, conflicts and epidemics should be reduced.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Effect on Economy																		
Economic development should be strong and stable.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The use of raw materials and service from local industries where possible.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Development should encourage the local retention of capital and the development of downstream industries, utilizing local raw materials, products and labour.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5

Source: JICA Expert Team

20.4 Mitigation Measures for Implementing Alternative Scenario 3 for Regional Spatial Development

Based on the above two analyses, Scenario 3 is selected as the desired development scenario for Northeast Gazelle Peninsula. However, the some of the development proposed in the infrastructure development plan includes projects that have negative impact on the environmental and social situation. In particular, the impact of the new port development and SEZ location on the marine environment and the surrounding social environment should be thoroughly studied at an early stage, as shown in Table 20.1. Ataliklikun Bay is a very large bay, so it is necessary to select the most suitable site from multiple factors, and when the actual project is implemented, it is necessary to consider measures to ensure that surrounding residents are not left behind by the development and sufficient mitigation measures for natural environment.

In Scenario 3, development will be promoted especially in the Kerevat Growth Area, and consideration should be given to the impact of development, while in Rabaul, which will cede its function as the primary port to the new port, it is expected that the surrounding logistics facilities will also be relocated to the area around the new port. It is desirable to consider the use of the site in line with the vision of the Rabaul Growth Area. Therefore, when ENBPA formulates future

urban development plans for Kerevat and Rabaul, it is necessary to formulate them with such a super long-term perspective.

In that case, it is necessary to identify and designate solid waste disposal sites for the Kerevat Growth Area. The increase of development is also expected to increase the issue of waste management for both urban population and industrial waste. Especially for Kerevat Growth Area, it is necessary to identify and designate the landfill site. How to handle industrial waste must be considered in conjunction with the preparation of the SEZ.

20.5 Recommendations from SEA

In the development proposed in the infrastructure development plan, there are projects that could have negative impact on the natural and social environments. Therefore, prior to implementing each project, it is important that Environmental Impact Assessment is conducted, and necessary mitigation measures are implemented. In addition to the EIA, detailed assessment is necessary for land acquisition for projects that need land acquisition.

The result of Initial Environmental Evaluation (IEE) for the 11 high priority projects planned to be implemented in the next 10 years are shown in Chapter 19 of the Main Text.

PART IX Pre-Feasibility Study on the Project for Strengthening of Kokopo-Rabaul Coastal Road

Chapter 21 Pre-Feasibility Study on the Project for Strengthening of Kokopo-Rabaul Coastal Road

21.1 The Target Project for Pre-Feasibility Study

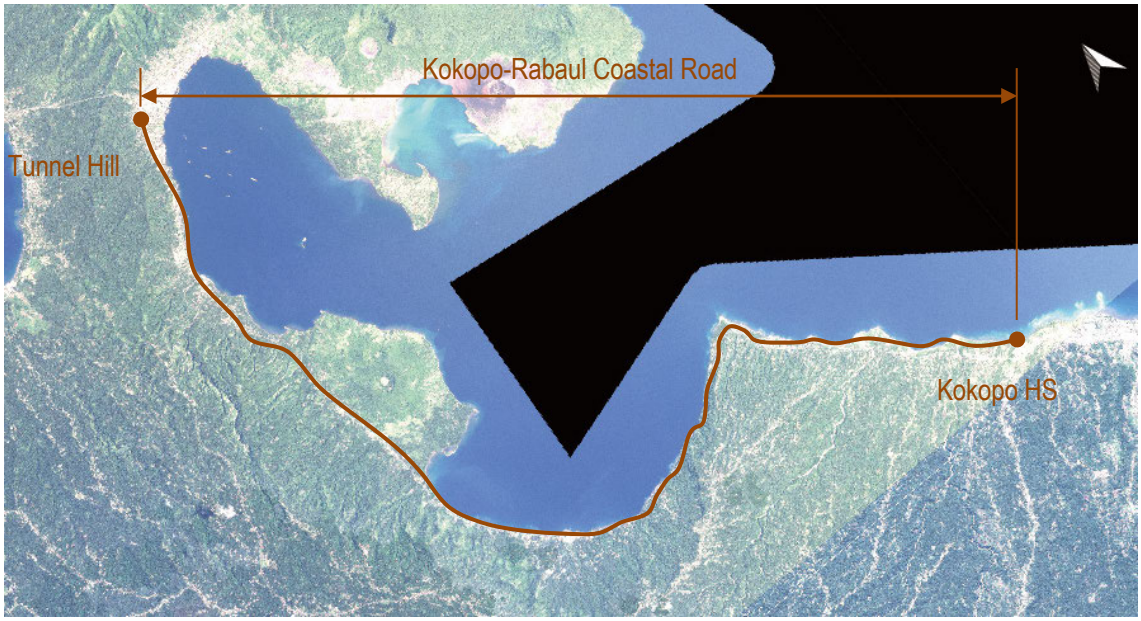
As stated in "Section 18.5. Selection of Candidates for Pre-Feasibility Study in NEGID-Plan", one of the high priority projects is selected for the conduct of a pre-feasibility study.

The selected target project for the pre-feasibility study is the Project for Strengthening Kokopo-Rabaul Coastal Road (hereinafter referred to as "the Project Road").

The outline of the Project Road is as follows:

1. Road Type: National Road
2. Road Length: 24.2 km
3. Start Point: Kokopo Secondary School
4. End Point: Tunnel Hill
5. Number of Lanes: 2 lanes
6. Pavement: Double Bituminous Surface Treatment (DBST). The project road is paved by DBST, except for an approximately 2 km long section near the Vulcan Volcano.

The location map of the project is shown in Figure 21.1.



Source: JICA Expert Team

Figure 21.1 Location Map of Kokopo-Rabaul Coastal Road

21.2 Rationale for the Target Project for Pre-Feasibility Study

21.2.1 Selection of the Target Road

In Northeast Gazelle Peninsula region, a variety of projects or actions in infrastructure sectors have been proposed by the past and current provincial development plans as discussed in Appendix C. Those proposed projects are necessary and useful for sustaining socio-economic activities and promoting socio-economic development in the region. In addition to these projects, NEGID-Plan has also identified high priority and priority projects according to the regional development strategies described in Part IV.

The high priority projects selected by NEGID-Plan satisfy the following criteria as described in Section18.3:

- To initiate significant efforts at development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
- To break through difficult problems on development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
- To create synergies for development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure by implementing in conjunction with different infrastructure development

21.2.2 Necessity and Relevance of Strengthening Kokopo-Rabaul Coastal Road

(1) Importance of the Kokopo-Rabaul Coastal Road

The Kokopo-Rabaul Coastal Road is the most important trunk road linking the Rabaul Port to many centres in the Northeast Gazelle Peninsula Region, as shown below:

- Rabaul Por is the main port in the Northeast Gazelle Peninsula, responsible for the import and export of containers, bulk cargo and fuel.
- Cargo from Rabaul Port to all areas (except for Rabaul) in the region is transported by heavy vehicles using the Kokopo-Rabaul Coastal Road.
- As an alternative to the Kokopo-Rabaul Coastal Road, there is an inland road (locally called “Top Road”) between Burmah Junction and Kokopo Secondary School, but it has steep gradients and sharp bends and is not accessible to large heavy vehicles. (Fuel tankers can, however, be allowed on the road with leading cars in front and behind.)
- The Kokopo-Rabaul Coastal Road is an important regional arterial road linking Rabaul Port with Kokopo Town and Tokua Airport, as well as the Gazelle District (Kerevat Town) and Pomio District (Warangoi).
- The Gazelle and Pomio Districts also produce export-oriented agricultural and forest products, which need to be trucked by road to Rabaul Port. The Kokopo-Rabaul Coastal Road is used for this purpose, as it is the shortest route and allows the passage of large heavy vehicles.

(2) Vulnerability of the Kokopo-Rabaul Coastal Road

However, the Kokopo Rabaul Coastal Road is a coastal road formed by a submerged caldera created by major eruptions of volcanos in the region in the past. On the landward side of the road are the outer slopes of the caldera, which are covered with ash from past volcanic eruptions. Several floodways have formed, and the slopes are prone to collapse. As a result, several times a year, during heavy rainfall events, the slopes collapse and a large supply of sediment flows into the area, causing the coastal road to be closed to traffic.

- The area has weak ground due to soil deposits of volcanic ash. As a result, when it rains, the

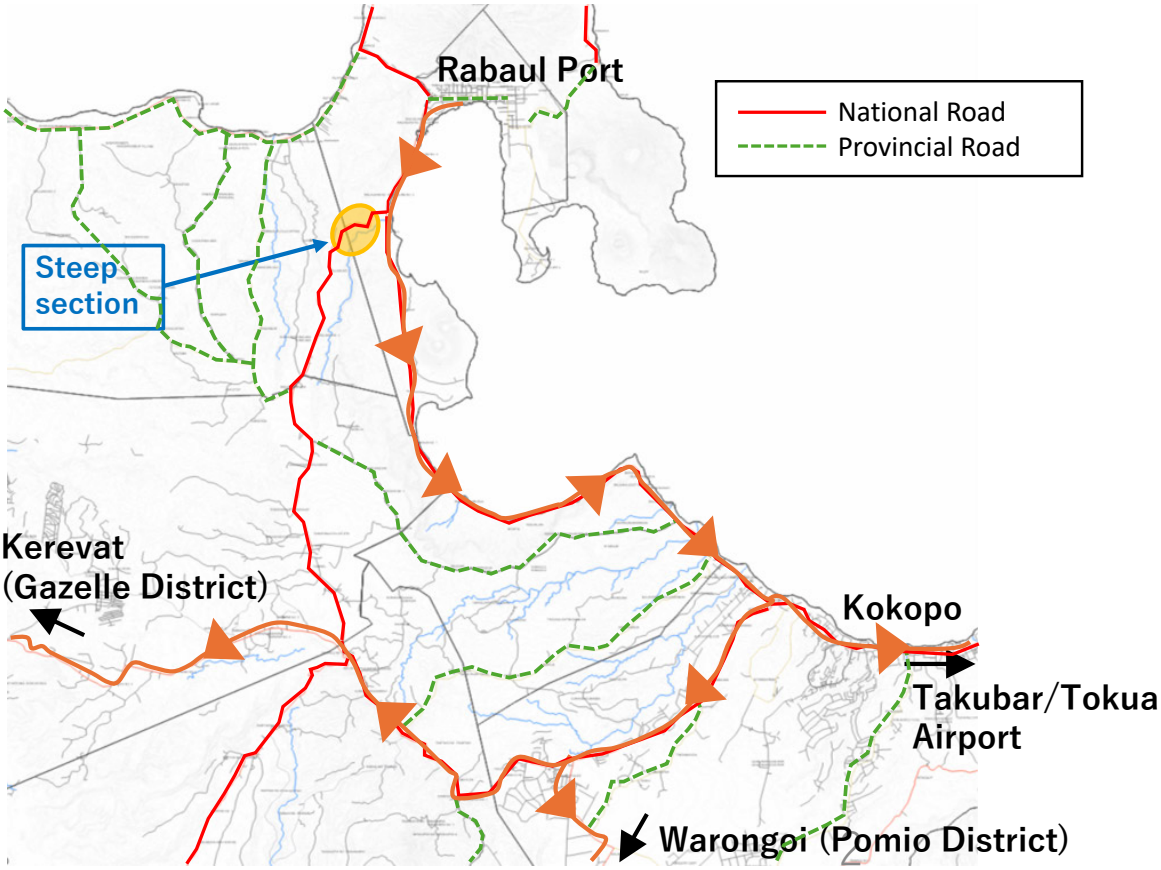
slopes are prone to landslides, which repeatedly cause damage to roads and bridges.

- In particular, the Kokopo-Rabaul Coastal Road, which connects Kokopo to Rabaul in the shortest distance, is often closed during the rainy season.
- Although there is an inland road for diversion, there are some steep sections that are impassable for large trailer vehicles carrying 40-feet containers.
- As a result, there is sometimes a physical cut-off between Rabaul Town, which has the ENBP's main port, and Kokopo Town, the administrative and economic centre of the province, resulting in disruption of logistics.

(3) Need to Strengthen the Kokopo-Rabaul Coastal Road

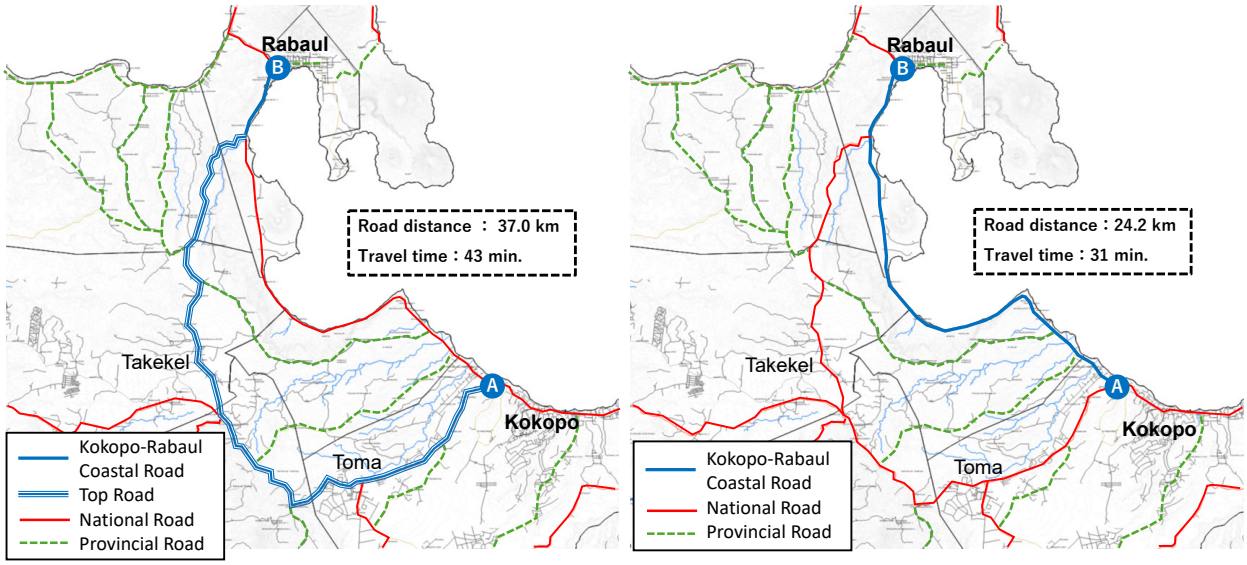
The Regional Development Scenario for Northeast Gazelle Peninsula indicates that it will take about 20 years for the cardo demand at Rabaul Port and the size of the regional economy in the Northeast Gazelle Peninsula to continue to grow in the future and for measures to move the Port of Rabaul away from the volcanic eruption hazard of Rabaul to as safe an area as possible to be feasible. In order to promote regional development and regional infrastructure development according to this scenario, it is first necessary to aim for sustainable development of the regional economy, centred on the Rabaul Port, in the short to medium term.

To this end, the Kokopo-Rabaul Coastal Road, a regional trunk road connecting Rabaul Port to Kokopo, the largest administrative and commercial city in the region needs to be strengthened in terms of improving disaster resilience and ensuring mobility.



Source: JICA Expert Team

Figure 21.2 Logistics Route in Northeast Gazelle Peninsula Region



Source: JICA Expert Team

Figure 21.3 Kokopo-Rabaul Coastal Road and Top Road (Inland Road) in Northeast Gazelle Peninsula Region

21.2.3 Objectives of the Study

The objectives of the pre-feasibility study are as follows:

- To review existing conditions of the project road
- To prepare a road improvement plan by road section
- To conduct preliminary design for strengthening the project road
- To prepare preliminary cost estimates for strengthening the project road
- To conduct a study on environmental and social considerations
- To conduct an economic analysis based on future traffic demand forecast
- To select priority road sections for a further feasibility study

21.3 Future Traffic Demand Forecast

A summary of the methodology for setting the traffic volume of passenger vehicles and the traffic volume of cargo vehicles in Cases 1, 2, 3 and 4 is provided in Table 21.1.

Table 21.1 Four Growth Cases of Traffic Demand for Kokopo-Rabaul Coastal Road and Top Road

	Traffic Volume of Passenger Vehicles	Traffic Volume of Cargo Vehicles
Case 1 Lower than Basic Growth	**The same** as annual average population increase rates	**The same** as annual average population increase rates
Case 2 Basic Growth	**The same** as annual average population increase rates	**The same** as annual average GRDP increase rates
Case 3 Medium Growth	**1.5 times** larger than annual average population increase	**2.0 times** larger than annual average GRDP increase rates
Case 4 High Growth	**2.0 times** larger than annual average population increase rates	**2.5 times** larger than annual average GRDP increase rates

Source: JICA Expert Team

The future vehicle traffic volumes on Kokopo-Rabaul Coastal Road and Top Road are estimated for Case 4 as shown in Table 21.4 and Table 21.5.

On the other hand, the baselines (in 2023 and 2020) of the present traffic volumes for Kokopo-Rabaul Coastal Road and Top Road volumes are shown in Table 21.2 and Table 21.3.

Table 21.2 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Baseline

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual
2023 (1)	1,004	196
	Passenger Volume (Both Directions, Persons/Day) Estimated	Cargo Volume (Both Directions, Tons/Day) Estimated
2023 (2)	5,920	1,187
	Rabaul Port Total Cargo Handled (1,000 tons per Day) Actual	Rabaul Port Toral Container Handled (TEUs) Actual
2020 (3)	603.0	20,300

Source:
(1) JICA Expert Team's Traffic Count Survey in October 2023
(2) JICA Expert Team's Vehicle Occupation Survey in October 2023
(3) Rabaul Port Office of PNG Ports Corporation Ltd., 2202

Table 21.3 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Baseline

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual
2023 (1)	1,495	155
	Passenger Volume (Both Directions, Persons/Day) Estimated	Cargo Volume (Both Directions, Tons/Day) Estimated
2023 (2)	36,789	121

Source:
(1) JICA Expert Team's Traffic Count Survey in October 2023
(2) JICA Expert Team's Vehicle Occupation Survey in October 2023

Table 21.4 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Case 4 with Project

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day)	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day)
2048	6,302	1,233
	Passenger Volume (Both Directions, Persons/Day)	Cargo Volume (Both Directions, Tons/Day)
2048	304,362	7,746

Source: JICA Expert Team

Table 21.5 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Case 4 with Project

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day)	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day)
2048	17,340	659
	Passenger Volume (Both Directions, Persons/Day)	Cargo Volume (Both Directions, Tons/Day)
2048	132,870	435

Source: JICA Expert Team

21.4 Present Road Conditions and Natural Conditions

21.4.1 Present Road Conditions

The Project Road is basically paved with Double Bituminous Surface Treatment (DBST). However, damages (such as potholes and cracks) are found in some sections.

The Project Road has been damaged mainly by rainwater that remained on the road surface during rainy season. Drainage facilities, such as side ditches and cross culverts, are installed only in a few sections, but these have not functioned properly due to lack of maintenance.

Approximately 2 km-long section near Vulcan Volcano has not been paved after the 1994 volcanic eruption because donors, such as the World Bank and Australian Aid, consider it too costly to restore and maintain this road section due to its vulnerability to volcanic eruption.

21.4.2 Present Drainage Conditions

As a result of the JICA Expert Team's survey, the following flood/ drainage situation have been confirmed.

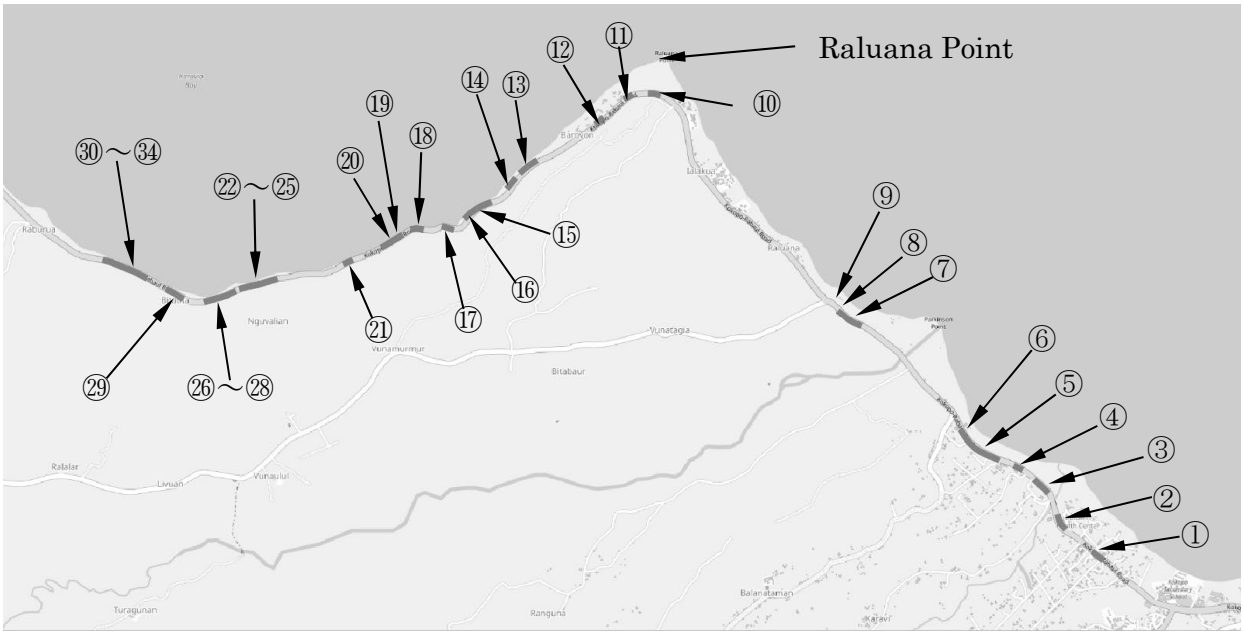
- Before the 1994 eruption, the natural channels within the study area maintained a groove-like shape. But after the eruption, the channels were gradually buried and lost this shape (i. e., the groove-like shape of the natural channels disappeared/buried as the ash within the catchment area eroded and was carried by rainwater and deposited).
- The status of the installed drainage facilities, such as U-shaped channels and culverts, is as follows: (1) drainage facilities near Rabaul's city centre are relatively well maintained, but drainage capacity of other areas is not very high and is not well maintained, (2) ditches and crossing culverts have been installed only in some sections of the Kokopo-Rabaul Coastal Road, but they are buried under the soil and are not functioning.
- As a result of siltation in the stream channel, stormwater from the floodway flows over the carriageway, accelerating the deterioration of the road pavement structure.
- Sediment generation and deposition during floods are the most serious problems in the study area. In particular, the coastline (delta) at the end of the flood flow channel in Karavi / Ralaguna / Rabulo is still changing and developing. Sediment deposition on the road around Raluana / Blue Lagoon / Malaguna / Rabaul town and road erosion around Vulcan are also problems.
- The results of the interviews and other information indicate that there are sections where large amounts of sediment have accumulated on the road, where the road has eroded, and where the road height has been changed by sediment.
  - Old building columns remained at the site, and historical Google Earth imagery indicates that 2.4 m of sediment has been deposited in the Languna Recreation Area in 17 years between 2005 and 2022. (According to the interview with local informants)
  - The results of the interviews with residents and the topographic analysis show that a section of the Balkan Earth Road has eroded downwards by up to approximately 2 m in 12 years between 2010 and 2022 (According to the interview with local informants).

21.4.3 Slope Conditions

This area consists of the volcaniclastic material (mainly pyroclastic flow deposits) erupted during the formation of Rabaul Volcano (Pleistocene to Holocene). The Kokopo-Rabaul Coastal Road on the east side of Raluana Point passes through the foot of the mountain slope and cut slopes with a maximum height of about 10 m can be seen along the road. On the other hand, to the west of Cape

Raluana, the Rabaul Caldera Wall looms over the coast, and steep cliffs more than 100 m high are distributed along the Kokopo-Rabaul Coastal Road.

Figure 21.4 shows the location of slopes where slope protection is determined to be necessary for road rehabilitation.



Source: JICA Expert Team

Figure 21.4 Location Map of Slopes to Be Protected

A summary of information for each slope is given in Appendix E of the Main Text. In addition, elastic wave velocity measurements and Schmidt Hammer tests were conducted as appropriate to determine the strength of the ground mass in a simplified method.

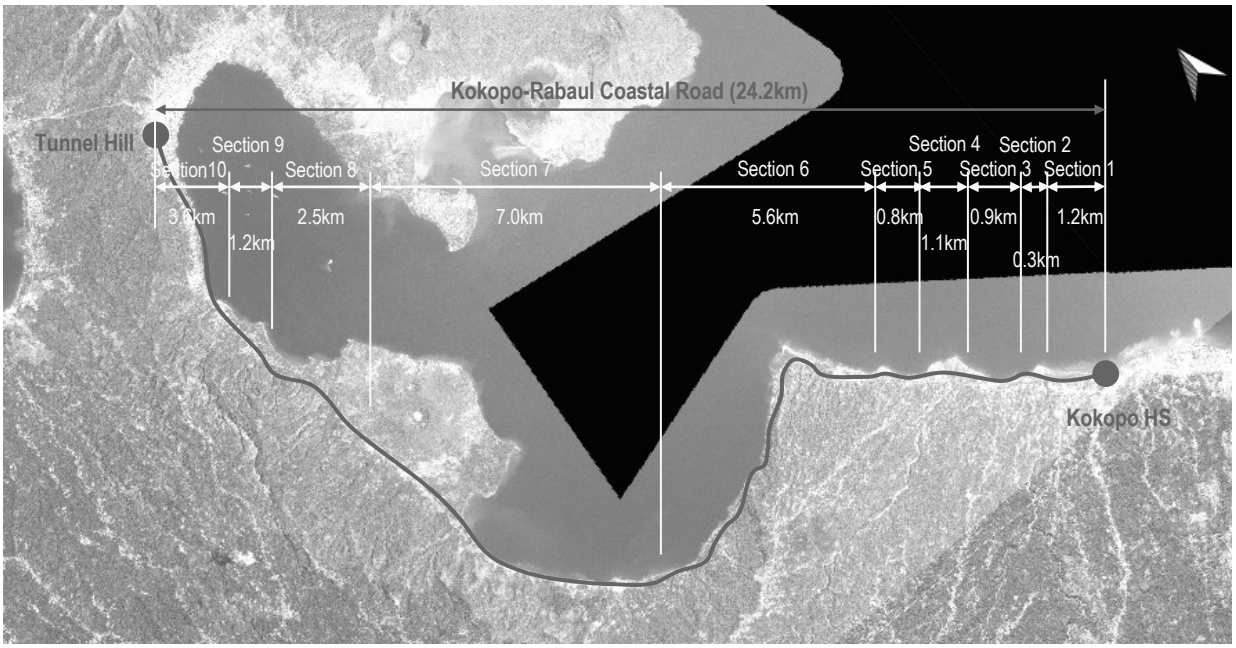
21.5 Review of Existing Plans and Projects

Tokua-Kokopo-Rabaul Road is the most important trunk road in the region under the government's Connect PNG Programme. In the Connect PNG Programme, upgrading of the road from Tokua Airport to Takubar and then to the Kokopo City is to be started through the ENBPA's budget in 2024.

Kokopo-Rabaul section, the western part of Tokua-Kokopo-Rabaul Road is also the target area of the Connect PNG Programme. It is important to also upgrade the west part of this Road (Kokopo - Rabaul) as Phase 2 project in order to provide proper road transport service in all road sections. The national government of PNG, as well as ENBPA, will have to find funds including international development partners' assistance.

21.6 Road Improvement Plan

Road sections of Kokopo-Rabaul Coastal Road are shown in Figure 21.5.



Source: JICA Expert Team

Figure 21.5 Road Sections of Kokopo-Rabaul Coastal Road

It is proposed that improvement measures shown in Table 21.6 will be conducted for each road section. These improvement measures were determined in consideration of road conditions for each road section.

Table 21.6 Improvement Measures for Road Sections

Section	Road Improvement	Drainage Improvement	Slope Improvement
Section 1	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 2	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand / soil from the mountain during heavy rain.	- Slope protection is provided.
Section3	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 4	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand/soil from the mountain during heavy rain.	-
Section 5	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 6	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 7	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	-
Section 8	- DBST is provided. - Proper cross fall to discharge rainwater is	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some	-

	provided. - Road height is raised to secure the waterway under the road.	points. - Waterway is constructed along the mountain side of road to prevent inflow of the water from the mountain into the road.	
Section 9	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand/soil from the mountain during heavy rain.	-
Section 10	-	-	-

Source: JICA Expert Team

21.7 Preliminary Design

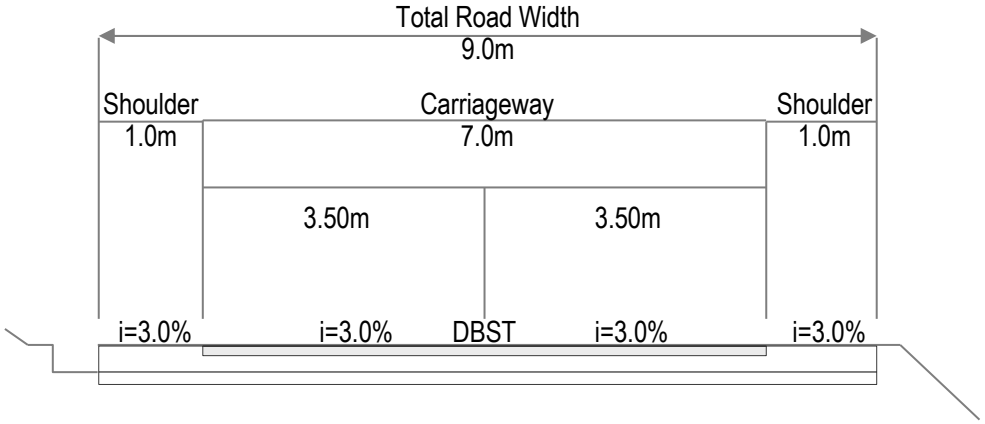
21.7.1 Preliminary Road Design

(1) Geometric Design

Horizontal alignment will follow the existing one. Also, the vertical alignment will basically follow the existing one, but road height will be raised at some sections considering the flood level and to install cross drainage culvert under the road.

(2) Cross-Section

Cross-section of the Project Road will be the same as the existing condition, as this project is carried out for the improvement of existing road and not for new road construction. Typical cross-section of the Project Road is shown in Figure 21.6. However, the width of shoulder will vary at each road section. The existing shoulder width will be followed.



Source: JICA Expert Team

Figure 21.6 Typical Cross-Section of the Project Road

(3) Pavement

DBST (Double Bituminous Surface Treatment) will be applied as the pavement of the Project Road based on the following aspects.

- It was considered to apply asphalt concrete pavement, as heavy vehicles use the project road. However, the traffic volume of such vehicles is not high.
- There is no asphalt plant in New Britain Island, thus construction cost for asphalt road becomes too high. Thus, this is not economically feasible.

Pavement structure was determined based on Road Note 31: A Guide to the Structural Design of Surfaced Roads in Tropical and Sub-Tropical Regions. Pavement structure of the Project Road is shown in Table 21.7.

Table 21.7 Pavement Structure of the Project Road

Surface	DBST
Roadbase	200 mm (crushed rock)
Sub-base	250 mm (natural gravel)

Source: JICA Expert Team

(4) Bridges

Existing bridges or box culverts located in Road Section 2, 4 and 9 have been filled with soil and uprooted trees from the mountain during heavy flooding in the rainy season; thus, these are not functioning. Therefore, new bridges will be constructed in this project. Length, span and abutment height were determined based on the simplified hydrological analysis. Steel I girder was selected in this pre-feasibility study as it is the popular superstructure type in New Britain Island.

21.7.2 Preliminary Drainage Design

(1) Simplified Flood Analysis and Necessary Road Raising Heights

Simplified flood analysis was conducted to estimate the flood height above the road. A two-dimensional flood analysis was carried out using ALOS-DEM terrain with a simple 24-hour rainfall distribution over the target basin.

Based on the simplified flood analysis results, the height of the project road was estimated (equivalent to 50-year probability). Table 21.8 shows the road raising section and the average flood height for each section.

Table 21.8 Inundation Length along Proposed Kokopo-Rabaul Coastal Road

Road Improve-ment Section	BP	EP	Total Length (m)	Heightening Length (=Inundated Length) (m)	Rate of (Inundation Length / Total Length)	Average Heightening Height: $Z_{50\text{-}20}$ (m)	Maximum Inundation Height in Inundation Section (m)	Remarks
Section 1	0+000.0	1+182.7	1182.711	860.559	72.8%	0.287	0.0 ~ 1.454	
Section 2	1+182.7	1+483.1	300.348	263.800	87.8%	**0.527**	0.0 ~ 1.594	Karavi
Section 3	1+483.1	2+380.1	897.057	378.618	42.2%	0.170	0.0 ~ 0.332	
Section 4	2+380.1	3+430.2	1050.133	767.405	73.1%	0.294	0.0 ~ 0.780	Ranguna
Section 5	3+430.2	4+208.3	778.073	146.190	18.8%	0.036	0.0 ~ 0.165	
Section 6	4+208.3	7+849.8	3641.501	1232.730	33.9%	0.056	0.0 ~ 0.214	
Section 7	7+849.8	16+802.2	8952.373	2786.995	31.1%	0.111	0.0 ~ 0.604	
Section 8	16+802.2	19+247.3	2445.141	2445.141	100.0%	**2.000**	0.0 ~ 0.638	Estimated
Section 9	19+247.3	20+423.4	1176.105	1005.815	85.5%	**0.337**	0.0 ~ 0.471	Rapolo
Section 10	20+423.4	24+069.5	3646.060	2028.176	55.6%	0.125	0.0 ~ 0.306	

Source: JICA Expert Team

(2) Drainage Structure Sizes

The design scale of the drainage structure was determined by adding a freeboard to the rainfall return period shown in Table 21.9, with reference to the PNG design standards, etc.

Table 21.9 Design Scale and Freeboard

	Return Period (Return period)	Freeboard
Road Side Ditch	10 years	20% of Cross Section Height
Culvert	20 years	20% of Cross Section Height
Bridge Channel	50 years	0.8 m for Karavi and Ranguna, 0.6 m for Rapolo
Road Shoulder Height	50 years	0.3 m

Source: JICA Expert Team

Table 21.10 and Table 21.11 show the size, number and length of drainage structures estimated from the probable rainfall amount.

Table 21.10 Necessary Culvert Size and Numbers for Kokopo-Rabaul Coastal Road

Culvert Type	C90-1	Ia	Ib	Ic	II	III	IVa	III-2	IVb	IV-2	V-2	Subtotal
Width (m)	0.90	1.00	1.00	1.00	1.50	2.00	3.00	2.00	3.00	3.00	4.00	
Height (m)	0.90	1.00	1.50	2.00	2.00	2.00	2.00	2.00	3.00	3.00	4.00	
Cell No.	1	1	1	1	1	1	1	2	1	2	2	
Slope	0.60%	0.60%	0.50%	0.50%	0.40%	0.35%	0.25%	0.35%	0.20%	0.20%	0.10%	
Discharge Capacity (m3/s)	1.19	1.88	2.83	3.96	6.46	9.13	13.49	18.26	20.35	40.70	61.98	
Section 1	1							1				2
Section 2												
Section 3	4	1	1			1						7
Section 4	1									1		2
Section 5	4	1										5
Section 6	10	3			2	2						17
Section 7	19	6	3	2	6	3	2	2		2		45
Section 8	3	1	3	1			1	1				10
Section 9	1		1		1	1						4
Section 10	14	3	2	1	3							23
Total	57	15	10	4	12	7	3	4		3		115

Source: JICA Expert Team

Table 21.11 Necessary Road Side Ditch Length for Kokopo-Rabaul Coastal Road

Section ID	Unit	U 0.3m*0.3m	U 0.6m*0.6m	U 1.0m*1.0m	U 3.0m*2.0m
Section 1	m	1582.65	782.77		
Section 2	m	425.89	174.81		
Section 3	m	1408.93	385.18		
Section 4	m	1699.19	401.08		
Section 5	m	1145.39	410.76		
Section 6	m	4716.91	1616.27		
Section 7	m	11743.13	3994.24	50.00	62.20
Section 8	m	3745.02	977.46		167.80
Section 9	m	1838.64	513.57		
Section 10	m	5867.78	1424.33		
Total Length	m	34173.53	10680.47	50.00	230.00

Source: JICA Expert Team

(3) Function and Size for Sediment Ponds

For the annual sediment yields and the sediment pond's cross-section determined, the sediment pond length from the annual number of sand removals was calculated. (See Table 21.12) After taking into account the length of the sedimentation pond, construction cost and its effects, the length of the sedimentation pond is proposed, assuming the "sand removal work four times a year." (See Table 21.13)

Table 21.12 Lengths and Sand Pit Volumes of Three Sediment Ponds

Floodway Name	Velocity in Sediment Pond				Movable Bedload (Sediment) Diameter (mm) for 1.1-Yr Flood		Annual Sediment Yield		1 Time/Year for Sand Removal Maintenance			
	Velocity of 50-Yr Flood: V50 (m/s)		Velocity of 1.1-Yr Flood: V1.1 (m/s)				Annual Mean Sediment Yield: Vas (m^3/year)	Estimated Yield: 50% * Vas (m^3/year)	Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) More Than 0.5 mm Grain Size	
											50 yrs Flood	1.1 yr Flood
Karavi	1.12	~ 1.95	0.33	~ 0.94	0.64	~ 7.58	51,067	25,533	**290.0**	25,891	78.1%	94.8%
Ranguna	1.06	~ 1.93	0.31	~ 0.90	0.55	~ 6.64	56,005	28,003	**240.0**	28,608	74.6%	93.5%
Rapolo	1.22	~ 1.97	0.34	~ 0.97	0.76	~ 8.59	16,323	8,162	**340.0**	8,262	80.6%	95.7%

Floodway Name	2 Times/Year for Sand Removal Maintenance				3 Times/Year for Sand Removal Maintenance				4 Times/Year for Sand Removal Maintenance			
	Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) more than 0.5 mm grain size		Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) more than 0.5 mm grain size		Sediment Pond Length: L (m)	Sand Pit Volume: Va (m3)	Average Sand Removal Ratio (%) More than 0.5 mm Grain Size	
			50 yr Flood	1.1 yr Flood			50 yr Flood	1.1 yr Flood			50 yr Flood	1.1 yr Flood
Karavi	**150.0**	13,392	64.8%	90.3%	**100.0**	8,928	55.1%	86.2%	**75.0**	6,696	48.0%	82.4%
Ranguna	**120.0**	14,304	59.5%	87.7%	**80.0**	9,536	49.5%	82.7%	**60.0**	7,152	42.3%	78.2%
Rapolo	**170.0**	4,131	67.5%	91.8%	**115.0**	2,795	58.4%	88.4%	**85.0**	2,066	50.9%	84.9%

Source: JICA Expert Team

Table 21.13 Approximate Construction Cost of Three Sediment Ponds

Floodway Name	Length (m) for Sediment Pond				Approximate Construction Cost (JPY)				Remarks
	Sand Removal Maintenance				Sand Removal Maintenance				
	1 time/ year	2 times/ year	3 times/ year	4 times/ year	1 time/ year	2 times/ year	3 times/ year	4 times/ year	
Karavi	290.0	150.0	100.0	75.0	572,321,379	390,194,288	310,701,960	282,192,087	
Ranguna	240.0	120.0	80.0	60.0	542,752,630	392,275,687	342,117,139	317,037,865	
Rapolo	340.0	170.0	115.0	85.0	387,509,360	237,596,553	183,191,187	158,276,937	
Σ Total Construction Cost (JPY)					1,502,583,369	1,020,066,528	836,010,286	757,506,888	

Source: JICA Expert Team

21.7.3 Preliminary Slope Protection Design

List of Target Slope for the protection works are shown in Table 21.14.

Table 21.14 List of Target Slope for Protection Works

Slope No	Start		End		Slope Condition					Vp (m/s)				SH test		Section
	Latitude	Longitude	Latitude	Longitude	Length	Heght	Angle	Area	Geology	Surface Vp	Surface Thickness(m)	Core Vp	Core Strength kN/m2	R	Strength kN/m2	
1	-4.32827	152.24398	-4.32791	152.2436	61	5	90	280	PFD	388	0.35	483	691			1
2	-4.32616	152.24127	-4.32541	152.2409	98	9	60	925	PFD							1
3	-4.32349	152.24016	-4.3228	152.2395	110	7.5	80	781	PFD							2
4	-4.3219	152.23832	-4.32183	152.238	36	9	80	247	PFD							3
5	-4.32122	152.23662	-4.31999	152.2347	262	8	80	2063	PFD	260	0.32	385	478			3
6	-4.31983	152.23453	-4.31933	152.2342	66	6	80	366	PFD							3
7	-4.31184	152.22681	-4.31152	152.2262	81	11	45	1089	PFD							5
8	-4.31142	152.22601	-4.311	152.2255	77	6	60	492	PFD							5
9	-4.31066	152.22514			36	7	70	216	PFD	240	0.49	357	423			5
10	-4.29569	152.21253	-4.29564	152.212	56	6.5	90	322	PFD							6
11	-4.29577	152.21052	-4.29598	152.2103	35	14.5	60	343	PFD							6
12	-4.29744	152.20847	-4.29754	152.2082	36	17	60	373	PFD							6
13	-4.30037	152.20376	-4.30106	152.2028	128	7	90	847	PFD	233	0.56	370	488	10	7154	6
14	-4.30175	152.20228	-4.30218	152.2019	63	15	60	831	PFD							6
15	-4.30331	152.20043	-4.30389	152.1993	138	8.5	90	1101	PFD	467	NA	556	868	35	25039	6
16	-4.30409	152.19911	-4.30427	152.1989	30	8.5	80	186	PFD							6
17	-4.30508	152.19786	-4.30487	152.1974	51	9	90	378	WT	300	1.02	611	1011	41	29331	6
18	-4.30513	152.19567	-4.30508	152.1951	57	10	90	470	PFD							6
19	-4.30563	152.1942			15	7	80	57	PFD							6
20	-4.30567	152.19405	-4.30632	152.193	136	13	90	1599	PFD/WT	385	NA	400	509	53	37916	6
21	-4.3074	152.19067	-4.3075	152.1903	38	8.5	70	267	PFD					19	13593	6
22	-4.30867	152.18529	-4.30873	152.185	35	7	45	277	PFD							6
23	-4.3088	152.18467			60	10	80	508	PFD							6
24	-4.309	152.184			36	8	80	227	PFD							6
25	-4.30913	152.18359	-4.30922	152.183	71	9	60	644	PFD							6
26	-4.30951	152.18228			44	8	65	318	PFD							6
27	-4.30966	152.18184	-4.30989	152.1816	37	9.5	65	288	PFD							6
28	-4.30995	152.18127	-4.31021	152.1805	94	11	70	972	PFD					11	7869	6
29	-4.30986	152.17867	-4.30942	152.1778	108	8	55	977	PFD							6
30	-4.30849	152.17605	-4.30837	152.1758	32	5.5	45	206	PFD							6
31	-4.3082	152.17556			60	8	60	480	PFD							6
32	-4.30796	152.175	-4.30772	152.1743	72	10	80	630	PFD							6
33	-4.30772	152.17431	-4.30758	152.174	43	10	70	351	PFD							6
34	-4.30744	152.17364	-4.30735	152.1733	42	9	50	388	PFD							6
				Total	2344			19,499		Geology (PFD: Pyroclastic Flow Deposit, WT: Welded Tuf)						

Source: JICA Expert Team

21.8 Preliminary Cost Estimates

The construction cost of the Project Road was estimated based on the following conditions in this Pre-Feasibility Study.

- Construction cost was estimated in accordance with the JICA Design and Cost Estimate Manual.
- Unit costs of labour, materials, equipment, etc. were determined basically based on the quotations obtained in PNG.
- Unit costs which could not be obtained in quotations were determined based on information from past projects in PNG considering price escalation.
- Unit costs of bridge girders were determined in reference to past projects in other countries.
- 1 USD = 143.97 JPY and 1PGK = 41.07 JPY were used as exchange rates.

Construction cost of the Project Road is shown in Table 21.15. It shows construction cost of all road sections as well as alternative implementation scheme (selection of road sections to be included in the project).

Table 21.15 Construction Cost of the Project Road

Alternative Implementation Scheme	Construction Cost (PGK Million)	Sections									
		1	2	3	4	5	6	7	8	9	10
			Bridge Sediment Pond		Bridge Sediment Pond				Road Height Raising	Bridge Sediment Pond	
All Road Sections (without 10)	PGK 187 mil. (L=20.4 km)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Road Sections Including Bridges, Sediment Pond and Road Height Raising (Sections 2, 4, 8, 9)	PGK 92 mil (L=5.1 km)		✓		✓				✓	✓	
Road Sections Including Bridges and Sediment Pond (Sections 2, 4, 9)	PGK 66 mil (L=2.4 km)		✓		✓					✓	
Road Sections Including Bridges and Sediment Pond for Only Around Beginning Section and In Between (Sections 2, 3, 4)	PGK 57 mil (L=2.3 km)		✓		✓						
Road Sections Including Bridges and Sediment Pond for Only Around Beginning Section (Sections 2 and 4)	PGK 50 mil (L=1.4 km)		✓		✓						

Note: ✓ shows the sections that are selected as target area.

Source: JICA Expert Team

21.9 Economic Analysis of the Project

Table 21.16 shows the annual cash flow of the Project for four cases. Based on the costs and benefits calculated as explained above, the economic internal rate of return (EIRR) and the net present value (NPV) at a discount rate of 12% are calculated as shown in Table 21.17.

(1) Cost

Cost for the Project consists of investment cost and maintenance cost. Investment cost includes construction cost and consulting service cost. Maintenance cost includes routine maintenance cost and periodic maintenance cost.

(2) Benefit

Economic benefit of the Project consists of the following:

- Value in operation cost savings
- Value in travel time savings
- Value in time saving for cargo
- Reduction amount of cost for emergency responses

A distinctive benefit of this project road is the benefit generated by the reduction in emergency disaster response costs. On the Kokopo-Rabaul Coastal Road, emergency disaster response is carried out to remove the soil that has flowed onto the road due to landslides that occur every year during the rainy season on slopes and floodways along the road. By implementing this project, the cost of removing soil from the road will no longer be necessary, which is expected to generate benefits. The reduction in emergency disaster response repair costs (PGK 5 million) was calculated as a benefit.

(3) Economic Internal Rate of Return (EIRR)

The results of all cases of the Project are judged economically inviable as the calculated EIRRs do not exceed 12%, which is considered a threshold to judge project viability in developing countries.

Table 21.16 Cash Flow of the Project (PGK Million)

<Case 1>

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	6.5	0.3	0.01		6.8	-40.5
2029		0.2		0.2	13.4	0.6	0.01	5.0	19.0	18.8
2030		0.2		0.2	13.7	0.6	0.01	5.0	19.3	19.1
2031		0.2		0.2	14.0	0.6	0.01	5.0	19.7	19.5
2032		0.2		0.2	14.3	0.7	0.02	5.0	20.0	19.8
2033		0.2		0.2	14.7	0.7	0.02	5.0	20.3	20.2
2034		0.2		0.2	14.9	0.7	0.02	5.0	20.6	20.5
2035		0.2		0.2	15.2	0.7	0.02	5.0	20.9	20.8
2036		0.2		0.2	15.5	0.7	0.02	5.0	21.2	21.1
2037		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2038		0.2	3.6	3.8	16.1	0.7	0.02	5.0	21.9	18.1
2039		0.2		0.2	16.4	0.7	0.02	5.0	22.2	22.0
2040		0.2		0.2	16.8	0.8	0.02	5.0	22.5	22.4
2041		0.2		0.2	17.1	0.8	0.02	5.0	22.9	22.7
2042		0.2		0.2	17.4	0.8	0.02	5.0	23.2	23.0
2043		0.2		0.2	17.7	0.8	0.02	5.0	23.6	23.4
2044		0.2		0.2	18.0	0.8	0.02	5.0	23.9	23.7
2045		0.2		0.2	18.3	0.8	0.02	5.0	24.2	24.0
2046		0.2		0.2	18.6	0.8	0.02	5.0	24.5	24.3
2047		0.2		0.2	18.9	0.9	0.02	5.0	24.8	24.6
2048		0.2	3.6	3.8	19.2	0.9	0.02	5.0	25.1	21.3
	192.9	3.6	7.3	203.8	332.7	15.1	0.35	100.0	448.2	244.4

<Case 2>

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	6.6	0.3	0.01		6.9	-40.5
2029		0.2		0.2	13.5	0.6	0.01	5.0	19.1	19.0
2030		0.2		0.2	13.9	0.6	0.01	5.0	19.5	19.3
2031		0.2		0.2	14.2	0.6	0.01	5.0	19.9	19.7
2032		0.2		0.2	14.6	0.7	0.02	5.0	20.3	20.1
2033		0.2		0.2	15.0	0.7	0.02	5.0	20.7	20.5
2034		0.2		0.2	15.3	0.7	0.02	5.0	21.0	20.8
2035		0.2		0.2	15.7	0.7	0.02	5.0	21.4	21.2
2036		0.2		0.2	16.1	0.7	0.02	5.0	21.8	21.6

2037		0.2		0.2	16.5	0.7	0.02	5.0	22.2	22.0
2038		0.2	3.6	3.8	16.9	0.8	0.02	5.0	22.6	18.8
2039		0.2		0.2	17.3	0.8	0.02	5.0	23.1	22.9
2040		0.2		0.2	17.7	0.8	0.02	5.0	23.5	23.3
2041		0.2		0.2	18.1	0.8	0.02	5.0	24.0	23.8
2042		0.2		0.2	18.6	0.8	0.02	5.0	24.5	24.3
2043		0.2		0.2	19.1	0.9	0.02	5.0	25.0	24.8
2044		0.2		0.2	19.5	0.9	0.02	5.0	25.4	25.2
2045		0.2		0.2	19.9	0.9	0.02	5.0	25.9	25.7
2046		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2047		0.2		0.2	20.9	0.9	0.02	5.0	26.8	26.7
2048		0.2	3.6	3.8	21.4	1.0	0.02	5.0	27.3	23.5
	192.9	3.6	7.3	203.8	350.9	16.0	0.37	100.0	467.3	263.5

<Case 3 >

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	7.0	0.3	0.01		7.3	-40.0
2029		0.2		0.2	14.5	0.7	0.02	5.0	20.2	20.0
2030		0.2		0.2	15.2	0.7	0.02	5.0	20.9	20.7
2031		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2032		0.2		0.2	16.5	0.8	0.02	5.0	22.3	22.1
2033		0.2		0.2	17.2	0.8	0.02	5.0	23.0	22.8
2034		0.2		0.2	17.9	0.8	0.02	5.0	23.8	23.6
2035		0.2		0.2	18.7	0.9	0.02	5.0	24.6	24.4
2036		0.2		0.2	19.5	0.9	0.02	5.0	25.4	25.3
2037		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2038		0.2	3.6	3.8	21.3	1.0	0.02	5.0	27.3	23.5
2039		0.2		0.2	22.3	1.0	0.02	5.0	28.3	28.2
2040		0.2		0.2	23.3	1.1	0.02	5.0	29.4	29.2
2041		0.2		0.2	24.5	1.1	0.03	5.0	30.6	30.4
2042		0.2		0.2	25.7	1.2	0.03	5.0	31.8	31.7
2043		0.2		0.2	26.9	1.2	0.03	5.0	33.2	33.0
2044		0.2		0.2	28.2	1.3	0.03	5.0	34.5	34.3
2045		0.2		0.2	29.6	1.3	0.03	5.0	36.0	35.8
2046		0.2		0.2	31.1	1.4	0.03	5.0	37.5	37.3
2047		0.2		0.2	32.7	1.5	0.03	5.0	39.2	39.0
2048		0.2	3.6	3.8	34.0	1.5	0.04	5.0	40.5	36.7
	192.9	3.6	7.3	203.8	462.3	21.0	0.49	100.0	583.8	380.0

<Case 4 >

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6

2028	47.3			47.3	7.2	0.3	0.01		7.5	-39.8
2029		0.2		0.2	15.1	0.7	0.02	5.0	20.8	20.6
2030		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2031		0.2		0.2	16.6	0.8	0.02	5.0	22.4	22.2
2032		0.2		0.2	17.5	0.8	0.02	5.0	23.3	23.1
2033		0.2		0.2	18.4	0.8	0.02	5.0	24.3	24.1
2034		0.2		0.2	19.4	0.9	0.02	5.0	25.3	25.1
2035		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2036		0.2		0.2	21.5	1.0	0.02	5.0	27.5	27.3
2037		0.2		0.2	22.7	1.0	0.02	5.0	28.8	28.6
2038		0.2	3.6	3.8	24.0	1.1	0.03	5.0	30.1	26.3
2039		0.2		0.2	25.5	1.2	0.03	5.0	31.6	31.5
2040		0.2		0.2	27.0	1.2	0.03	5.0	33.3	33.1
2041		0.2		0.2	28.7	1.3	0.03	5.0	35.0	34.8
2042		0.2		0.2	30.5	1.4	0.03	5.0	37.0	36.8
2043		0.2		0.2	32.5	1.5	0.03	5.0	39.1	38.9
2044		0.2		0.2	34.7	1.6	0.04	5.0	41.3	41.1
2045		0.2		0.2	37.0	1.7	0.04	5.0	43.7	43.5
2046		0.2		0.2	39.5	1.8	0.04	5.0	46.4	46.2
2047		0.2		0.2	42.4	1.9	0.04	5.0	49.3	49.1
2048		0.2	3.6	3.8	44.4	2.0	0.05	5.0	51.5	47.7
	192.9	3.6	7.3	203.8	540.7	24.6	0.57	100.0	665.9	462.1

Source: JICA Expert Team

Table 21.17 EIRR and NPV by Case

	EIRR (%)	NPV (PGK million): At discounted rate of 12%
Case 1	8.1	-39
Case 2	8.5	-36
Case 3	10.5	-15
Case 4	11.6	-3

Source: JICA Expert Team

21.10 Environmental and Social Considerations for the Project

21.10.1 Scoping of the Pre-Feasibility Study

Based on JICA's "Guidelines for Environmental and Social Considerations" and PNG DoWH's "Guidelines for Environmental Assessment of Road and Bridge Infrastructure Projects", the potential environmental and social impacts of the Pre-Feasibility Study were identified and summarised in the table below.

Table 21.18 Scoping Results for the Pre-Feasibility Study

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
1	Air Pollution		✓	✓	[During construction] Air quality degradation is expected due to base camp operations, construction activities, and emissions from construction-related vehicles. [Operation and Maintenance] Negative impacts on air quality from vehicle emissions are expected but are not significant. The impact of dust is mitigated by the paving of unpaved roads.
2	Water Pollution		✓		[During construction] Soil erosion from land clearing and excavation can lead to poor water quality in areas such as rivers, beaches, seagrass beds, mangroves, wetlands and swamps. In addition, the water quality of such areas may be affected by turbid water from earthworks and jetties on the onshore road, and by effluent from construction sites and workers' accommodation.

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
3	Soil Pollution				Soil contamination is expected if the soil of the construction site/construction materials contains contaminants due to some factors (natural conditions, industrial waste). However, the impact of soil contamination from construction equipment and materials is not expected.
4	Waste		✓		[During construction] Excavated soil, concrete lumps, etc. are generated during site preparation and construction work. If these are not properly managed, they may have adverse effects on the surrounding environment. In addition, general waste generation is expected from workers at the base camp.
5	Noises and Vibrations		✓	✓	[During construction] Temporary noise and vibration impacts are expected from construction machinery and vehicles. [Operation and Maintenance] Possible impacts are expected due to increased traffic and higher travel speeds in sensitive areas (e.g., residences, schools, medical facilities) around the road.
6	Ground Subsidence				Land subsidence is not expected.
7	Offensive Odours				Since no chemicals with a strong odour will be used, no impact is expected.
8	Topography and Geology		✓	✓	[During construction] Sedimentation and erosion associated with the construction are expected. Civil engineering works such as cuttings and embankments are expected to occur, affecting the topography. [Operation and Maintenance] The implementation of effective drainage systems can prevent submergence and flooding on land around roads and in low-lying areas. In addition, soil erosion control works can increase the stability of landforms and reduce the risk of landslides and slope failures.
9	Bottom Sediment		✓		[During construction] If the construction overburden generated during construction is not disposed properly, sediment may be deposited on the riverbed or beaches, affecting the characteristics of the river and the marine and aquatic life.
10	Biodiversity and Ecosystems		✓	✓	[During construction] The construction activities associated with the project are expected to affect various natural ecosystems, including terrestrial forests, mangroves, tidal flats, coastal reefs, and marine ecosystems. As there may be important species, habitats and ecosystems in the areas affected by the project, a literature review of previous studies, interviews with ecologically knowledgeable local people and field surveys may also be required. [Operation and Maintenance] The operation of the roads can introduce various forms of pollution into ecosystems, including noise, light, and chemical pollution.
11	Hydrological Phenomena		✓		[During construction] Possible changes in the river due to river crossing structures are expected. Also, construction activities can change natural drainage systems, potentially leading to increased runoff into the ocean and river. This can affect the hydrological balance and may lead to changes in river flow regimes. In addition, if there are seasonal patterns of sand movement in the area, the project activities may restrict that movement, which may cause coastal erosion.
12	Accidents		✓	✓	[During construction] There is possibility of accidents, injuries, and illnesses occurring at construction sites. Also, there may be an increase in accidents due to changes in usual traffic patterns, presence of construction equipment, and possible road closures or detours [Operation and Maintenance] Restoring and upgrading road pavement can reduce the likelihood of accidents by providing smoother and more stable driving surfaces, reducing vehicle skidding and control loss. Meanwhile, enhanced road conditions may lead to a higher likelihood of accidents due to the increased number of vehicles interacting on the road.

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
13	Climate Change				No large-scale greenhouse gas emissions are expected from the project activity.
14	Involuntary Resettlement	✓			[Pre-construction] Even if physical relocation is not required, the project can still impact livelihoods (for example, affecting businesses or farms adjacent to the road), leading to economic displacement.
15	Local Economy, such as Employment and Livelihood		✓	✓	[During construction] The construction phase of the project can create direct employment opportunities in construction, engineering, and economic activities associated with workers' base camp. [Operation and Maintenance] Improved roads enhance accessibility to markets, services, and other economic opportunities, thereby facilitating trade and commerce. Also, as the area has tourism potential, improved roads can make tourist spots more accessible, thereby boosting the local tourism industry.
16	Land Use and Utilisation of Local Resource			✓	[Operation and Maintenance] The upgrading of roads (implementation of sediment pond) may require additional land. Meanwhile, the upgraded road infrastructure is expected to markedly improve transport efficiency as it is the most direct route linking the region's primary port with its provincial capital and core commercial zone. Local communities will have improved access to broader markets, both for procuring inputs and selling their products, thereby enhancing the utilisation of local resources.
17	Social Institutions such as Social Infrastructure and Local Decision-Making Institutions			✓	[Operation and Maintenance] Improved roads can enhance access to essential services such as healthcare, education, and emergency services. In addition, enhanced road infrastructure can strengthen connectivity between communities, which may lead to more robust social networks and increased social interaction.
18	Existing Social Infrastructure and Services		✓	✓	[During construction] The construction phase might temporarily disrupt access to existing services, causing inconvenience to local communities. This can include road closures, traffic delays, and increased noise and air pollution. [Operation and Maintenance] Enhanced road connectivity can significantly improve access to essential services like healthcare, education, emergency services, and government facilities.
19	Socially Vulnerable People (Indigenous People, Ethnic Minorities)				The project is not expected to have a direct impact on indigenous people and ethnic minorities.
20	Socially Vulnerable People (People in Poverty, Persons with Disabilities, Refugees, Internally Displaced persons and minorities)	✓			[Pre-construction] Road expansion may require land acquisition, which can lead to displacement of communities, particularly affecting vulnerable groups. Meanwhile, improved transport links can facilitate better access to markets and job opportunities, which can be particularly beneficial for people in poverty or marginalized communities.
21	Misdistribution of Benefits and Damages			✓	[Operation and Maintenance] If land acquisition for the project disproportionately affects a particular community or demographic group, this can lead to social and economic displacements. In addition, while the improved road might boost economic activities in certain areas or for certain groups, others might not experience these benefits equally.
22	Local Conflicts of Interest	✓			[Pre-construction] The project may benefit certain groups (like business owners) more than others (like low-income communities), leading to conflicts over the perceived unequal distribution of benefits.
23	Gender				The project is not expected to have a direct impact on gender equality.
24	Children's Rights				The project is not expected to have a direct impact on child labour.
25	Cultural Heritage	✓			[During construction]

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
					Construction activities might damage historical or cultural sites including the war relics from the Second World War along the Kokopo-Rabaul Coastal Road.
26	Infectious Diseases such as HIV/AIDS		✓		[During construction] Large infrastructure projects can lead to an influx of workers from different areas, potentially increasing the spread of infectious diseases like HIV/AIDS.

Source: JICA Expert Team

21.11 Conclusions and Recommendations from the Pre-FS

21.11.1 Conclusions from the Pre-FS

Project implementation for all sections of Kokopo-Rabaul Coastal Road requires approximately PGK 187 million. This may be not economically feasible because of the low traffic volume of the Project Road (1,695 vehicles/day in 2024), relatively small population of the region (277 thousand people in 2022), low amount of export from Rabaul Port (64 billion JPY in 2021), among others.

Therefore, it is proposed that only critical sections should be strengthened under the JICA grant-aid scheme. Technical transfer regarding design and construction of sediment ponds and bridges based on the hydrologic analysis, etc. will be covered in JICA grant-aid project. Implementation of other sections should be made by PNG government with its own fund or from other donor agencies utilising the knowledge to be transferred in the JICA grant-aid project.

The target sections should be finally determined in a prospective full-scale feasibility study. However, it can be considered that the project providing enough benefit to the region can be implemented within the budget of JICA grant-aid aid.

21.11.2 Recommendations from the Pre-FS

Road Sections 2 and 4 or Road Section 2, 3 and 4 have been selected as priority target sections initially in this pre-feasibility study, without the conduct of any natural condition surveys.

It is recommended that priority target sections and intervention menus for the JICA grant-aid project should be selected based on natural condition surveys, such as topographic survey, geological survey and hydrological survey, as well as basic design, construction plan, detailed cost estimates, and maintenance plan in a full-scale feasibility study.

PART X Pilot Projects

Chapter 22 Pilot Projects

22.1 Introduction

22.1.1 Expected Outcome and Overall Goal

Pilot projects in the NEGID-Plan were implemented as initiatives that contribute to improving the attractiveness of the region by involving local businesses and landowners, as well as local governments.

With the support of the JICA Expert Team, the Project Implementation Unit (PIU) for NEGID-Plan had discussed and determined the overall goal for the implementation of the pilot projects which is as follows:

> "To provide a lively space and vibrant atmosphere which can be enjoyed by both residents and tourists."

This overall goal is to guide the local governments, local business owners and other stakeholders for selecting the pilot projects to be implemented.

The pilot projects were designed to make immediate and short-term impacts to the improvement of local physical and business environments. At the same time, they were intended to initiate local activities by creating opportunities to establish private-public partner relationships for seeking the above overall goal in the long run.

22.1.2 Methods Considered for Pilot Projects

There is an initiative in Japan called Area Management which is a proactive initiative where the private sector (residents, business owners, landowners, etc.) takes the lead to maintain and improve the good environment and local values in the community.

Such initiatives shall be considered for the implementation of pilot projects in the NEGID-Plan. The target areas for the pilot projects will be within the Urban LLGs of Rabaul and Kokopo.

22.1.3 Organisational Structure for Pilot Project Implementation in NEGID-Plan

Based on discussions among PIU members of the NEGID-Plan, it was decided that in representing the provincial administration, the PIU should function to facilitate the implementation of pilot projects in Kokopo City and Rabaul Town. The actual project implementation in Rabaul and Kokopo is to be managed by Rabaul Urban LLG and Kokopo/Vunamami Urban LLG, respectively.

22.2 Pilot Project for Kokopo/Vunamami Urban LLG

22.2.1 Pilot Project Ideas for Kokopo/Vunamami Urban LLG

In order to achieve the overall goal described in Section 22.1.1, the objectives to implement a pilot project in Kokopo City are as follows:

- To utilise the existing public open space for the vitalisation of Kokopo City as the capital of the Islands Region and ENBP
- To provide necessary public facilities and services for effective use of open space
- To promote and encourage citizens to enjoy the economic activities in the city
- To improve the attractiveness of Kokopo City for tourists and visitors from outside the city

Pilot project ideas proposed by the local government and private stakeholders are initiatives such as night market, implementation of beach promenade, town library and children's playground, and city beautification activities, etc.

22.2.2 Night Market

ENBP has been known as one of the safest areas in PNG. Therefore, it is one of the areas in PNG where people can enjoy and relax outside. However, in Kokopo City, except for a few restaurants of tourist hotels, most activities and businesses end before 6 p.m., and there are no economic activities for the residents who would like to go out after work in the evening.

Kokopo Market is situated in the centre of Kokopo Town, and there is an open space adjacent to the Kokopo Market. This is a potential space to be used in the evening for the residents to enjoy the time after school and after work with their families and friends.

Figure 22.1 Site Plan of the Night Market Pilot Project in Kokopo Town

Based on coordination meetings with Kokopo/Vunamami Urban LLG, benches, pedestrian bridges, portable toilets, flood lights and solar lights were installed at the project site as necessary facilities for holding the Night Market with the support of JICA Expert Team for NEGID-Plan.

The Night Market was held from 5 p.m. to 9 p.m. on Friday, the 22nd of December 2023.

22.2.3 Organisations for the Pilot Project in Kokopo/Vunamami Urban LLG

(1) Organisation in Charge of Implementation and Operation

Kokopo / Vunamami Urban LLG and ENBP Governor's Office had taken the lead of the pilot project.

The Night Market Committee was organised as a partnership between government agencies and private sector to manage the Night Market and future events.

22.2.4 Evaluation of the Pilot Project for Kokopo/Vunamami Urban LLG

To analyse the sustainability of the Night Market by verifying outcomes and issues of the initiative for making new lively space in manner of the Area Management method and partnership between public and private sectors, questionnaires were conducted targeting the visitors, vendors, users of the urban amenities implemented for the pilot project and the implementation organisation of the night market.

22.3 Pilot Project for Rabaul Urban LLG

22.3.1 Pilot Project Ideas for Rabaul Urban LLG

The following are identified as issues preventing citizens/residents and tourists from to utilise public open spaces in Rabaul Urban LLG:

- No public transport connecting the town centre to tourist spots
- Lack of rest places and public toilets for tourists and citizens
- Existence of unused and unavailable spaces after the volcanic eruption in 1994

In order to achieve the overall goal described in Section 22.1.1, the objectives to implement a pilot project in Rabaul Town are identified as follows:

- To utilise the existing public open space and unused space for the revitalisation of Rabaul Town
- To provide necessary public facilities and services for effective use of open space in Rabaul Town
- To improve the attractiveness of Rabaul Town for cruise ship tourists from overseas, as well as residents, by improving the urban environment including open space and streets in Rabaul Town

Pilot project ideas proposed by the local government and private stakeholders are revitilisation of Queen Elizabeth Park, development of waterfront walkway, implementation of signboards, etc.

22.3.2 Provision of Street Furniture

Rabaul Town is a tourist destination but public amenities, such as benches for tourists and citizens, are insufficient. As a result of coordination meetings with Rabaul Urban LLG and Rabaul Community and Business Council, a private organisation based in Rabaul Town, benches, public kiosks (pergolas with seats) and signboard were installed at public open spaces and sidewalks to improve public amenities and urban environment in Rabaul Town. Figure 22.2 shows locations of the installed facilities.

Source: JICA Expert Team

Figure 22.2 Locations of the Installed Facilities in Rabaul Town

22.3.3 Organisations for the Pilot Project in Rabaul Urban LLG

Rabaul Urban LLG and Rabaul Community and Business Council have taken the lead for the Pilot Project in Rabaul. They had been responsible for planning and implementing the Pilot Project and maintaining the installed facilities.

22.3.4 Evaluation of the Pilot Project for Rabaul Urban LLG

To analyse the perspective of tourism promotion in a manner of the Area Management by verifying outcomes and issues of the pilot project, questionnaires were conducted targeting the implementation organisation of the pilot project and the cruise ship tourists.

22.4 Recommendations for Pilot Projects

(1) Kokopo Pilot Project for Organising a Night Market

Although the night market has been accepted by the vendors and visitors as a good initiative for improving the urban environment, local economies, and communities, there are challenges in continuing it.

For making the night market a regular event, the provision of substantial security and transportation services until the event is finished is important for both vendors and visitors so that participants will have a sense of security. During the pilot project, a private company's security guards were hired with the support of the JICA project. For the LLG to secure financial resources for security, considering that the source of this resource is expected to come from the participation fee of the vendors, the number of vendors participating in the night market is crucial. Also, for the PMVs to operate during nighttime, sufficient number of passengers is also important. Therefore, wider and earlier public relations are required to attract more visitors and vendors.

In the future, Kokopo/Vunamami Urban LLG expects to expand the night market by holding the event at various public open spaces in the LLG regularly. For the sustainable implementation of the night market, further improvement of public facilities, especially streetlights, garbage bins, car parking, and public toilets are important to continue attract visitors and vendors. In order to implement such facilities, it is necessary for Kokopo/Vunamami Urban LLG, Kokopo District and ENBP to discuss and consider how to collect or allocate the budget for such additional facilities.

In addition, increasing the members of the Night Market Committee including the Chamber of Commerce, major business operators in Kokopo and PMV operators is important to continue improving the event. Through the meetings with the committee members, priority projects for improving the event could be identified and, collaboration with the private sector can also be expected.

It is also recommended that various LLG officers (such as those in business development, culture and tourism officer, community officer, and civil works engineer) should establish a team in the LLG to be the main implementation body of the night market and work together for its sustainable operation.

(2) Rabaul Pilot Project for Installing Street Furniture and Open Space Furniture

In Rabaul, benches and public kiosks are highly needed not only for the tourists but also for the residents. At the same time, the local people are eager to revitalise the eastern area of the town which used to be the commercial centre of Rabaul before the volcanic eruption in 1994.

In the discussions for selecting the pilot project for Rabaul, various ideas to improve its urban environment and promote tourism were listed and shared among the local government and private sector. Rabaul Urban LLG and Rabaul Community and Business Council (RCBC) should continue the collaboration for the maintenance of the facilities installed through this pilot project, and further implementation of other facilities. The roles and responsibilities of each organisation should be determined for the future activities based on the experience of the implementation process of the pilot project. In addition, regular meetings should be held between the Rabaul Urban LLG and RCBC.

Regarding the budget for the implementation of facilities for tourists and visitors, revenue collection method should also be considered.

PART XI Conclusions and Recommendations

Chapter 23 Conclusions and Recommendations

23.1 Conclusions

(1) Formulation of Infrastructure Development Plan taking into consideration Regional Development Perspectives that are based on characteristics of the region

In the Northeast Gazelle Peninsula, infrastructure development planning revealed the need to reorganise the regional spatial structure over the very long term by clarifying the direction of the region's economic sector development and measures to improve its disaster resilience. Various infrastructure development strategies were identified to support the reorganisation of the regional spatial structure, and a phased development plan was formulated.

In the Northeast Gazelle Peninsula, to work on improving disaster resilience from volcanic eruptions, it was necessary to consider a super-long-term perspective (beyond 25 to 30 years) for the formulation of a 10-year infrastructure development plan.

Given that the population and regional economy in the Northeast Gazelle Peninsula are not very large, the demand for infrastructure is not high enough. For this reason, it is not financially or economically feasible to make the regional spatial structure disaster resilient in the short or medium term. Therefore, the following two-stage development scenario is planned for economic sector development, strengthening disaster resilience, and infrastructure development.

First, in the short and medium terms, measures will be taken to expand the production of existing export-oriented agricultural, forestry, and fishery products. Regarding infrastructure, measures will be taken to rehabilitate and upgrade port and road functions. To improve disaster resilience, measures will be taken to make each infrastructure more disaster resistant.

In the medium term, while continuing the above measures, some industries will also work on diversifying into high-value-added manufacturing and international tourism. For realising such high-value-added economic activities, it is necessary to focus on developing urban infrastructure while establishing the SEZs.

In the long and super-long terms, as the population and regional economy grow, it will be possible to reorganise the regional spatial structure and transfer port and production functions, and develop infrastructure to make the region more disaster resilient.

(2) Formulation of a 10-Year Infrastructure Development Plan

Important projects for each infrastructure sector that correspond to the short and medium-term scenarios above were prepared, and among them the high-priority and priority projects were selected. Eleven high-priority infrastructure projects are to be implemented over the next eight years (by 2032 in line with the target year of PNG's medium-term plan).

(3) Relocation of the functions of Rabaul Port: with comprehensive considerations, not only industrial development and disaster hazards but also environmental perspectives

When considering the location of the new port, which will have an impact on the future spatial structure, a preliminary survey of the marine environment was carried out to investigate the natural environment like flora and fauna that inhabit Kokopo and Ataliklikun Bay. Also, the possibility of changes to the marine environment and the possible impact on the tourism industry due to the proposed location of the port in Kokopo was also taken into consideration since several resort hotels are currently located in Kokopo.

(4) Budget Planning

ENBPA had formulated long-term plans in the past with large number of projects, but the prioritisation of projects and the steps for implementation are not indicated.

In the NEGID-Plan, 11 high-priority projects were selected to secure budgets for important infrastructure development. The importance of these 11 high-priority projects was explained through the development scenario for the entire region. Coordination was also carried out at an early stage with each central government departments and infrastructure state companies, including the Department of National Planning and Monitoring, to secure funds for feasibility studies and project implementation. These 11 high-priority projects are to be included in the national plans and each sector plan, making it possible to secure certain funding.

(5) Capacity Development

Through TWG meetings, Joint TWG meetings, and SC meetings held at each stage of the plan formulation process, the coordination capacity was strengthened by utilising the forum of the meetings for coordination among stakeholders within the province, and between ENBPA and each sector agency at the central government.

In addition, a PIU was established within the ENBPA, and core members were selected among the PIU members. Through continuing meetings, understanding of each stage of the plan formulation was deepened.

(6) Pre-Feasibility Study

The pre-feasibility study was carried out on the "Kokopo-Rabaul Coastal Road Strengthening Project," with the aim of reducing the risk of landslides and improving transportation functions in line with the short- and medium-term scenarios mentioned above.

23.2 Recommendations

(1) Importance of Formulation of Regional Plans Targeting Part of a Province

The Government of PNG should pay attention on formulating regional development plans and infrastructure development plans targeting "parts of the province" with high development potential, such as the Northeast Gazelle Peninsula, in addition to provincial development plans that cover the entire province. Provincial development plans, tend to be generic as they follow the national government template as medium-term development plans for the need to treat all sectors equally. In contrast, regional development plans targeting specific regions are more likely to be plans that address specific challenges and specific potentials without being bound by given templates.

(2) Characteristics, Logics and Strategies of Provinces and Districts

To achieve sustainable regional development, it is important for national-level planning agencies to listen and understand the regional logic and strategies of the provincial and district-level governments. On the other hand, alongside that, provincial and district-level governments should seek ways to align with national-level policies and priorities while respecting the local characteristics and logics in the province.

(3) Continuing Dialogues Between the National and Local Governments

To promote sustainable development through the implementation of high-priority projects selected through the formulation of this plan, dialogue between the East New Britain Provincial Administration (ENBPA) and the Department of National Planning and Monitoring (DNPM) should continue. Through this dialogue, it is necessary to aim to achieve the following points:

- To proceed with the process to officially approve the 11 high-priority projects by the National Executive Council (NEC).

- To ensure that the 11 high-priority projects are incorporated in the sector medium-term development plans formulated by the relevant organisations at the national level.
- To obtain the necessary national budget or international development partners' support to conduct full-scale feasibility study or pre-feasibility studies for all high-priority projects.
- To continue efforts to obtain national budget and international development partners' support for implementing the 11 high-priority projects.