4.6 URGENT REHABILITATION AND RECONSTRUCTION PLAN FOR EDUCATION SECTOR

Following the strategy, the urgent rehabilitation and reconstruction plan for education sector (the Plan) is suggested as followings.

(1) Clearing, cleaning, rehabilitating, and relocating damaged schools and establishing new schools, and maintaining the improved schools

(2) Recruiting temporary educators and permanent teachers and training in-service teachers and administrators

(3) Providing textbooks/learning materials and school furniture

(4) Providing the affected students/teachers with scholarship/subsidy and counseling traumatized students/teachers

(5) Developing teaching-learning process and curricula, and providing developed learning materials

(6) Modernizing non formal education

(7) Developing school management

4.7 PRELIMINARY IMPLEMENTATION COST

The preliminary implementation cost of the Plan is estimated at 969 billion Rp. for year 2005-2015 (Table 4.4).

The preliminary implementation cost is conditioned on the followings.

(1) The cost is based on "the necessary cost for rehabilitation and reconstruction program in Banda Aceh City" shown in chapter 3.

(2) The cost for the rehabilitation and reconstruction of school infrastructures covers the cost of approximately 170 damaged kindergartens and schools.

(3) The cost is added 20 % increase of the necessary cost to to school constructions as escape buildings in the coastal area.

(4) The cost does not include the land acquisition and compensation cost.

(5) The cost includes a physical contingency (10 % of a direct cost), a price escalation (10 % of each plan) and engineering services (10 % of construction cost). Construction includes a physical contingency, a price escalation and engineering services. The procurement and other program include only a price escalation.

(6) The direct construction cost is assumed to include the amount of VAT and but not to include import duties.

The cost will be finalized by Indonesian Authorities.

4.8 TENTATIVE IMPLEMENTATION SCHEDULE

The tentative implementation schedule of the Plan is shown by each stage (Table 4.4). The schedule will be finalized by Indonesian Authorities.

Table 4.4 Tentative Implementation Schedule

Implementation Plan	Year						Estimated Cost	Implementation Body
	2005	2006	2007	2008	2009	2010 - 2015		
(1) Implementation Plan of the Rehabilitation Stage							**621**	
a) Clearing, cleaning and rehabilitating damaged schools *1)	153	307					460	*2) EDNP, EDB, RDNP, RDB
b) Providing emergency schools and the class lessons	14	47					61	
c) Recruiting temporary educators and training them	25	8					33	
d) Providing textbooks/learning materials and school furniture	11	11					22	
e) Providing the affected students/teachers with scholarship/subsidy and counseling traumatized students/teachers	36	9					45	
(2) Implementation Plan of the Reconstruction Stage							**323**	
a) Continuing the reconstruction of schools, relocating schools and establishing new schools *1)			116	91	34		241	*2) EDNP, EDB, RDNP, RDB
b) Recruiting permanent teachers and training in-service teachers and administrators			2	2	2		6	
c) Developing teaching-learning process and curricula, and providing developed learning materials			10	4	3		17	
d) Modernizing non formal education			1	1	1		3	
e) Developing school management			14	14	14		42	
f) Continuing provision of scholarship/subsidy and couseling			6	4	4		14	
(3) Implementation Plan of the Revitalization Stage							**25**	
a) Continuing maintenance of rehabilitated and newly constructed schools						25	25	*2) EDNP, EDB, RDNP, RDB
Estimated Cost by year	239	382	149	116	58	25	969	

Unit: Billion Rp.
Source: JICA Study Team
Remark*1: The relocated schools and newly established schools in the coastal area will be designed as escape buildings where people can get on the roof as evacuation places in case of tsunami.
Remark*2: (EDNP) Education Department of NAD Province, (EDB) Education Department of Banda Aceh City, (RDNP) Religion Department of NAD Province, (RDB) Religion Department of Banda Aceh City

4.9 PRIORITY PROJECT

4.9.1 Basic Policy of Priority Projects

The basic policy of priority projects is as follows.

(1) Priority projects cover Banda Aceh city as a target area due to the worst disaster.

(2) Priority projects are planned and finalized in collaboration with MONE, the local education department and the local religion department to deal with the local needs.

(3) Priority projects cope with both of damages and losses of infrastructures and human resources in the education sector.

(4) Priority projects consider the orphans and widowed mothers in order to be beneficiaries.

(5) Priority projects also highlight important issues of the education sector to be resolved before the tsunami.

(6) Priority projects consider that the schools in the coastal area are designed as escape buildings.

Priority projects are examined by the criteria of success of the goal (Table 4.5).

Table 4.5 Priority Projects selected from Criteria for a Success of the Goal

Priority Projects	Criteria for a success of the goal					Priority
	(a) Increase of a net enrollment rate (Highest weight)	(b) Increase of trained teachers (Second highest weight)	(c) Increase of trained administrators (Low weight)	(d) Increase of community participation (Low weight)	(e) Consideration of orphans and widowed mothers (Low weight)	
Reconstruction and Improvement of Nucleus Schools for Upgrading Science and Mathmatics Education Level	◎◎◎	◎◎	×	△	△	1
School Relocations in Coastal Areas Heavily Damaged by the Tsunami	◎◎◎	×	×	◎	△	2
REDIP (Regional Education Development and Improvement Program) in Banda Aceh	△△△	◎◎	◎	◎	△	3
Improvement of Early Age Children Center	△△△	◎◎	△	△	◎	4
Reconstruction of a Senior Vocational High School	△△△	◎◎	×	◎	×	5
Reconstruction of In-Service Teacher Training Center	△△△	◎◎	△	×	×	6
Reconstruction of Boarding Schools	△△△	△△	△	◎	◎	7
Capacity Development of Education Administration	△△△	△△	◎	×	×	8

Source: JICA Study Team
Legend: □: Very applicable, □; Slightly applicable, ×; Not applicable
Note) Criterion (a) is the highest weight, (b) is the second highest weight and the remaining criteria are low weight.

4.9.2 Priority Projects

The following priority projects are formulated through discussions with persons concerned: MONE, Education Departments of NAD province, Education Departments of Banda Aceh city, Religion Department of Banda Aceh City and BAPPEDA of Banda Aceh City.

(1) Reconstruction and Improvement of Nucleus Schools for Upgrading Science and Mathematics Education Level

1) Background and Objectives

Indonesia has a unique school management system, namely school cluster system. A nucleus elementary school, which is a core school under the cluster system, has functioned as a key school which provides the member cluster schools with the teacher training and the use of laboratories for the lessons. A nucleus junior high school and senior high school have functioned as providing the member cluster schools with the teacher training. There are nucleus schools of 20 units in elementary schools, each one unit in junior high schools and senior high schools in Banda Aceh city. Some nucleus schools were damaged by the tsunami.

On the other hand, science and mathematics education in Banda Aceh city has been required to upgrade the level due to the worst level in Indonesia. Nucleus schools will contribute to extend the higher level of the education to the member schools.

The objectives of the priority project are to reconstruct the school infrastructures and equipment of science and mathematics for nucleus schools and strengthen the capacity of the nucleus school teachers for the upgrade of the science and mathematics education level.

2) Component

a) Reconstruction of nucleus schools damaged by the tsunami and earthquake disaster, including a construction of a student dormitory and natural science laboratory of a nucleus junior high school

b) Procurement of equipment of science and mathematics education for the target nucleus schools

c) Effective and practical training for nucleus school teachers in a science and mathematics, following a small experimental project of the education proposed by nucleus teachers, and a pilot project for the transfer of the training experiences from nucleus school teachers to the member school teachers

3) Beneficiary and the target nucleus schools

3-1) Beneficiary

The beneficiaries are all students and teachers of the target nucleus schools. Especially science and mathematics teachers including representative teachers from the member schools are highlighted as beneficiaries of the training.

3-2) The target nucleus schools

The target schools are seven (7) units as follows.

a) Elementary nucleus schools

- SD87 (Meuraxa), SD47 (Meuraxa): Severely damaged by the tsunami

Note: SD 47 has used a temporary school after tsunami and gives a double shift lessons.

- SD16 (Baiturrahman), SD62 (Lueng Bata), SD56 (UleeKareng): Slightly damaged by the earthquake:

Washed-out SD87

Heavily damaged SD 47

b) Junior high schools

- SMP Percontohan: Slightly damaged by the earthquake

Suspended construction of science laboratory of SMP Percontohan

c) Senior high schools:

- SMAN10 (Lueng Bata): Partially damaged by the tsunami

Note: Other nucleus schools damaged are planned to reconstruct by IACO (SD17 and SD93), Bank Jabar (SD50), UNICEF (SD28 and SD36), PMI (SD22), Lions club (SD61) and Save the Children (SD82). Those schools exclude from the target schools of the priority plan.

4) Execution Agency

- Education Department of NAD Province
- Education Department of Banda Aceh city

5) Project duration

Year 2006 to 2008

6) Project cost

The project cost is estimated at 90 billion Rp.

(2) School Relocation in Coastal Areas Heavily Damaged by the Tsunami

1) Background and Objectives

After the tsunami, the Education Department of Banda Aceh City formulated "a master plan of rehabilitation, reconstruction and relocation of schools located in coastal areas heavily damaged by the tsunami", namely 3 Kecamatans of Meuraxa, Kuta Raja and Jaya Baru. The relocation needs much time to acquire the relocation site and much budgets compared with the rehabilitation and reconstruction. Most of rehabilitation and reconstruction of schools are committed to implement by some donors but the relocation is not offered to implement by any donors.

The City Education Department has a plan to regroup the schools to be relocated and establish the new schools in the same Kecamata due to a shortage of available land and the budget of land acquisition.

The objectives of the priority project are to relocate heavily damaged schools located at the areas where the inhabitant population was decreased drastically by the tsunami and to return students to an ordinary study environment in the relocation schools.

2) Component

a) Public Consultation of relocation of heavily damaged schools

Relocation schools will be combined into some schools (Refer to Box 1 shown in the Chapter 4.5).

b) New construction of earthquake-resistant and escape building type schools with student dormitories in the relocated sites

c) Procurement of school furniture and equipment

d) Preparation of emergency evacuation plans against the disaster

3) Beneficiaries and a list of the target schools to be relocated

3-1) Beneficiary

The beneficiaries are all students and teachers of the target schools to be relocated.

3-2) List of the target schools to be relocated

-Meuraxa Kecamatan: SDN49, SDN98, SDN87 (to take measures by 1st priority project), SDN48, SDN74, SDN78, SDN91, SDN92, SDN47 (to take measures by 1st priority project), SDN88, SDN89, SDN94, SDN90, SDN46, SDN109, MIN Ulee Lheu, MTSN Meuraxa, SMAN6 and SMA Iskandar Thani

Photo 4. The ruin of SMAN6

Photo 5. A temporary school in IDPC located at inland area

-Kuta Raja Kecamatan: SDN38, SDN60, SDN70, SDN103 and SMP Iskandar Muda

Note) Jaya Baru has no relocation schools.

4) Execution Agency

- Education Department of Banda Aceh City

5) Project duration

Year 2006 to 2008

6) Project cost

The project cost is estimated at 59 billion Rp.

(3) REDIP (Regional Education Development and Improvement Program) in Banda Aceh

1) Background and Objectives

Aceh PEQIP (Primary Education Quality Improvement Project) was conducted in 1996 and 1997. However, the project had discontinued since 1998 due to the conflict. The school based

improvement of education quality facilitates community participation to education. REDIP is to find and reflect real local needs into the school activities in collaboration with local community people. Being thrown into confusion after the tsunami, Banda Aceh city needs to recover the normal education condition quickly through the community participation.

The objectives of the priority project are to implement experimental teaching-learning projects for improvement of the education quality in junior high schools through community based approach and to upgrade the capacity of the teachers and head masters.

2) Component

a) Organization of Kecamatan SMP (junior high school) development team

b) Workshop with stakeholders on needs of school education

c) Socialization for the participation on the suggested education process

d) Implementation of experimental projects by using proposal-based block grant

e) Monitoring and evaluation

3) Beneficiary and a list of the target schools

3-1) Beneficiary

The beneficiaries are head master and teachers of the target schools, representatives of a local education and religion department, and representatives of community people of the kecamatans located at the target schools

3-2) List of the target schools

-All junior high schools located at kecamatans to have received many displaced students

-All junior high schools located at kecamatans to have been damaged heavily

4) Execution Agency

- Education Department of Banda Aceh City

5) Project duration

Year 2007 to 2008

6) Project cost

The project cost is estimated at 14 billion Rp.

(4) Improvement of Early Age Children Center

1) Background and Objectives

There are lots of persons widowed by the tsunami disaster, who become breadwinners to support financially by themselves. Most of widowed mothers need to learn skills of livelihood because of no experiences of working outside and to require the place to take care of their children during the training session. An early age children center aims at providing preschool education, practical training to make widowed mothers' livelihood, and a counsel of health and bringing up their children. The center, moreover, provides traumatized children and widowed mothers with a mental counsel. This new system of a preschool education will be introduced ad hoc to reduce the serious difficulties of widowed mothers and early age children and to enrich the preschool education.

The objectives of the priority project are to provide the widowed mothers with self-support means by vocational training of household industry and give their children preschool education and day care, through establishing early age children centers.

2) Component

a) Reconstruction of the center in place of kindergartens (TK and RA) destroyed by the tsunami

b) Procurement of equipment for training and nursery

c) Preparation and execution of vocational training of the center staff

3) Beneficiary and a list of the target kindergarten

3-1) Beneficiary

The beneficiaries are the early age school children and the widowed mothers of the center and center staff.

3-2) List of the target kindergarten

- TK Negeri (Desa Lamjabat, Meuraxi): to be relocated
- TK Aisyiah B Aceh(Kelurahan Merduati, Kuta Raja: to be relocated
- TK Gaseh Poma(Kel. Mulia, Kuta Alam)
- RA Al Azmi (Bitai, Jaya Baru)
- RA Indah Sari(Taman, Sari, Jl.Tgk Abdullah Ujong Rimba, Baiturrahman)

Washed out TK Negri

Temporary houses are under construction beside theTK Negri

4) Execution Agency

- Education Department of Banda Aceh city
- Religion Department of Banda Aceh city

5) Project duration

Year 2006 to 2007

6) Project cost

The project cost is estimated at 8 billion Rp.

(5) Reconstruction of a Senior Vocational High School

1) Background and Objectives

Fisheries industry is one of the most important industry areas in Banda Aceh City. The Tsunami washed away a senior vocational high school (SMKN 4) as only one school which gave training lessons for a shipbuilding of fishing vessels, fishing gears and fishing methodology. The damage of the vocational high school caused by the tsunami is estimated at 1.5 billion Rp. The vocational high school is required to reconstruct from the local industry field.

The objectives of the priority project are to reconstruct the vocational high school to produce technicians for development of the local economy.

2) Component

a) Reconstruction of the senior vocational high school
b) Procurement of training equipment
c) Curriculum development and training of the new curriculum

3) Beneficiary and the location of the target school

SMKN 4 Banda Aceh (Jl. Sisingamanga Raja, Kuta alam)

The land area of the vocational school is approximately 1 ha.

The ruin of Classroom building of SMK4

Washed-out workshop

4) Execution Agency

- Education Department of NAD Province

5) Project duration

Year 2006 to 2007

6) Project cost

The project cost is estimated at 14 billion Rp.

(6) Reconstruction of In-Service Teacher Training Center

1) Background and Objectives

Education Department of Banda Aceh city is in real trouble with huge losses of teachers and a destruction of an in-service teacher training center by the tsunami disaster. On the other hand, Education Department of NAD Province started to put up an in-service teacher training center in 2002; however, the construction has made little progress due to the budget shortage. The reconstruction of the training center is needed to refresh the in-service teachers including contract teachers in proper manners and conditions because the teacher quality in the city is one of the worst levels in Indonesia.

Education Department of NAD Province plans to reconstruct the in-service teacher training center after the tsunami. The center consists of 4 buildings: a media center for formal education, a non formal education facilitator training center No.1, a non formal education facilitator training center No.2, and pubic facilities of vocational teacher training center. Out of 4 buildings, 2 buildings are planned to be assisted by donors as follows.

The media center will be constructed by Turkish NGO (pledged, but MOU is not yet). The No.1 non formal education facilitator center will be constructed by provincial government and the center equipment will be procured by AUSAID (pledged, but MOU is not yet). The No.2 non formal education facilitator center was planed for USAID to construct, but USAID cancelled the proposal of the construction.

The objectives of the priority project are to construct the No.2 non formal education facilitator center and the vocational teacher training center, and to train in-service teachers for upgrading teachers' capacities.

2) Component

a) Construction of No.2 non formal education facilitator center and the in-service vocational teacher training center

b) Procurement of the vocational training equipment and non formal education equipment

c) Formulation of a standardization of teaching method including demonstration lessons for vocational training and non formal education

d) Curriculum development and practical training how to use and maintain training machine and equipment

3) Beneficiary and the location of the target in-service teacher training center

3-1) Beneficiary

The beneficiaries are instructors for in-service teacher training.

3-2) Location of the target center

Desa Lamlgang, BandaRaya
The land area is approx. 2 ha.

Still under construction since 2002

Proposed site of the In-Service Teacher Training Center

4) Execution Agency

Education Department of NAD Province

5) Project duration

Year 2007 to 2008

6) Project cost

The project cost is estimated at 7 billion Rp.

(7) Reconstruction of Boarding Schools

1) Background and Objectives

Suffering from the tsunami disaster, Banda Aceh city has serious problems of many orphans' livelihood and education. A boarding school, which is a private non-formal education school, will receive the orphans who are of school age and not supported by anyone. The school, which is under the control of Education Department of NAD Province for the school infrastructure since 2002 and

under Religion Department of NAD Province for school management and curriculum, has provided young generation with non-formal education and lodging. The financial management of boarding schools has been supported by community people. The schools also have an issue to modernize physical conditions and school management. Three (3) boarding schools were heavily damaged by the tsunami. The reconstruction of the boarding schools is urgently required by orphans and local community.

The objectives of the priority project are to foster the school age orphans and give improved non-formal education to the learners by reconstructing the damaged schools and establishing modern boarding schools.

2) Component

a) Reconstruction of boarding schools destroyed by the tsunami disaster
b) Procurement of literacy primers and equipment for non-formal education
c) Preparation of a standardization of boarding school management

3) Beneficiary and a list of the locations of the target boarding schools

3-1) Beneficiary

The beneficiaries are all the head masters, the instructors and the learners of the target boarding schools.

3-2) List of the target boarding schools

-Darul Ulum, Jambo Tape, Kec., Kuta Alam
-Raudhatul Wustha, Bitai, Kec., Jaya Baru
-Ruhul Islam anak Bansa, Gue Gajah,

4) Execution Agency

- Education Department of Banda Aceh city
- Religion Department of Banda Aceh city

5) Project duration

Year 2006 to 2007

6) Project cost

The project cost is estimated at 17 billion Rp.

(8) Capacity Development of Education Administration

1) Background and Objectives

Education Department of NAD Province had trained for an education administrators. Sixty four (64) members of the education administrators trained overseas, however, were killed by the tsunami disaster. There is an old training center for education administrators, which has a dormitory of 14

rooms and 3 classrooms. A lack of well-trained trainers cannot conduct appropriate training in the training center.

Capacity development for education administrators is urgently needed to cope with the lower quality of education administration. Areas to be strengthened are education planning, a distance education by radio, and a public relations, which are important tasks of the Education Department.

The objectives of the priority project are to upgrade the capacity of education administration in the above-mentioned areas by training the administrators and procuring the necessary equipment and to extend the training experiences to the local education administration.

2) Component

a) Capacity development for a problem analysis, a project formulation, monitoring and evaluation of the education administration, a distance education, an effective public relation, and the information technology (IT) class

b) Overseas training of education administrators for education planning and distance education

c) Procurement of equipment for a radio broadcasting studio "VISI FM", a printing machine for magazine and distance education textbooks, and computers

3) Beneficiaries of the capacity development

Education Department of NAD province

4) Execution Agency

Education Department of NAD Province

5) Project duration

Year 2008

6) Project cost

The project cost is estimated at 7 billion Rp.

APPENDIX 8

DISASTER MITIGATION

APPENDIX 8 DISASTER MITIGATION

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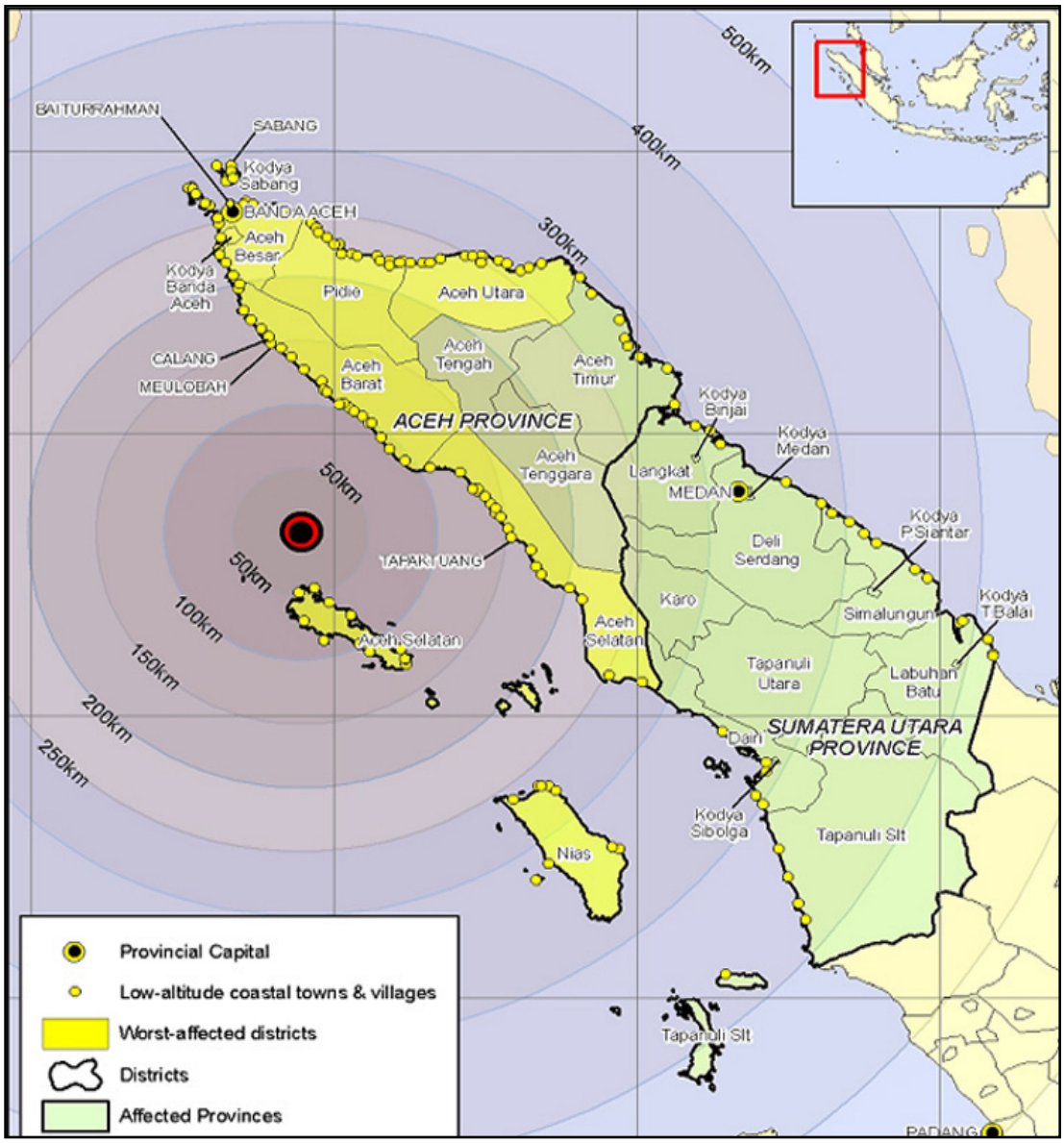
CHAPTER 1 EXTENT OF DAMAGE

1.1 EARTHQUAKE

A powerful earthquake of magnitude of 9.0 has struck northern Sumatra at 07:58 a.m (Figure 1.1). The earthquake was felt widely along the coast of Indian Ocean. A major Indian Ocean-wide tsunami was generated by this earthquake which stuck India, Sri Lanka, Bangladesh, Thailand and Malaysia causing heavy fatalities. Heavy damage and panic was reported from Banda Aceh City. Many buildings in the city collapsed in the earthquake and a number of cracks appeared in buildings which were shaken violently.



Source: United Nations OCHA

Figure 1.1 Epicenter of Earthquake (26 Dec. 2004)

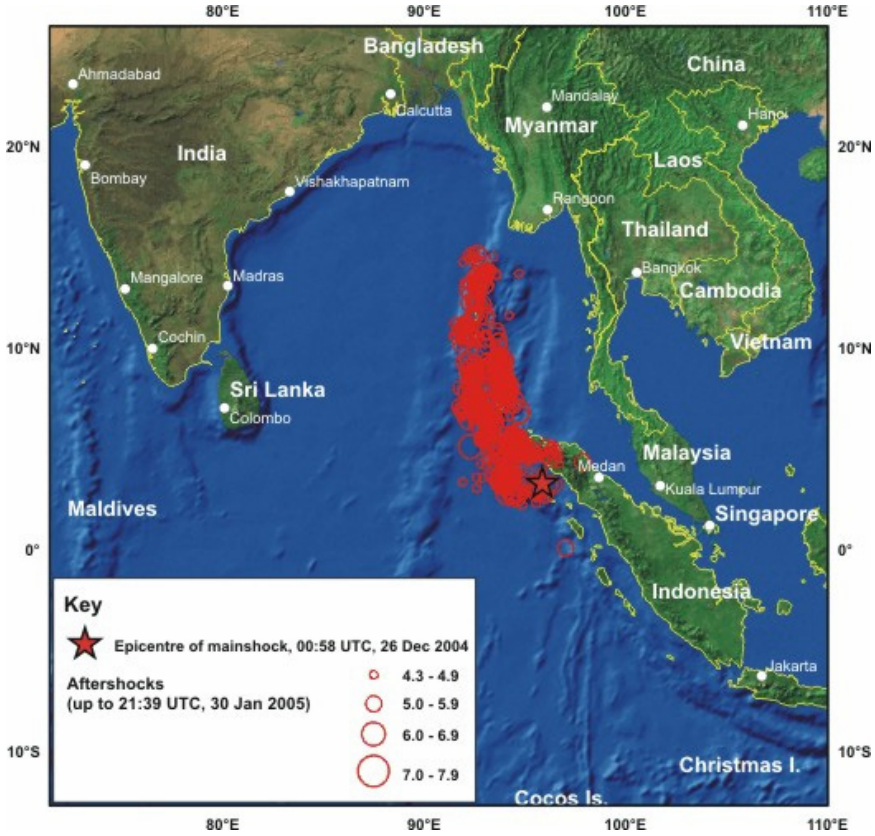
The earthquake was recorded as the third largest earthquake in the world (Table 1.1) and the strongest during the instrumented era in seismology i.e. 1966 to present.

Table 1.1 Historical Earthquake in the World since 1900

Location		Date	Magnitude
1.	Chile	1960/05/22	9.5
2.	Prince William Sound, Alaska	1964/03/28	9.2
3.	Off the West Coast of North Sumatra	2004/12/26	9.0
4.	Kamchatka	1952/11/04	9.0
5.	Off the coast of Ecuador	1906/01/31	8.8
6.	Northern Sumatra, Indonesia	2005/03/28	8.7
7.	Rat Islands, Alaska	1965/02/04	8.7
8.	Andreanof Islands, Alaska	1957/03/09	8.6
9.	Assam - Tibet	1950/08/15	8.6
10.	Kuril Islands	1963/10/13	8.5
11.	Banda Sea, Indonesia	1938/02/01	8.5
12.	Chile-Argentina Border	1922/11/11	8.5

Source: USGS

A number of aftershock occurred since 26 December 2004. The epicenter of the 26 December 2004 earthquake, marked by the star, is plotted along with over 590 associated aftershocks up to 30 January 2005, marked by red circles (Figure 1.2). These aftershocks clearly delineate a 1,000-km wide of the plate boundary between the Indian Plate and the Burmese Micro-Plate that ruptured in the main-shock on 26 December 2004. Some of the larger aftershocks were strong enough to be felt as far as Chennai on the east coast of India, causing panic and minor damage.



Source: British Geological Survey

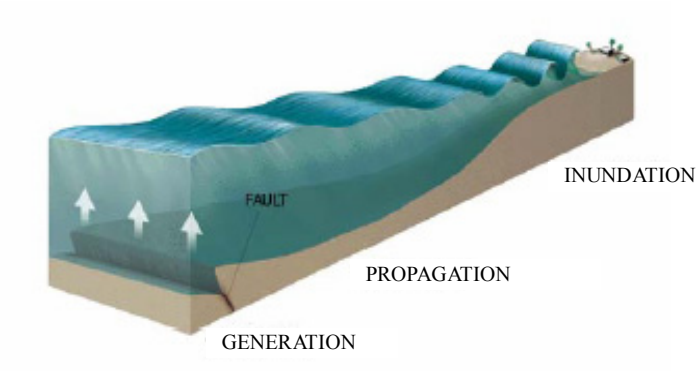
Figure 1.2 Location Map of Epicenters of Main-shock and Aftershock

1.2 TSUNAMI

1.2.1 Tsunami Generated by Earthquake

The devastating tsunami was a direct consequence of the earthquake, which causes movement of the seafloor all along the length of rupture, displacing a huge volume of water and generating the tsunami wave. The vertical uplift could have been as much as several meters.

A tsunami generally consists of a series of waves. When a tsunami approaches a shoreline, the wave begins to slow down an increase in height, depending on the topography of the seafloor (Figure 1.3). Often, the first signs of a tsunami are a receding sea water level caused by the trough of the wave. The receding sea level immediately before the tsunami approaches was also observed at the shoreline of Banda Aceh on 26 December 2004.

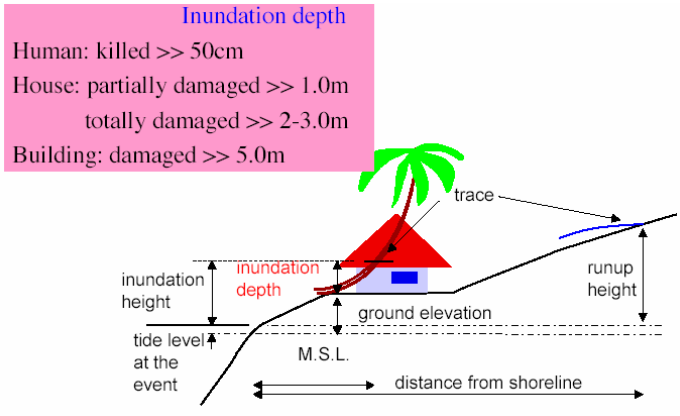


Source: Imamura, SOI Asia Special Seminar, 2005

Figure 1.3 Tsunami Generated by Earthquake

1.2.2 Tsunami Characteristics

The wave height of a tsunami can be highly variable in a local area depending on the underwater topography, orientation to the oncoming wave, the tidal level, and the magnitude of the tsunami. The most common method for determining tsunami wave height is by measuring the run-up[1], the highest vertical point reached by the wave (Figure 1.4). Run-up heights are measured by looking at the distance and extent of salt-killed vegetation, and the debris left once the wave has receded. This distance is referenced to a datum level, usually being the mean sea level.



Source: Imamura, SOI Asia Special Seminar, 2005

Figure 1.4 Characteristics of Tsunami

[1] In this report, the maximum vertical height to which the water is observed with reference to sea level is referred to as "**run-up**". The maximum horizontal distance that is reached by a tsunami is referred to as "**inundation**".

1.2.3 Magnitude of Tsunami

The earthquake was recorded as the third or fourth largest tsunami in the world (Table 1.2) and the strongest during the instrumented era in seismology i.e. 1966 to present.

Table 1.2 Historical Tsunami Magnitudes

Year	Epicenter	Tsunami Magnitude Mt
1837	Valdivia (Chile)	9.3
1841	Kamchatka	9.0
1868	Arica (Chile)	9.0
1877	Iquique (Chile)	9.0
1946	Aleutians	9.3
1952	Kamchatka	9.0
1957	Aleutians	9.0
1960	Chile	9.4
1964	Alaska	9.1
2004	Sumatra (Indonesia)	9.1

Source: Abe, Historical Tsunami in the world,

The tsunami scale at Sumatra in 2004 was the second or third largest scale of tsunami in 20th century. Historical tsunamis generated by the earthquake at a 1,000-km wide of the plate boundary between the Indian Plate and the Burmese Micro-Plate were summarized below (Table 1.3):

Table 1.3 Historical Tsunami at Southwest from Sumatra Island

Date	Latitude	longitude	Earthquake Scale (M)	Tsunami Scale (Mt)
1797/02/10	0°N	99°E	8	3
1833/11/24	2.5°N	100.5°E	8.25	2.5
1843/01/05	1.5°N	98°E	7.25	2
1861/02/16	1°N	97.5°E	8.5	3
1907/01/04	1.5°N	97°E	7.5	2

Source: Soloviev and Go, Tsunami Catalogue, 1975

In which, the scale of tsunami (Mt) was defined as follows (Table 1.4):

Table 1.4 Tsunami Scale

Tsunami Scale	Tsunami Wave Height	Extent of Damage
-1	Less than 0.5 m	No damage
0	About 1 m	Relatively small damage
1	More or less 2 m	Damage on shoreline/ship
2	4 to 6 m	Small at inland and casualties
3	10 to 20 m	Heavy damage along shoreline of more than 400 km
4	More than 30 m	Heavy damage along shoreline of more than 500 km

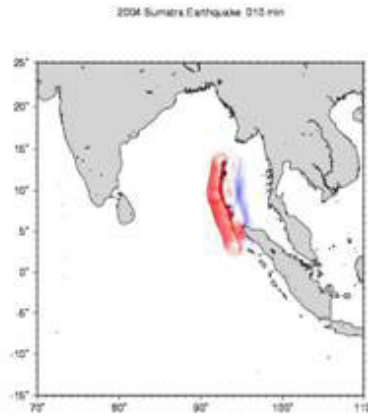
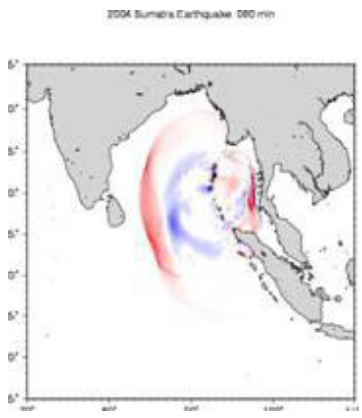
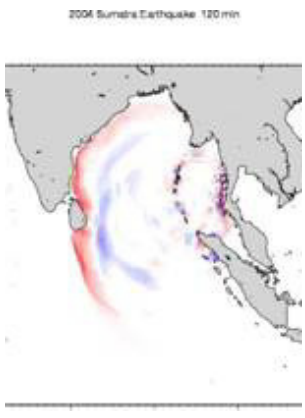
Source: based on Imamura-Iida scale

The large scale of tsunami (Mt=3) as same as that in 2004 was recorded in 1861; namely, 145 years ago, and the recent tsunami with medium-scale (Mt=2) was in 1907, 98 years ago. The magnitude of tsunami in 2004 is evaluated with a probability of once in 100 to 150 years.

1.2.4 Tsunami Propagation

Figure 1.5 shows a numerical model of the propagation of the Tsunami generated by the Earthquake. The red color means that the water surface is higher than normal, while the blue means lower. Because of the Fault geometry, the waves propagating to the East (towards Thailand and Myanmar)

begin with a receding wave, which explains why the sea started to retreat minutes before flooding the coast. On the opposite, to the West (towards India and Sri Lanka) a large wave suddenly hit the coast without warning. 10 hours later, the Tsunami reached the African coast.

		
Step1 : a tsunami is generated by the motion of the sea bottom. The waves propagate Eastward and Westward.	Step2 : 1 hour and 20 minutes later, the wave hits Phuket and the Indian ocean coast of Thailand and Myanmar.	Step3 : 2 hours later, the wave hits SriLanka and the East coast of India.

Source: Kenji Satake (National Institute of Advanced Industrial Sciences and Technology (AIST)

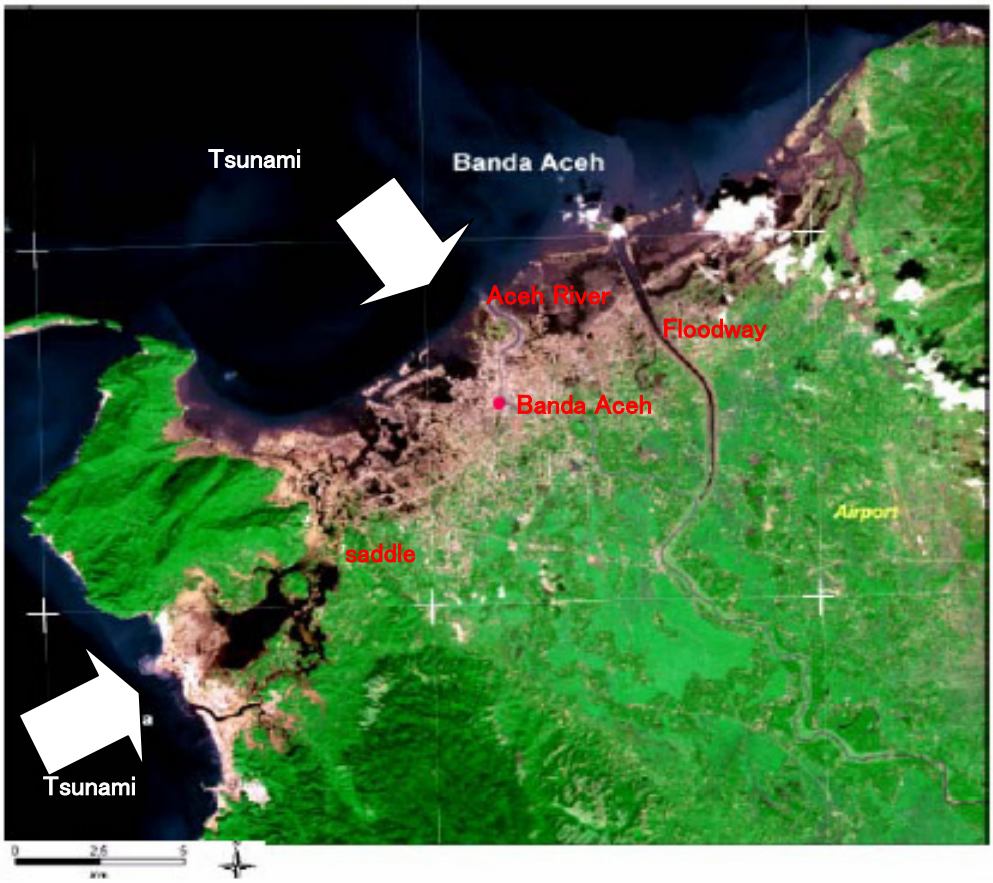
Figure 1.5 Numerical Simulation of Tsunami Propagation

1.2.5 Tsunami Inundation at Banda Aceh City

A major tsunami struck the coast of Aceh province shortly after the earthquake. Heavy damage and casualties are reported from Banda Aceh and other towns in the province of Aceh. Large sections of Banda Aceh were destroyed in the tsunami. Satellite photos show the true extent of the damage to the city, with large northern sections completely wiped out. The Indonesian army and police cordoned off these sections to survivors as they cleared away thousands of bodies.

Many fishing villages and towns such as Calang and Meulaboh, along the west coast of Aceh province were almost completely washed away. People are believed to have watched the water recede and ran to pick up fish left stranded on the seafloor while other rushed to take photographs. The waves that followed penetrated the coast to a great extent but in some places their force was arrested by high cliffs along the seashore.

A satellite photo around the city of Banda Aceh is shown in Figure 1.6. The area changed in color into charcoal indicated the area of tsunami inundation.



Source: BAPPENAS, Blueprint, 2005

Figure 1.6 Tsunami Inundation Area

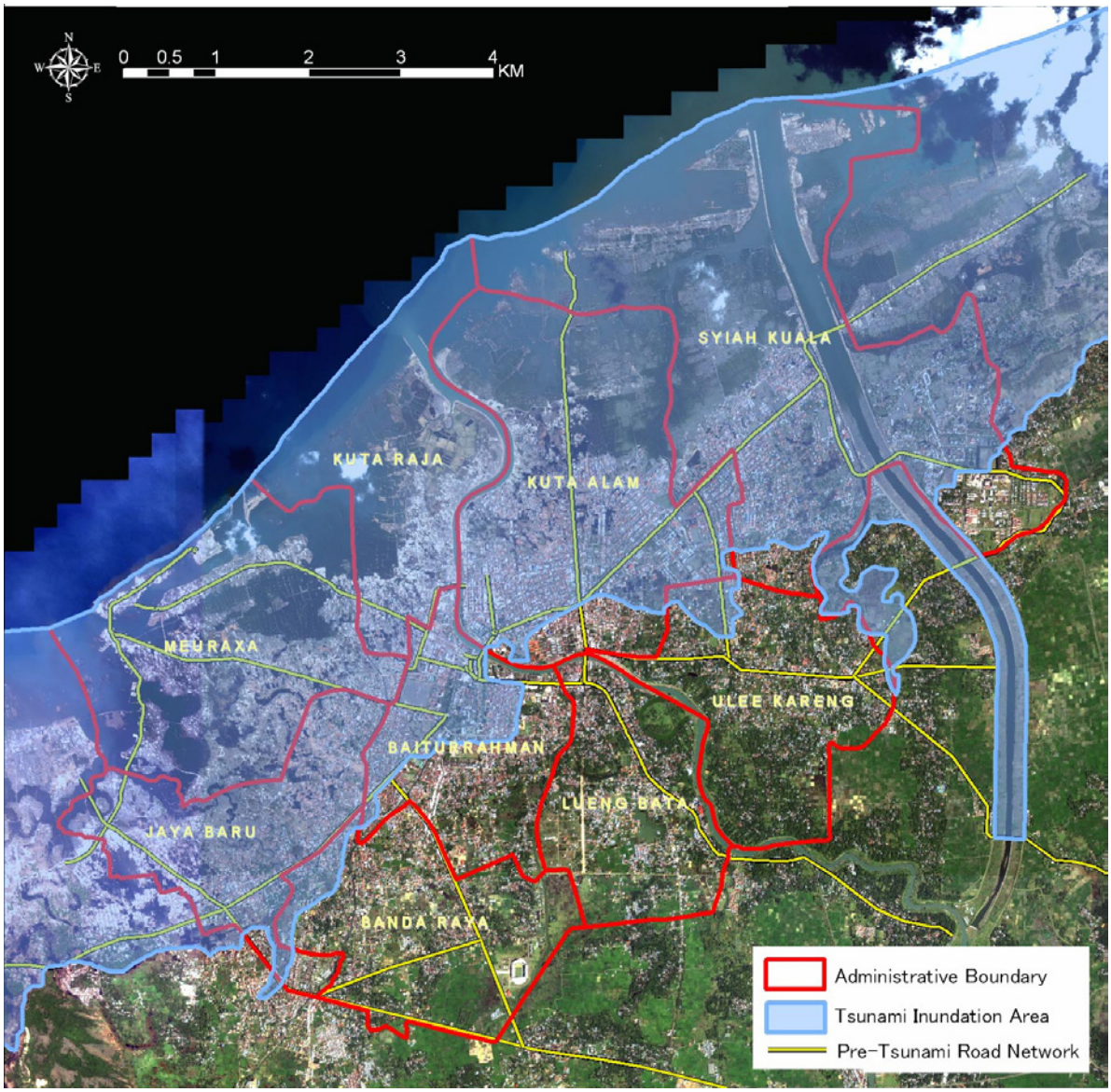
The tsunami wave height was estimated at about 10 m at northern coastline of Banda Aceh and about 20 m along western coastline at Indian Ocean. The tsunami from the western coastline overflowed a saddle of mountain ridge of EL.20m and rampaged into Banda Aceh City.

As shown in Figure 1.7 the wooden house was damaged by 1-m high tsunami and totally collapsed by 2-m high tsunami. The tsunami from the northern coastline destroyed whole wooden houses and reinforced-concreted building within a radius of 2 km and houses and building remained as a distance increased over 2 km from the coastline (Figure 1.8). The tsunami inundation extended to about 3.5 to 4.0 km radius from the coastline with the run-up height of El.3.8 m. The tsunami inundation and run-up height are illustrated schematically in Figure 1.9.

Houses/Building/Forest	Tsunami Wave Height (m)				
	1	2	4	8	16
1) Wooden House					
2) Stone House					
3) Reinforced Concrete House					
4) Coastal Forest					

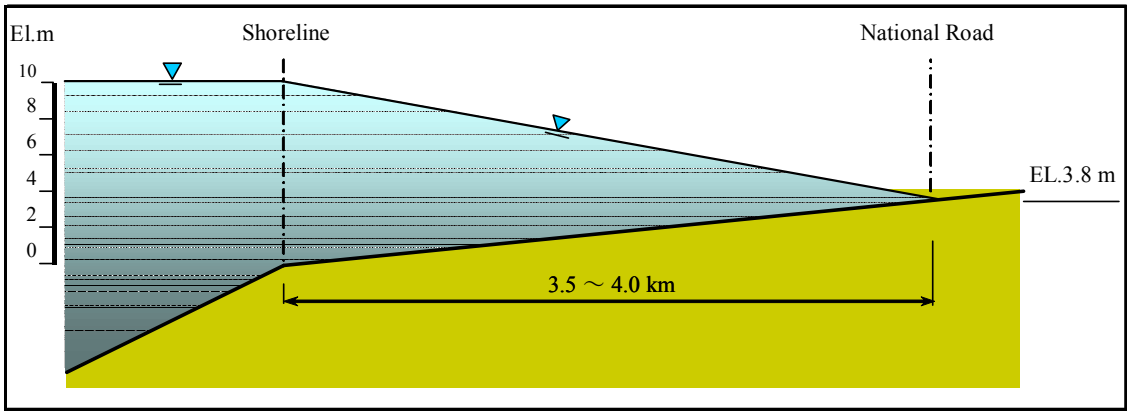
Note : Left side of bar chart shows the damage happens while the right side shows totally collapsed.
Source : N.Syuto, Tsunami Intensity and Damage, 1992

Figure 1.7 Tsunami Wave Height and Damage



Source: JICA Study Team

Figure 1.8 Tsunami Disaster Map at Banda Aceh City



Source: JICA Study Team

Figure 1.9 Schematic Diagram of Tsunami Inundation and Run-up