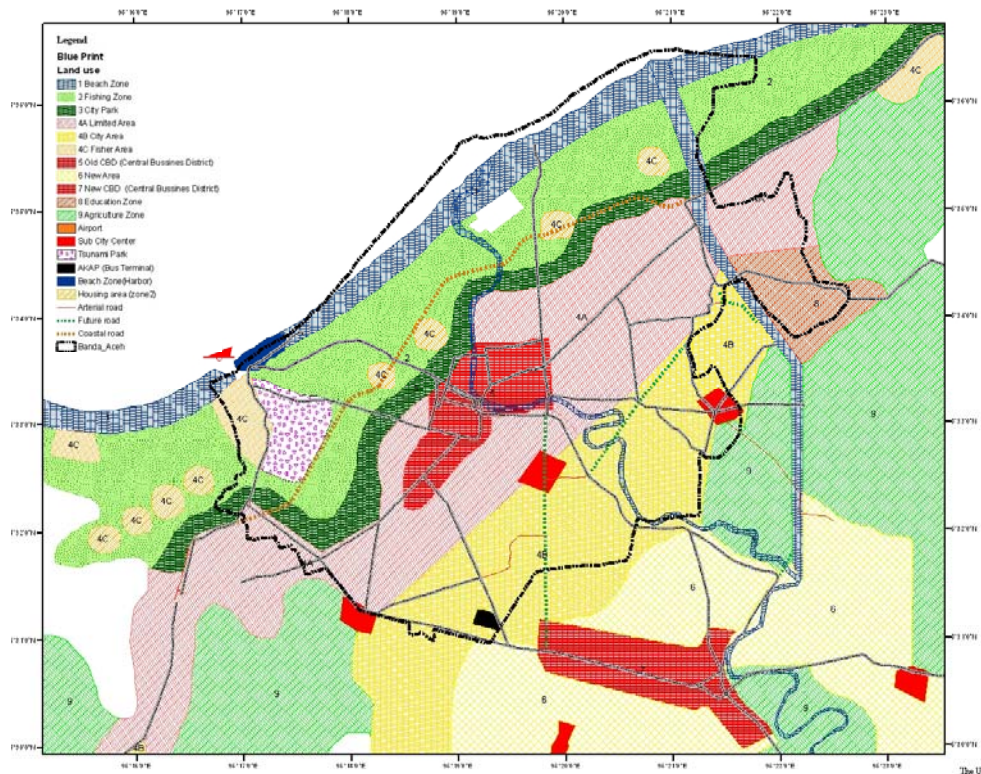


1.6 PROPOSED ZONING AND LAND USE PLAN

1.6.1 Proposed Zoning

The Blueprint also covers the zoning for the entire Aceh Region and Nias, and it is of concept of regional land use and the urban development as presented in Figure 1.6.1.



Source: BAPPENAS, Blueprint, 2005

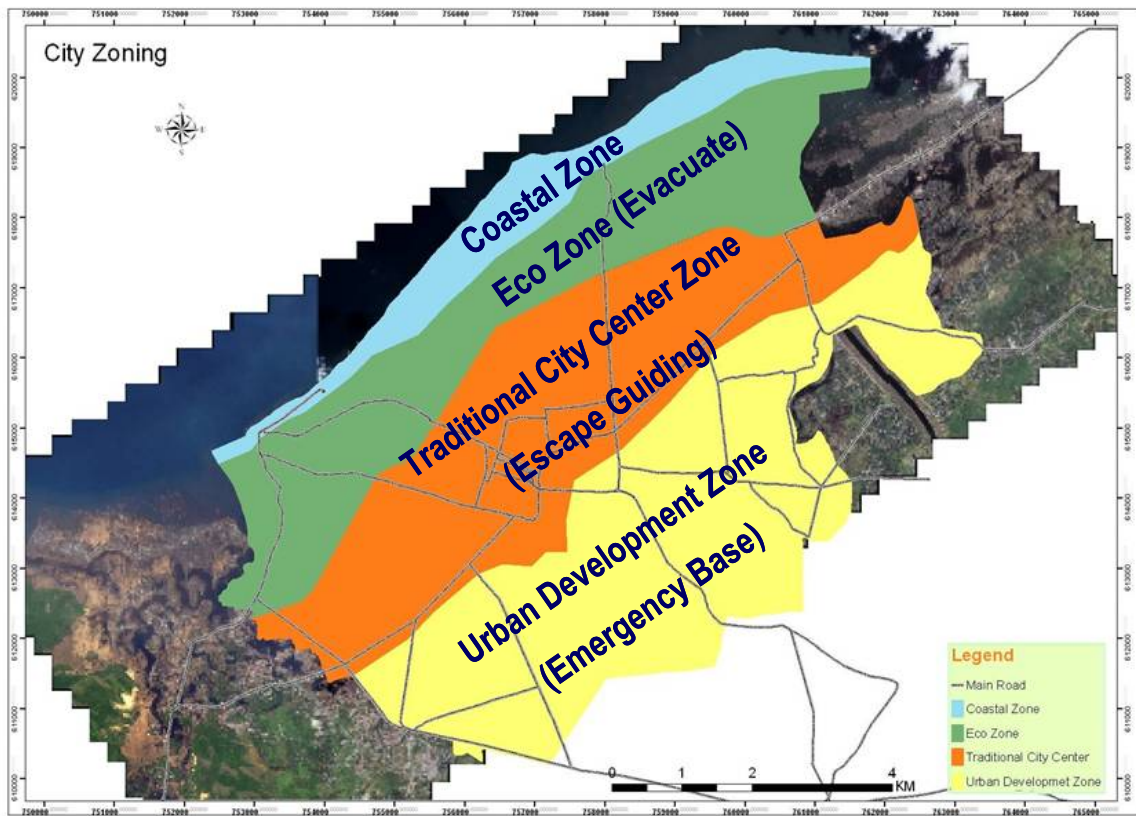
Figure 1.6.1 Zoning in the Blueprint

The Blueprint proposes 9 zonings for Banda Aceh City. It however appears that the Blueprint pays less attention to population increase and disaster preparedness. Under the present study, the said zoning was reviewed in the light of the proposed city development concept, population growth, available land resources and disaster preparedness. As a result, it is proposed to divide the city area into four (4) zones with keen attention to disaster preparedness as given in Table 1.6.1 and Figure 1.6.2.

Table 1.6.1 Proposed Zoning

No.	Zoning in Blueprint	Proposed Zoning under the Study
1.	Coastal	Coastal Zone
2.	Fishery (non-residential area)	Eco Zone : Evacuate Area
3.	City Park	
4.	Residential	Traditional City Center Zone: Escape Guiding Area
5.	Old City Center	
6.	New Residential	Urban Development Zone: Emergency Base - Disaster Mitigation Center
7.	New Central Business District (CBD)	
8.	Higher Education	
9.	Agriculture	

Source: JICA Study Team



Source: JICA Study Team

Figure 1.6.2 Zoning with Disaster Preparedness

1.6.2 Proposed Land Use Plan

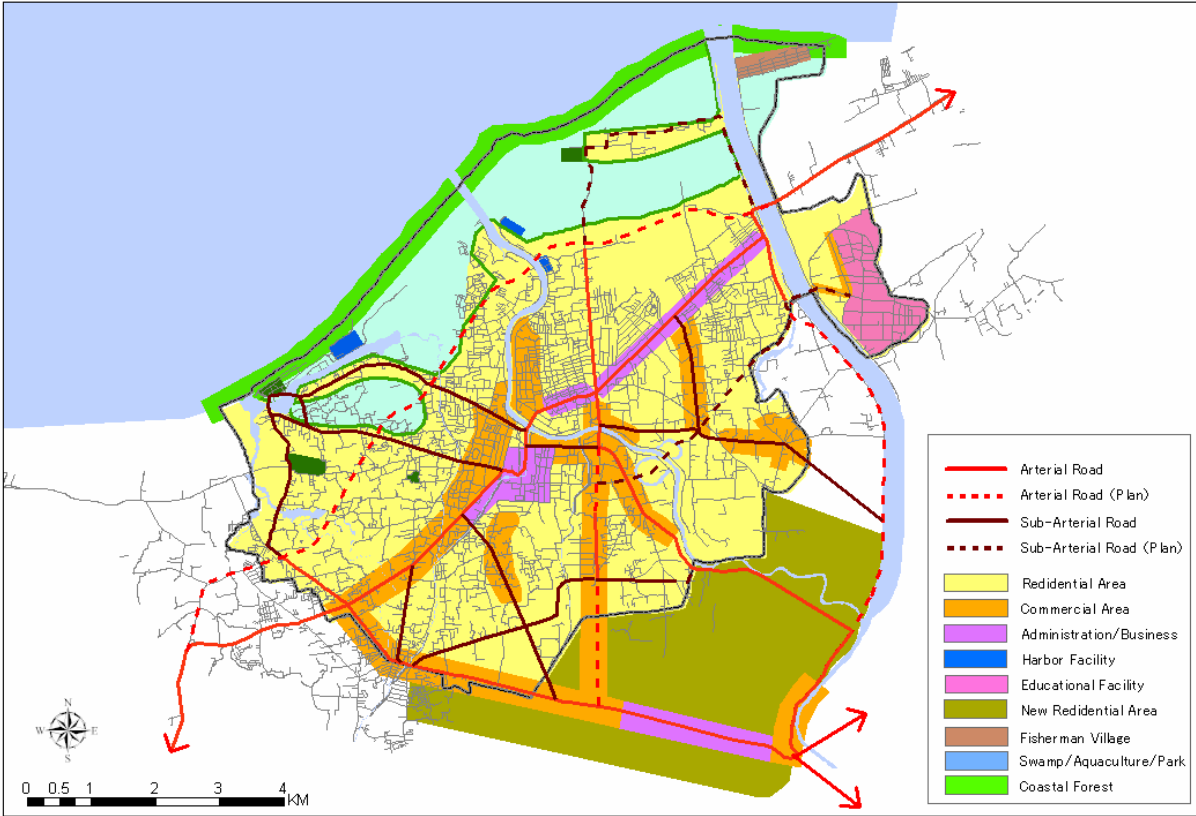
The land use plan is prepared on the basis of the proposed urban development concept and zoning, as well as due consideration of the present land use pattern and usable land after the disaster. Table 1.6.2 summarizes the proposed land use pattern in conjunction with the proposed zoning.

Table 1.6.2 Proposed Land Use Pattern

Zone	Disaster Zone Classification	Location / Function	Land Use / Disaster Preparedness
1.Coastal	Tsunami Mitigation Measures	Port Palm tree / Mangrove	Restoration of aqua eco-system Coastal forest Ferry terminal Seawall facilities along shoreline
2. Eco-Zone	Evacuate Area	Disaster memorial facilities Fish cultivation and port Fish market	Re-construction of residential area for returnees Escape buildings and towers Escape roads and relief roads Ring road (north part) Revival and conservation of aqua-eco system Re-building of fish culture industry Use of nature such as aquaculture and parks (education, recreation and tourism) will be promoted. Dumping site for garbage and solid waste Septage treatment plant
3.Traditional City Center Zone	Escape Guiding Area	Grand Mosque Museum Existing commercial center	Commercial activities area Cultural facilities area Escape buildings Road transport facilities such as bus terminal Escape and relief roads Administrative service areas Emergency relief center Educational facilities
4.Urban Development Zone	Emergency Base	New CBD New residential area	New Central Business District New residential areas Ring road New north-south road and east-west road Universities, religious centers and cultural centers Agricultural lands Emergency base

Source: JICA Study Team

The proposed land use plan is presented on the map shown in Figure 1.6.3.



Source: JICA Study Team

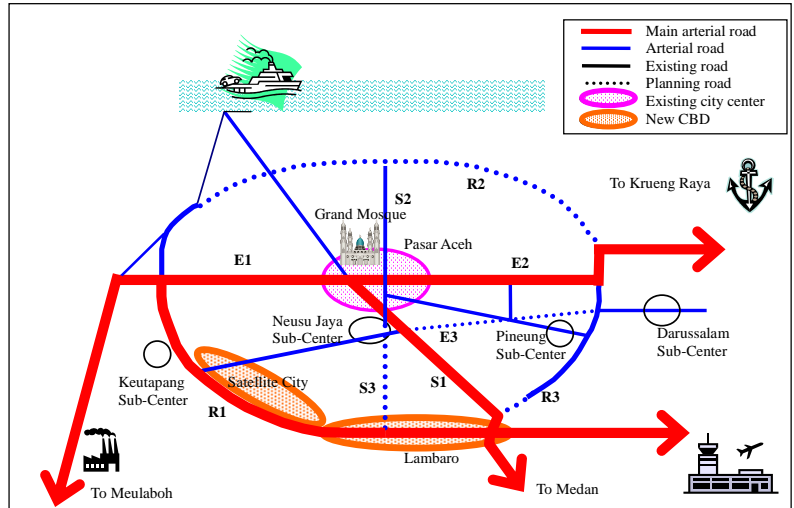
Figure 1.6.3 Land Use Plan of Banda Aceh City

1.7 ROAD FRAMEWORK PLAN

In accordance with the new city development concept and knowing the present traffic situation in the city, improved road framework plan is established as seen in Figure 1.7.1.

It is proposed to complete the ring road and to construct coastal road <R2> which will be connected to existing road <R1>. This is to bifurcate traffic passing through the city center.

It is also proposed to align new road <R3> in the south and <S2-S3> with north-south direction between the coast and existing city center to link main arterial road such as coastal road and <E1-E2> road. These roads will be not only effective to link among the sub-centers to be developed but also contribute to emergency case. In the south new road <R3> and the third east-west road <E3> are proposed to be routed as additional linkage among sub-centers.



Source : JICA Study Team

Figure 1.7.1 Road Network Structure

1.8 HOUSING DEVELOPMENT PLAN

1.8.1 Damages on Houses and Dislocated People

Housing plan is formulated with the special attention to the dislocated families who wish either return to their homeland or resettle their houses in the new settlement areas.

Owing to the disaster, houses were damaged and/or destroyed and according to the survey, existing houses could be broadly divided into three (3) by degree of the damages; namely, Destroyed (heaviest at coastal area), Damaged (heavy at city) and No Damage as summarized in Table 1.8.1.

Table 1.8.1 Condition of Housing Damages

Description	Unit	Modern Houses	Semi-modern Houses	Traditional Houses	Total
No Damage	houses	835	10,231	70	11,136
Damaged	houses	543	6,650		7,193
Destroyed	houses	2,798	34,275	278	37,351
Total	houses	4,176	51,156	346	55,680
Damage Amount	Rp. million	139,676	1,979,246	4,918	2,123,840

Source: Preliminary Damage & Loss Assessment, December 26, 2004 Natural Disaster, Technical Annex

According to the above table, 44,544 houses out of the whole houses of 55,680 were damaged, of which 37,351 houses or 67 % of the entire houses were destroyed. Majority of damaged and destroyed houses are concentrated in the coastal area.

Due to damage/destroy of houses as many as 65,000 people are dislocated, though part of them has started to move in to their original location without regard to quality of accommodation. The situation of dislocated people is reported in Table 1.8.2.

Table 1.8.2 Condition of Dislocated Population (as of 12 April 2005)

Accommodation				Total
Tent	Temporary House	Rental House	Mosque	
6,921	2,892	55,653	34	65,500

Source: Banda Aceh City

PU, IOM, NGOs and various organizations have constructed temporary and permanent houses and many projects are on-going or planned. UNHCR forecasts that most people will be settled in permanent houses in 2 years.¹

1.8.2 Housing Development Plan

The required number of houses for dislocated people is estimated at 13,100 assuming average family size of 5, while there would be required another 10,800 houses in 2009 due to influx of population. The requirement of houses would therefore amount to 23,900 in 2009.

¹ 26 June 2005, Reuter

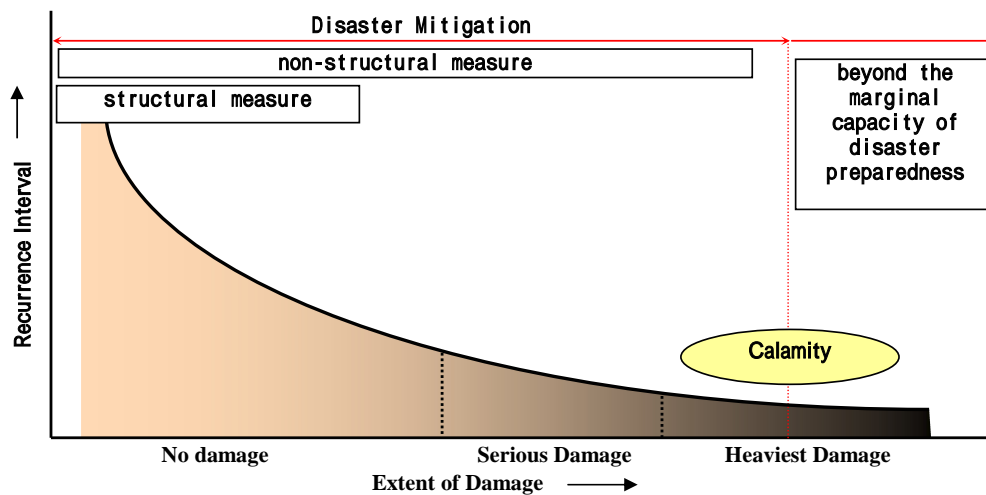
1.9 DISASTER PREPAREDNESS

1.9.1 Disaster Control and Mitigation Plan

City planning with disaster preparedness is formulated in combination with both structural measure and non-structural measure systems. Major concerns for the disaster preparedness are;

- (1) Banda Aceh City expands southward; namely, more safely side against natural disasters such as tsunami, high tide and flooding,
- (2) Plan of disaster preparedness is organized into both structural measure and non-structural schemes, and
- (3) Phased disbursement of public investment should be considered in rehabilitation and reconstruction of basic infrastructures.

A concept on integrated disaster preparedness is shown schematically in Figure 1.9.1. Vertical axis shows recurrence interval of natural disaster while horizontal axis is extent of damage. It shows disaster management system mainly consists of structural measure and non-structure measure.



Source: footnote¹

Figure 1.9.1 Schematic Diagram of Integrated Disaster Preparedness

In general, disaster preparedness by structural measure is formulated on the basis of design criteria for the magnitude of natural disaster. Take design criteria for flood control structure for instance, the dike along river channel is designed against flood with a probability of once in 20-year or more. The safety against flood with a probability of design flood is ensured, once the flood control structures are constructed in accordance with the said design criteria.

¹ Yoshiaki Kawata, Characteristics of Catastrophic Disasters and Philosophy of their Reduction, Journal of Geography, 2001

However, there is a likelihood of natural disaster beyond the design criteria. In case of natural disaster beyond the capability of structural measure, the non-structural measure would be more effective in mitigating damage and reducing duration.

Taking into account the casualties in Banda Aceh City, tsunami is the most serious disaster among natural disasters such as flooding, earthquake, big fire, and so on. Although structural measures against large-scale tsunami can reduce inundation area and tsunami run-up height, the measures can not control tsunami completely. Thus, the efficient disbursement of public investment taking into account marginal capacity of structural measures is required in rehabilitation and reconstruction of basic infrastructures.

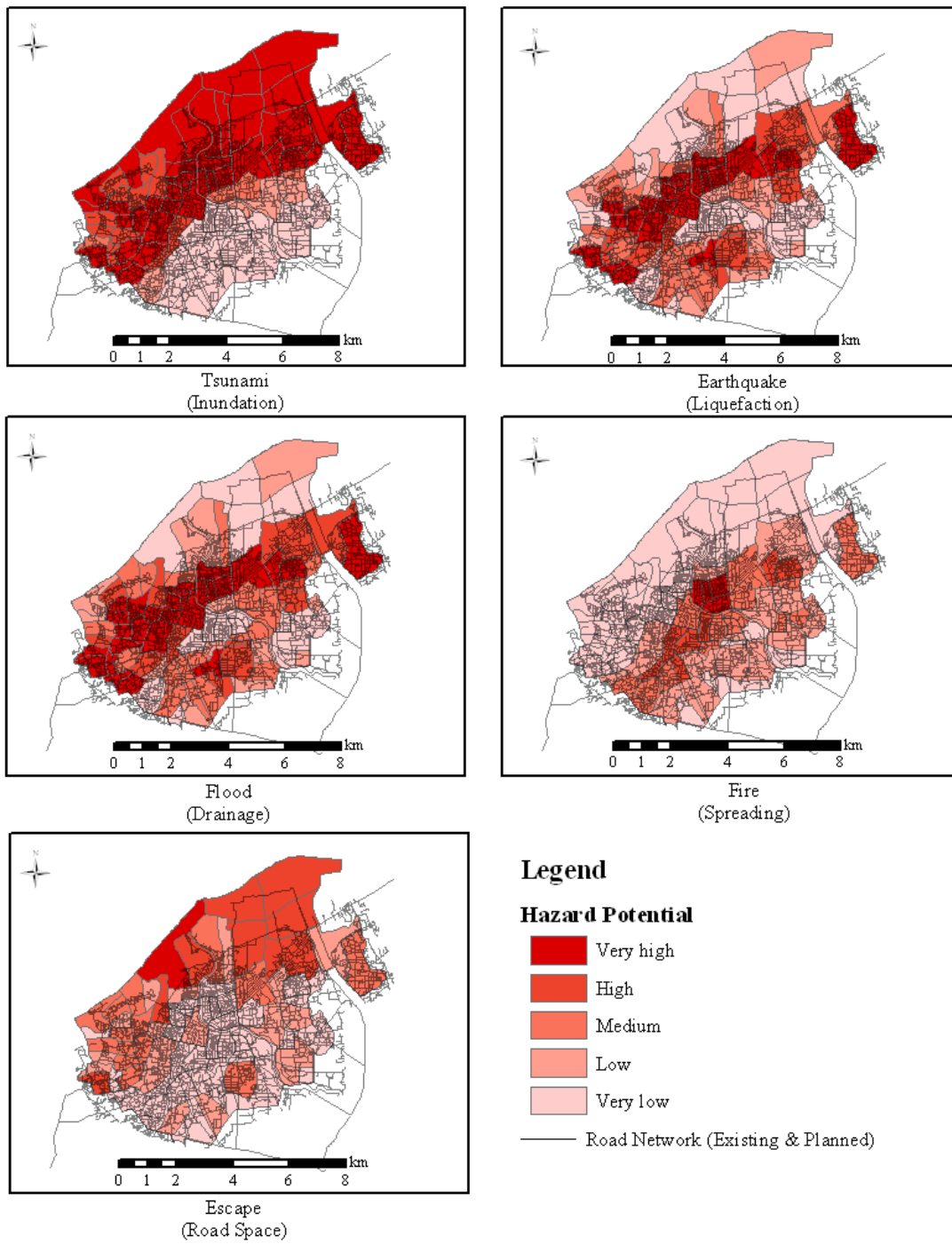
1.9.2 Hazard Potential

To evaluate the Hazard Potential is one of the important issues where a particular natural hazard could potentially be a problem. The maps are constructed by establishing risk factors, such as topographic condition, road space, density of population, etc., then noting where such factors exist in combination. The areas meeting the risk factors are illustrated by coloring them on a base map.

Risk factors (Table 1.9.1) are the criteria to decide where a particular hazard is present. The following factors are evaluated by *Desa* against natural hazards; namely, tsunami inundation, liquefaction, drainage, fire spreading and escape from hazard. The preliminary results are shown in Figure 1.9.2.

Table 1.9.1 Risk Factors for Natural Hazard

Natural Hazard	Topographic Factors	Physical Factors
(1) Tsunami inundation	Coastal lowland zone	Land area of <i>Desa</i>
(2) Earthquake (Liquefaction)	Depression/Lowland zone	Land area of <i>Desa</i>
(3) Flood (drainage)	Depression/Lowland zone	Land area of <i>Desa</i>
(4) Fire spreading	none	Building Area/Land Area
(5) Escaping activity	none	Road Space/Land Area



Source: ARRIS (GIS) prepared by JICA Study Team

Figure 1.9.2 Potential Hazard Maps

1.9.3 Disaster Mitigation Structures at Shoreline

Tsunami wave height generated by earthquake on 26 December 2004 reached about 10 m at shoreline based on the trace on palm trees. For protecting completely City of Banda Aceh from a huge tsunami, the sea wall of 15 m high along shoreline is required. However, such a high sea wall requires remarkable amount of public investment and it would be an obstacle from the viewpoint of environmental conservation. Thus, the structural measures at shoreline are designed to cope with small-scale and medium-scale tsunami. The structural measures are arranged in combination with (i) detached breakwater, (ii) seawall, (iii) coastal forest and (iv) tidal gate at river mouth.

Proposed structural measures at shoreline are illustrated as shown in Figure 1.9.3.

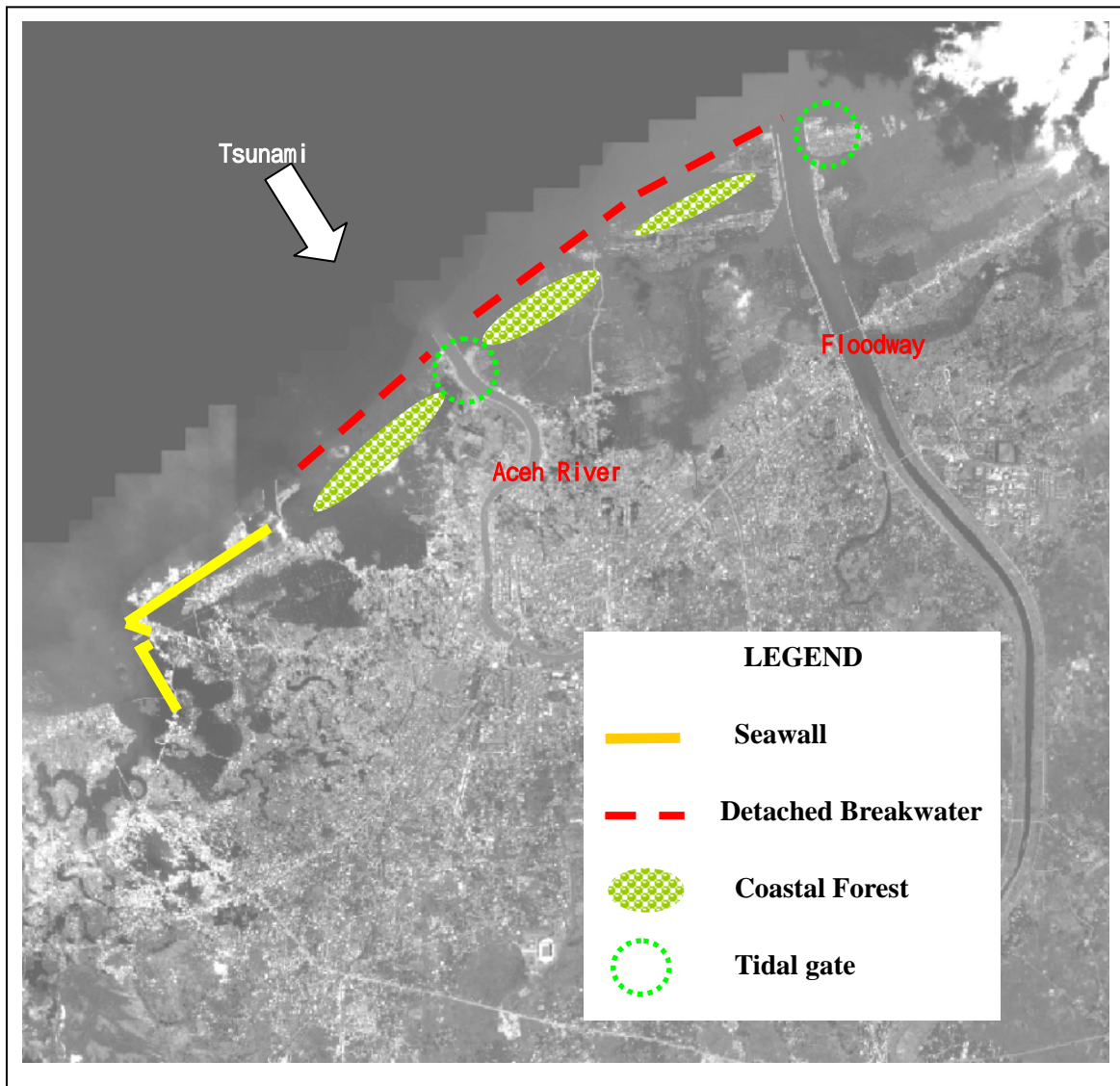


Figure 1.9.3 Structural Arrangements at Coastline

(1) Detached Breakwater

A series of detached breakwaters are structures situated offshore and generally parallel to the shore. Detached breakwaters protect the adjacent shoreline by attenuating incoming wave energy due to storm surge, mid-scale and small-scale tsunami (Figure 1.9.4).

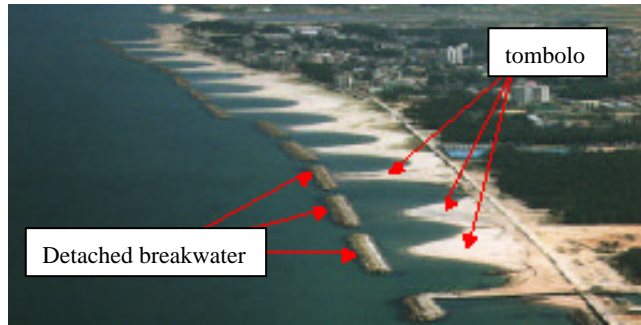
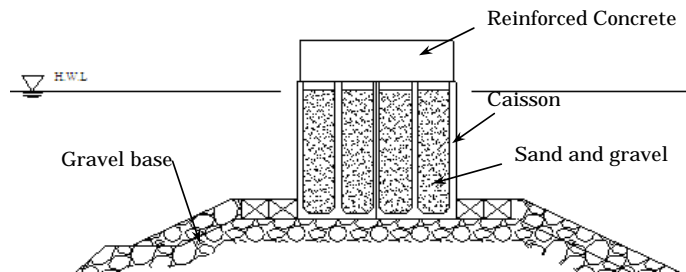


Figure 1.9.4 Series of Detached Breakwater

Detached breakwater with composite wall-type typically consists of caissons² sitting on a gravel base. Exposed faces are vertical or slightly inclined (Figure 1.9.5). It may protrude above High Water Level.

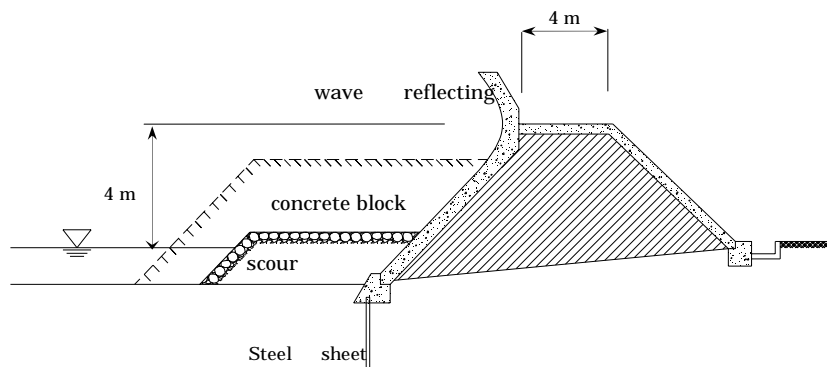


Source: JICA Study Team

Figure 1.9.5 Typical Cross Section of Detached Breakwater (Composite Wall-type)

(2) Seawall

A seawall is a structure built along the shoreline parallel to the beach. Its purpose is to impose a landward limit to coastal erosion and to provide protection to development behind the wall. Figure 1.9.6 shows typical cross section of a rigid seawall.



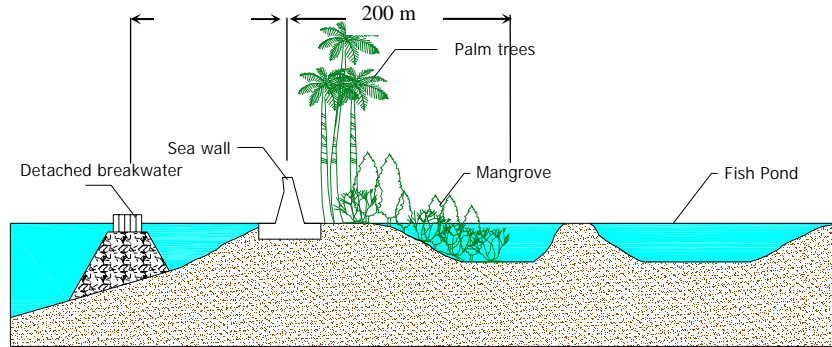
Source: JICA Study Team

Figure 1.9.6 Typical Cross Section of Rigid Seawall

² A concrete or steel shell filled with sand or gravel.

(3) Coastal Forest

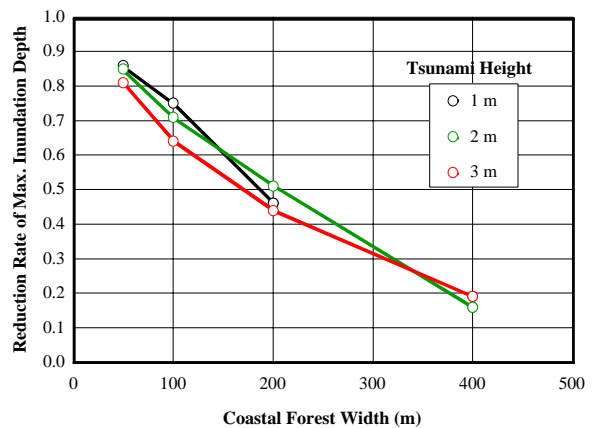
Coastal forest, with mangrove, sago palm, casuarinas tree and coconut tree, is known as natural functions to reduce the tsunami force and it is one of the solutions for disadvantages due to artificial measures. The construction of seawalls and breakwaters combined with coastal forest is likely to ensure the pre-tsunami environmental condition (Figure 1.9.7).



Source: JICA Study Team

Figure 1.9.7 Schematic Diagram of Arrangement of Coastal Forest

Quantitative effect due to coastal forest is evaluated preliminary on the basis of the results of numerical simulation in the past³. Coastal forest is generally collapsed by tsunami of over 4 m height. However, in case of tsunami wave height of 3 m, coastal forest with forest density of 30 trees per 100 m², the diameter of trunk of 15 cm, and forest width of 200 m can reduce tsunami inundation depth to 50-60 % and flow velocity to 40-60 % (Figure 1.9.8).



Source : Footnote ³

Figure 1.9.8 Coastal Forest Width and Reduction Rate of Inundation

Out of the parameters, such as forest density, diameter of trunk and forest width, to evaluate the quantitative effect, the most outstanding parameter is the forest width to amplify the reduction rate of tsunami inundation. Thus, the forest width of more than 200 m would be required to maintain for the purpose of reducing tsunami inundation.

In combination with detached breakwater, the coastal forest is regarded as the alternative measures against small and medium-scale tsunami until the seawall is completed for the whole stretch of shoreline in the future.

³ Kenji Harada and Yoshiaki Kawata, "Study on the effect of coastal forest to tsunami reduction", Annuals of disaster prevention, Research Institute of Kyoto Univ., No.47C, 2004

(4) Tidal Gate

Tsunami travels in a form of bore into river channel. Tsunami inundation map on 26 December 2004 also shows the furthestmost point of tsunami inundation at floodway reached 6.5 km upstream section from river mouth, although the tsunami inundation at inland extended with a radius of 3.5 km from shoreline. The collapse of bridge due to tsunami has been often reported due to hydraulic bore traveling to upstream.



Figure 1.9.9 Tidal Gate

Tidal gates for the river mouth of the floodway and the Aceh River are required to cope with small-scale and medium scale tsunami and to mitigate the damages along river channel (Figure 1.9.9).

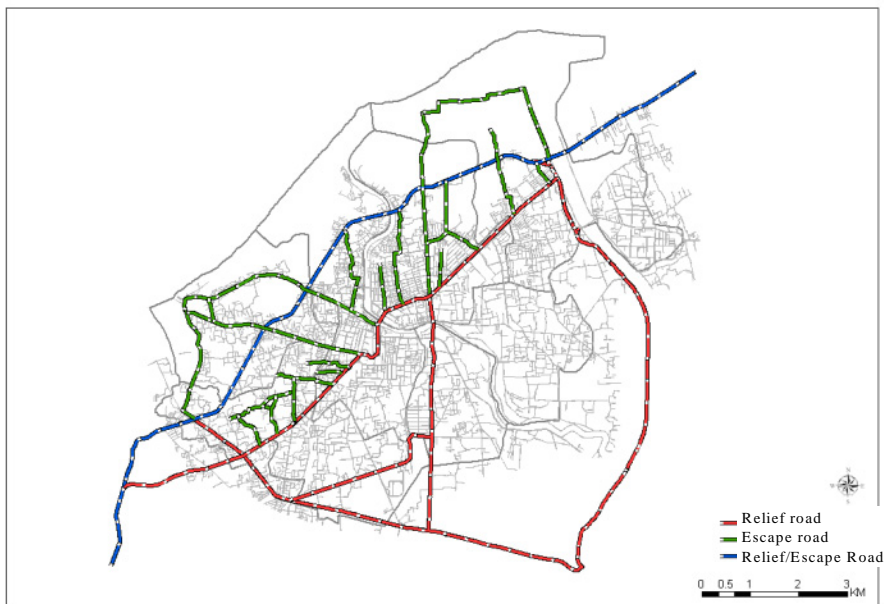
Lower priority is given to the construction of tidal gate because of high construction cost. The tidal gate would be required when the land use along river channel is developed.

1.9.4 Emergency Facility Plan

(1) Emergency Road Network

Emergency road network is organized into (i) escape road which citizens are able to escape from disaster in a short time, and (ii) relief road for immediate treatment (first-aid), evacuating citizens, and supplying relief materials. The network ensures to connect with southward area where is much safer against serious disasters.

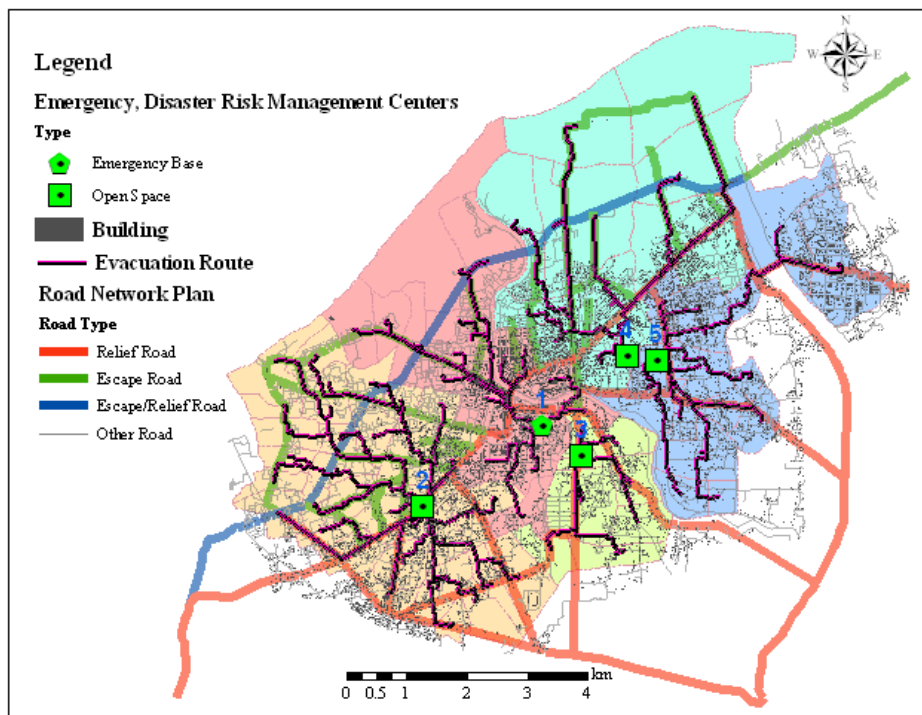
Emergency road network is provided for smooth activities in an emergency such as people's escape, rescue and relief by relevant government agencies. The relief road plays an important role for providing immediate treatment, evacuating citizens and supplying relief materials, while the escape road leads the citizens to escape from disaster to safer place (Figure 1.9.10).



Source : ARRIS (GIS) prepared by JICA Study Team

Figure 1.9.10 Emergency Road Network

The most effective escape route with shortest distance to emergency base and/or emergency management centers (open space) was analyzed by *Desa*. Figure 1.9.11 shows the results of analysis by GIS simulation.



Source: ARRIS (GIS) prepared by JICA Study Team

Figure 1.9.11 Escape Route by *Desa*

(2) Relief Road

For the purpose of rescue and relief activities, a peripheral road delineated around the residential area of Banda Aceh City connects with southern area, new north-south and east-west arterial roads. The relief road ensures the linkage with the network of escape roads.

Relief road is delineated to ensure the immediate response to stricken area from both directions with the concept of “fail-safe”; namely, access from the eastern side (Syiah Kuala) and the western side (Jaya Baru). The road also provides the linkage with city center, sub-centre and major public facilities (emergency bases). Especially, the relief road is regarded as a belt line connecting with city center and the sub-center as satellite districts.

Along the relief road, emergency bases having relatively wider area are provided for temporary settlement (a shelter tent) of dislocated families and for various relief activities. City parks, plaza in the mosques and schoolyard might be the site of proposed emergency bases. Whilst the low-lying areas extend southward crossing the proposed alignment of relief road, the area by filing up is available for emergency purposes.

(3) Escape Road

Network of escape roads located between relief roads and the east-west national road enables the citizens to escape from disasters in a short time.

The most serious concerns for the purpose of disaster mitigation are how to lead the citizens lived hazard area to the southward; namely safer side. Several existing south-north roads are proposed as possible escape roads for the citizens. Signboards and lights are provided in case of tsunami in the night time.

Time required for escape is quite limited when the tsunami generated by earthquake at the nearest fault. Thus, the place having higher elevation, such as tower, building with public stairs and bridges, are provided along the escape road.

Locations and the number of escape tower, building and bridges are examined taking into account the population distribution, escape road network and distance from the houses. The possible distance for escape on foot is estimated at the radius of 900 m (15 minutes at a walking speed of 1.0 m/sec on the average among the aged, handicapped and children).

(4) Public Emergency Facilities for Disaster Preparedness

Public emergency facilities for disaster preparedness are organized into (i) escape buildings, (ii) escape bridges, (iii) emergency bases and (iv) city parks.

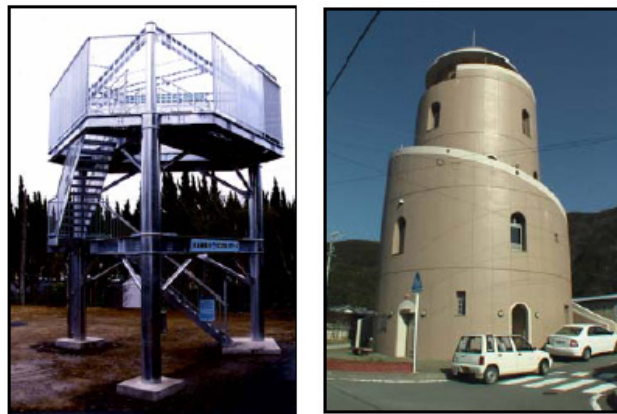
Public emergency facilities are provided assuming the following functions and period (Table 1.9.2).

Table 1.9.2 Classification of Emergency Facilities and Required Period

	Emergency Facility	Required Period	Function
1.	Escape building	Temporary (a half to whole day)	<ul style="list-style-type: none"> Temporary escape from tsunami inundation to the building, bridge, and tower.
2.	Public facility for emergency use	Short (a couple of days)	<ul style="list-style-type: none"> Dislocated families station immediately after tsunami.
3.	Emergency bases, Park with open space	Long (1 to 2 months)	<ul style="list-style-type: none"> A base for rescue and relief activities conducted by government agencies and NGOs. Shelter tents are provided for refugee.
4.	Temporary Housing	Rather Long (more than 2 months)	<ul style="list-style-type: none"> Temporary houses are provided in open-space.

a) Escape Building

The building is tsunami and earthquake proofed. Schools, mosques, markets, rental flats and building of ferry terminal could be good alternatives for the building. Also, the existing private buildings could be utilized as escape building. Escape towers are one of alternatives for fishermen and tourists since there is none of the houses and building with 10m high in the coastal area (Figure 1.9.12).

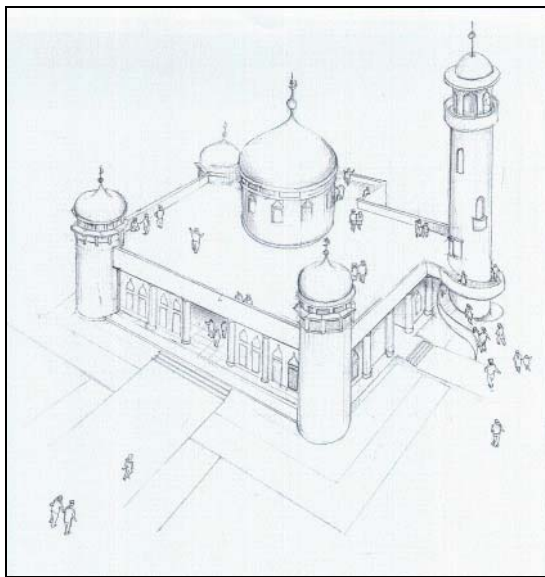


Source: Guideline for tsunami-escape building, 2005

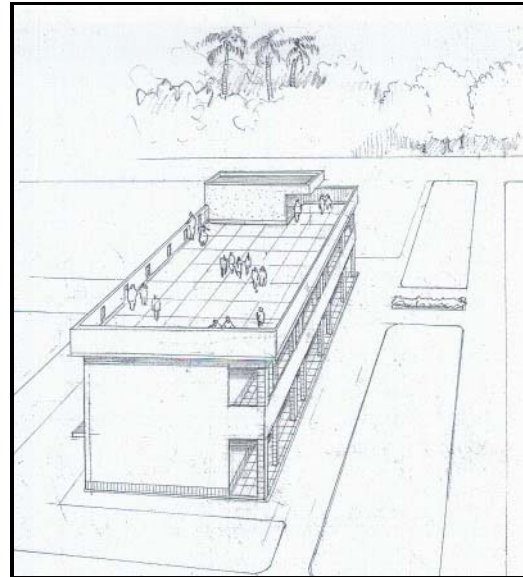
Figure 1.9.12 Escape Tower

Administrative guidance by the government agencies are necessary to make the existing buildings with flat roof, such as mosques, schools, public buildings and shopping centers, renovated as escape building with external stairs.

General plans for escape building by renovating mosque and school are illustrated in Figure 1.9.13. In the case of school, the 2nd floor can be utilized as storehouses for requisites for use in the event of disaster. The location map of required escape building is shown in Figure 1.9.14.



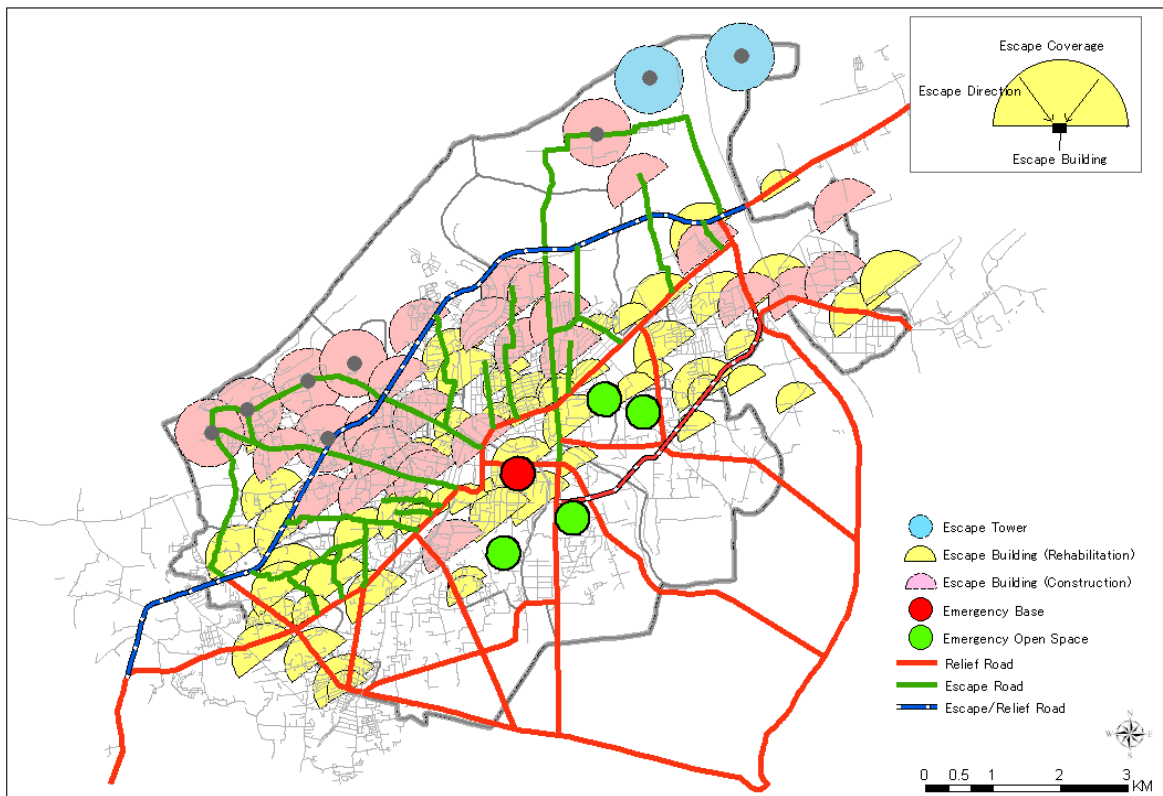
a) Escape Building of Mosque



b) Escape Building of School

Source: JICA Study Team

Figure 1.9.13 Escape building

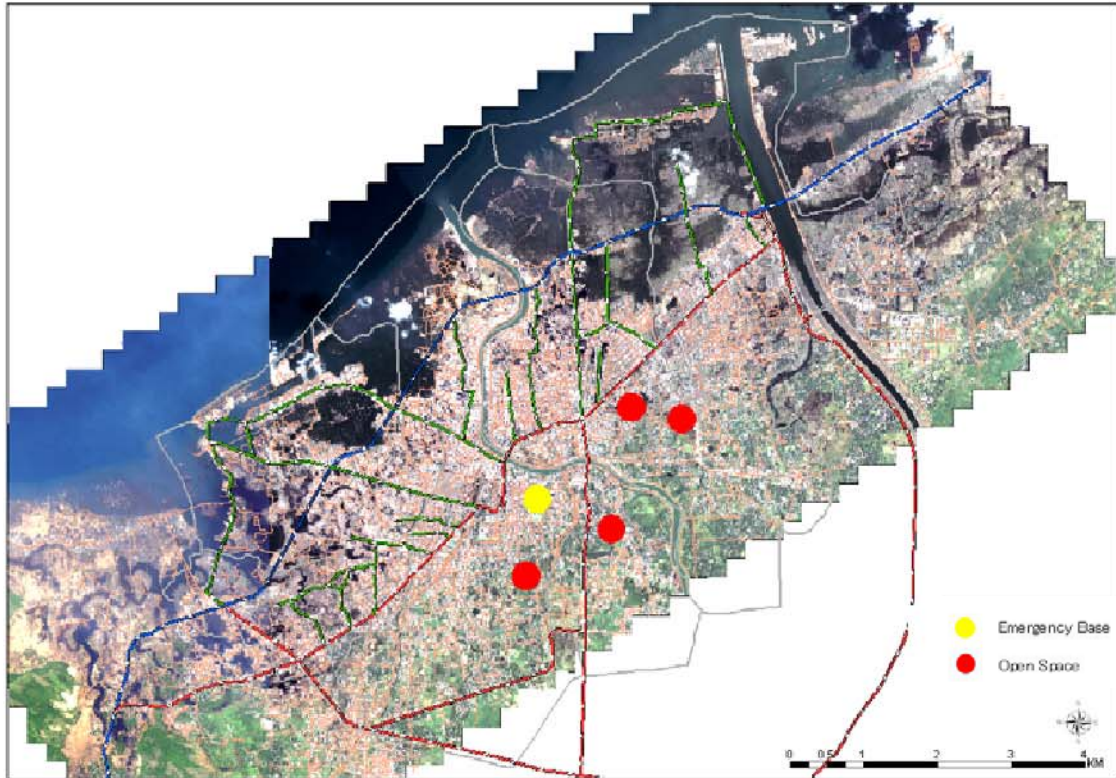


Source: ARRIS (GIS) prepared by JICA Study Team

Figure 1.9.14 Location of Emergency Public Facilities

b) Integrated Emergency Base and Open Space for Disaster Preparedness

Integrated emergency base and open spaces are utilized for the purpose of not only the destination of escape but also the base for rescue, relief and temporary housing. The location map is shown in Figure 1.9.15.



Source: JICA Study Team

Figure 1.9.15 Location of Emergency Public Facilities and Open Spaces

Integrated emergency base is located under the condition that (i) along main arterial road, (ii) in the vicinity of hazard area, and (iii) nearer to city center and sub-center. The base is operated and maintained under the management of city office and will be a operation and information center for disaster preparedness in an emergency, while the base is utilized for place for a ceremony and/or a event in a normal condition. The building for the base has a flat roof with external stair and its upper floor is equipped with requisites for use in the event of disaster.

Open spaces as emergency base are the land for a shelter tent and/or temporary houses for dislocated families. Mosque situated by the *Desa* is also regarded as open space.

Low-lying areas extend southward crossing the proposed alignment of relief road, the area by filing up is available as open space for emergency purposes.

c) City Park for Disaster Preparedness

Over 70,000 casualties were recorded when the tsunami rampaged on 26 December 2004. One of the most serious reasons for such a calamity is that the people did not aware of tsunami generated by earthquake.

City parks are provided as part of public education and disaster awareness. The functions of city parks are:

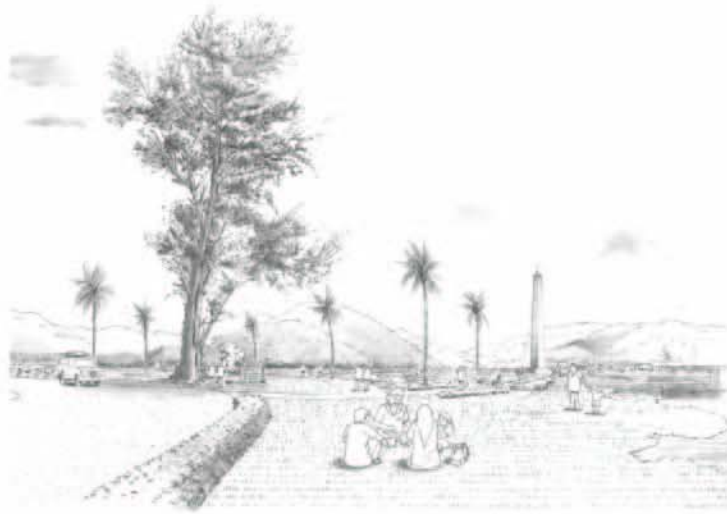
- i) Public education : The awareness of tsunami disaster is handed down from generation to generation. A science museum provided with signboard showing earthquake induced tsunami, tsunami disaster in 2004 and system on disaster preparedness is constructed.
- ii) Emergency base : Open-spaced city parks would be one of the emergency bases which is equips with requisites for use in the event of disaster.
- iii) Recreation : City parks are available for the place of recreation and relaxation of citizens and tourists.
- iv) Memorial Park : City Park mourned over casualties in the vicinity of cemetery.

The location map of proposed city parks is given in Figure 1.9.16. The artistic views are shown in Figure 1.9.17.

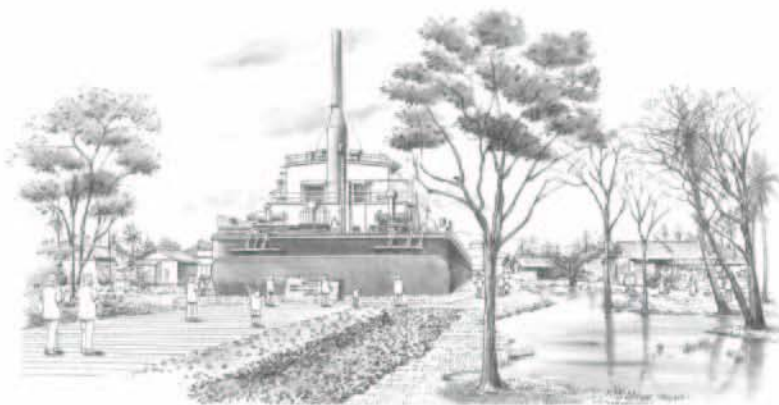


Source: JICA Study Team

Figure 1.9.16 Location Map of City Parks



a) City Park utilized a Big Tree as a Symbol (Big Tree)



b) City Park utilized PLN barge (Big Ship)



b) City Park located in low-lying Areas (Tsunami Park)

Source: JICA Study Team

Figure 1.9.17 Artistic Views of City Parks