No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL CENTRE FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION (N-CERWASS)

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

(SUPPORTING)

MARCH 2009

TOKYO ENGINEERING CONSULTANTS CO., LTD.

IN ASSOCIATION WITH

OYO INTERNATIONAL CORPORATION

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JR
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Abbreviation and Acronyms

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
BHN	Basic Human Needs
CD	Capacity Development
CEMA	Committee for Ethnic Minorities
CPC	Communal People's Committee
CPRGS	Comprehensive Poverty Reduction and Growth Strategy
DANIDA	Danish International Development Assistance
DARD	Department of Agriculture and Rural Development (Provincial Level)
DOET	Department of Education and Training (Provincial Level)
DOH	Department of Health (Provincial Level)
DONRE	Department of Natural Resources and Environment (Provincial Level)
DPC	District People's Committee
DPI	Department of Planning and Investment (Provincial Level)
DVCL	Double Vault Composting Latrine
EIA	Environmental Impact Assessment
FS	Feasibility Study
GOV	Government of Vietnam
HEP	Horizontal Electrical Profiling
IEC	Information, Education and Communication
IEE	Initial Environmental Evaluation
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOET	Ministry of Education and Training
MOF	Ministry of Finance
MOH	Ministry of Health
MOLISA	Ministry of Labour, War Invalids and Social Affairs
MONRE	Ministry of Natural Resources and Environment
MP	Master Plan
N-CERWASS	National Centre for Rural Water Supply and Environmental Sanitation
NGO	Non Government Organization
NRWSSS	National Rural Water Supply and Sanitation Strategy

NTP	National Target Programme
ODA	Official Development Assistance
O&M	Operation and Maintenance
P-CERWASS	Provincial Center for Rural Water Supply and Sanitation
PMU	Project Management Unit
PPC	Provincial People's Committee
RWSS	Rural Water Supply and Sanitation
SRTM	Shuttle Radar Topography Mission
TPBS	Targeted Programme Budget Support
UNICEFF	United Nations Children's Fund
USD	US Dollar
VBSP	Vietnam Bank for Social Policy
VES	Vertical Electrical Sounding
VND	Vietnamese Dong (The Vietnamese currency unit)
WSS	Water Supply and Sanitation

CURRENCY EQUIVALENTS

(July 2008)

USD 1.00 = JPY 106.17

USD 1.00 = VND 16,852

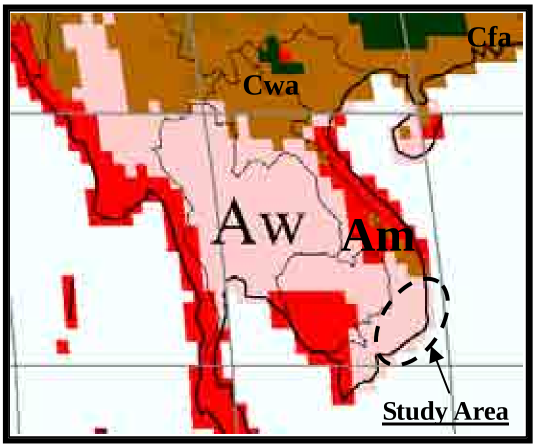
CHAPTER 1

METEOROLOGY AND HYDROLOGY

CHAPTER 1 METEOROLOGY AND HYDROLOGY

1.1 Climate type of the Study Area

Climate type of Vietnam is mainly classified into humid subtropical (Cwa), tropical monsoonal climate (Am) and tropical savannah climate (Aw)" based on Koppen Climate Classification as shown in Figure 1.1.1. According to the climate classification, the study area in this study belongs to tropical savanna climate entirely. Meteorological and hydrological data such as temperature, precipitation, sunshine hours, potential evaporation, and river discharge have been collected and analyzed. The locations of their stations are shown in Figure 1.1.2. The period and items of data acquisition are shown in Table 1.1.1. These data are used for a water balance analyses in the study area.



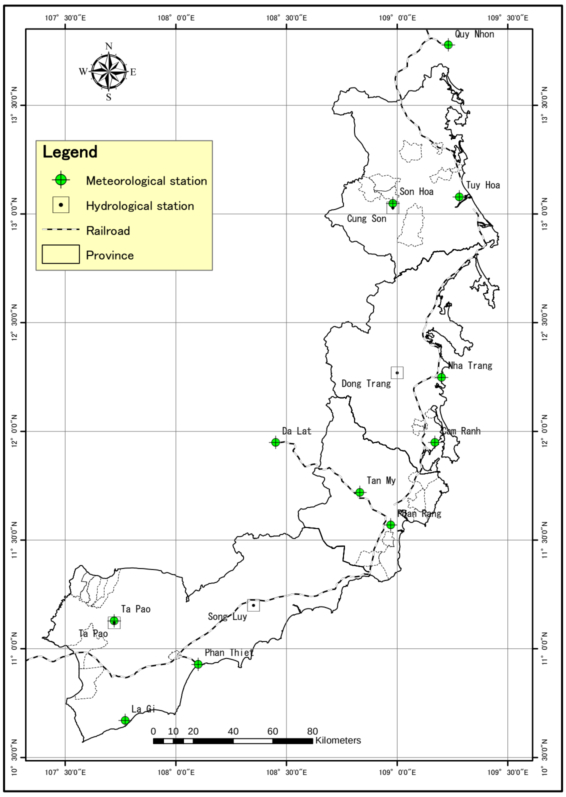
Aw: Tropical Savanna Climate, **Am**: Tropical Monsoonal Climate, **Cwa/Cwb**: Humid Subtropical Climate, **Cfa**: Humid Subtropical (No dry season) (Source: World Map of Koppen-Geiger Climate Classification Updated, Univ. of Vienna (April 2006))

Figure 1.1.1 Climate Types of Vietnam and the Study Area

Table 1.1.1 Period and Items of Meteorological Data Acquisition

Station				Meteorology				Hydrology
Name	Province	Period	*Source	M. Precipitation	M. Ave. Temp.	M. Total Sunshine Duration	M. Evaporation	M. Ave. Water Flow
Tuy Hoa	Phu Yen	1996 - 2005	HGSC	○	○	○	○	
Son Hoa	Phu Yen	1996 - 2005	HGSC	○	○		○	
Nha Trang	Khanh Hoa	1996 - 2005	HGSC	○	○	○	○	
Cam Rang	Khanh Hoa	1996 - 2005	HGSC	○	○		○	
Tan My	Ninh Thuan	1996 - 2005	HGSC	○				
Phan Rang	Ninh Thuan	1996 - 2005	HGSC	○	○	○	○	
Phan Thiet	Binh Thuan	1996 - 2005	HGSC	○	○	○	○	
Ta Pao	Binh Thuan	1996 - 2005	HGSC	○				
La Gi	Binh Thuan	1996 - 2005	HGSC	○	○		○	
Da Nang	Da Nang	2002 - 2005	GSO	○	○	○		
Playku	Gia Lai	2002 - 2005	GSO	○	○	○		
Quy Nhon	Binh Dinh	2002 - 2005	GSO	○	○	○		
Da Lat	Lam Dong	2002 - 2005	GSO	○	○	○		
Vung Tau	Ba Ria	2002 - 2005	GSO	○	○	○		
Cung Son	Phu Yen	1996 - 2005	HGSC					○
Dong Trang	Khanh Hoa	1996 - 2005	HGSC					○
Song Luy	Binh Thuan	1996 - 2005	HGSC					○
Ta Pao	Binh Thuan	1996 - 2005	HGSC					○

*HGSC: Hydrology and Geology Station Center, GSO: General Statistics Office



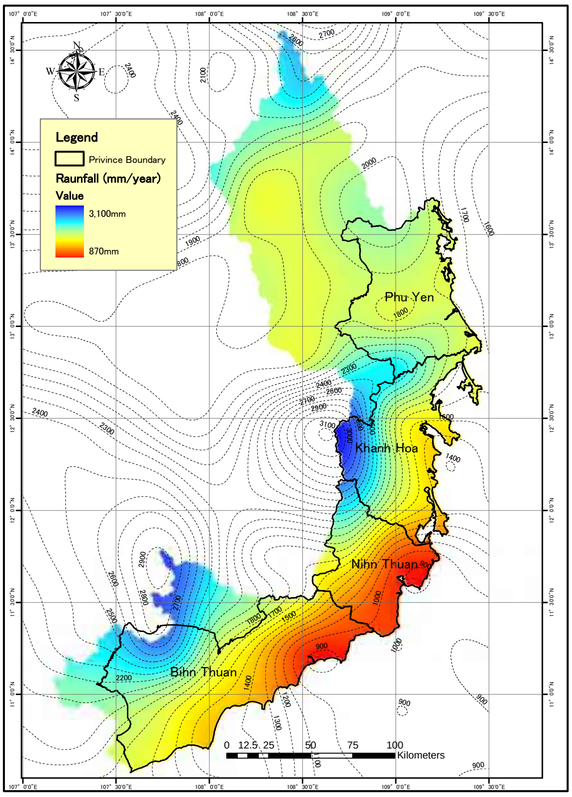


Figure 1.1.2 Locations of Observation Stations (left)

Figure 1.1.3 Annual Precipitation in Study Area (right)

(1) Precipitation

1) Annual precipitation

The annual and monthly precipitation map of the study area was created from the precipitation data of the published atlas and meteorological stations above mentioned. Figure 2.1.2 shows the annual precipitation map of the study area.

The annual precipitation varies from 780 to 3,100 mm. The annual precipitation in most of the study area is greater than 1,500 mm. Especially the mountainous area in Khanh Hoa and Binh Thuan province reaches to grater than 2,500 mm. On the other hand, the annual precipitation of coastal lowland areas in Ninh Thuan province and the northern part of Binh Thuan province is less than 1,000 mm and the precipitation in dry season is significantly low. Period of collected data of the nine meteorological stations is from 1995 to 2005.

Annual precipitation gradually decreases from northern part to southern part in the three northern provinces, and shows significantly small in Phan Rang. On the other hand, in Binh Thuan province, annual precipitation in inland area has 150 to 180 percent greater than that of coastal area. The cause may be due to direction of seasonal wind and distribution of mountains in the area.

2) Monthly Precipitation

Seasonal change of monthly precipitation of the nine meteorological stations in the study area was analyzed as Figure 1.1.4 and Figure 1.1.5. This figure presents average monthly precipitations at each meteorological station. Monthly variation patterns of precipitation among the stations are divided into two groups, which are Phu Yen, Khanh Hoa and Ninh Thuan group and Binh Thuan group. The stations of former group show that the rainy season begins in September and finishes in December, and dry season begins from January to August. (This tendency is not clear at Tan My.) Annual precipitation of the group varies from 700 mm to 2,400 mm. This value is large, but the precipitation pattern of each rainfall event is similar to storm-water so that its contribution to groundwater recharge is not so much expected.

On the other hand, the stations of the latter group show that the rainy season begins in May and finish in October.

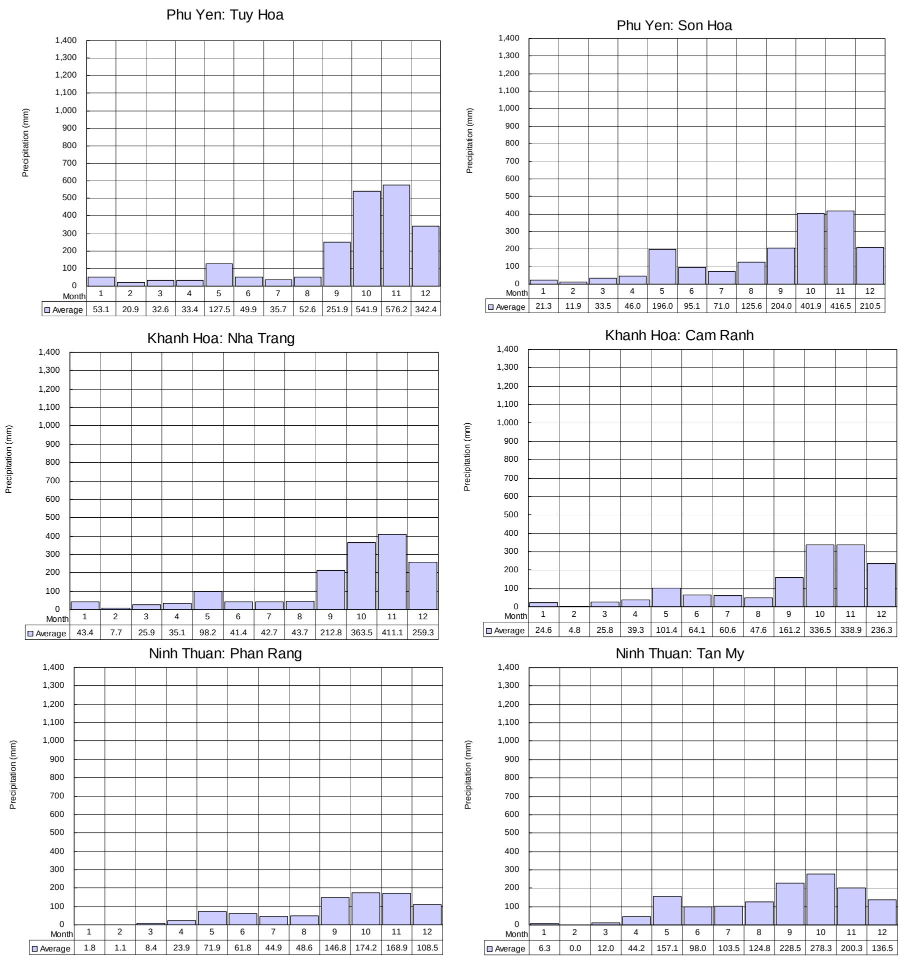


Figure 1.1.4 Monthly Precipitation Change of Stations in Group One

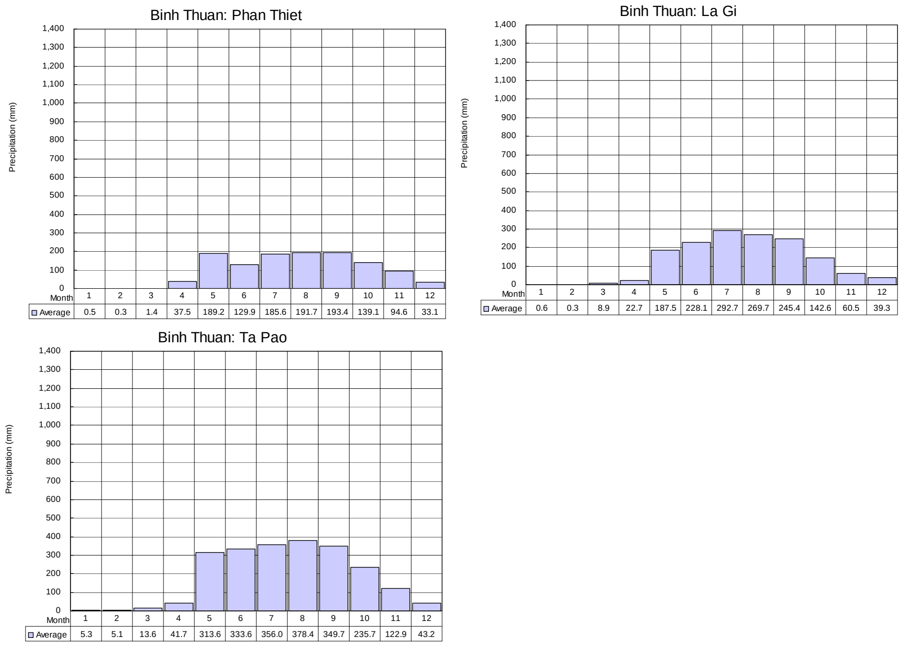


Figure 1.1.5 Monthly Precipitation Change of Stations in Group One

(2) Air temperature

1) Monthly average of air temperature

Monthly air temperature of the seven stations in the study area was analyzed as Figure 1.1.6. (The stations are located at coastal areas except one (Son Hoa station at mountainous area.)

Monthly average air temperature changes from about 25 to 30 degrees and the variation among the stations has almost the same tendency except Phan Thiet and La Gi stations in Binh Thuan province. Maximum temperature is about 30 degrees on June and July. Two stations at Binh Thuan Province (Phan Thiet and La Gi) have a little lower temperature from June to August. This may be due to the rainy season in Binh Thuan province.

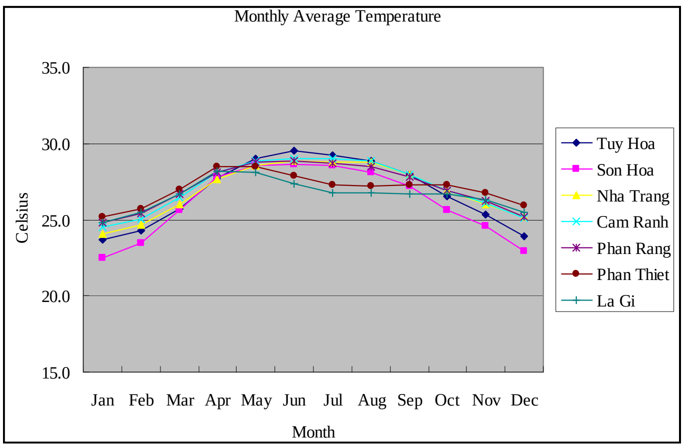


Figure 1.1.6 Monthly Average of Air Temperature

Minimum temperature is less than 25 degrees on January. Son Hoa and Tuy Hoa stations have lower temperature less than 25 degrees from December to February. This may be caused by those locations, which are relatively at north part of the study area, and by high elevation of Son Hoa station in mountainous area.

(3) Sunshine Duration

Sunshine duration of the four stations in the study area was analyzed as Figure 1.1.7. Annual variation patterns of sunshine duration among the stations are divided into two groups, which are Tuy Hoa and Nha Trang group, and Phan Rang and Phan Thiet group. The distributions of former group show sharper change pattern than that of latter group.

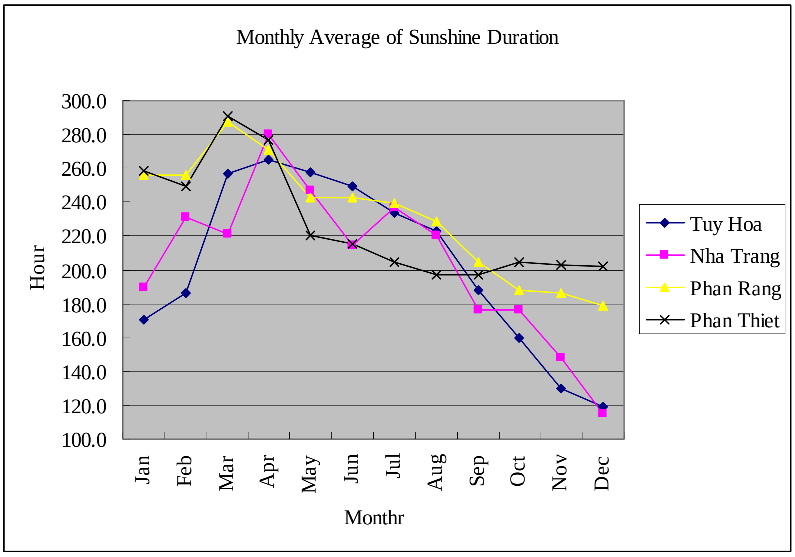


Figure 1.1.7 Monthly Average of Sunshine Duration

(4) Pan Evaporation

Pan evaporation of the seven stations in the study area was analyzed as Figure 1.1.8. Average pan evaporation of each station follows monthly average temperature and period of those rainy seasons. It shows the highest value of 190 mm in September and the lowest value of 50 to 80 mm in November and December at Phu Yen Province (Tuy Hoa, Son Hoa stations).

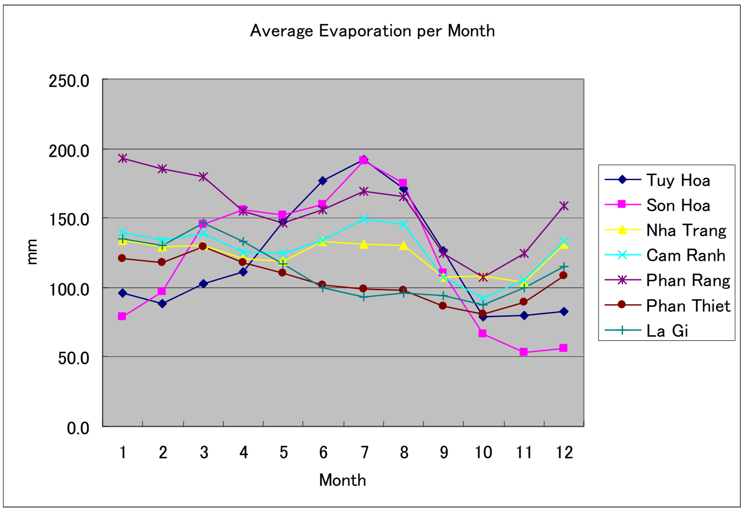


Figure 1.1.8 Pan Evaporation of Seven Stations

In Khanh Hoa Province, Nha Trang and Cam Ranh stations have the highest value of 130 to 150 mm in July and August, and the lowest value of 90 to 110 mm from September to November. However the differences among the monthly pan evaporations are relatively small throughout years.

In Ninh Thuan Province, Phan Rang station has the highest value of 190 mm in July, and the lowest value of 110 to 130 mm in rainy season from September to November.

In Binh Thuan Province, Phan Thiet and La Gi stations have the highest value of 130 to 140 mm from July to March, and the lowest value of 90 to 100 mm in rainy season from June to October.

1.1.1 Hydrology (river discharges)

Monthly discharges of main four rivers in the study area are collected. The period of the data acquisitioned is from 1995 to 2006. The outline of each hydrological station is shown in Table 1.1.2.

Table 1.1.2 Outline of each River Gauging Station

River	Hydrological Station	Province	Notes
Ba	Cung Son	Phu Yen	Ba river is a main tributary of Da Rang river. The station stands near P-7 (Suoi Bac) about 40 km far from the river mouth. The catchment area is very large among the four rivers.
Cai	Dong Trang	Khanh Hoa	Cai river flows through Nha Trang city. The station is about 20 km far from the river mouth. The catchment area is medium among the four rivers.
Luy	Song Luy	Binh Thuan	The station is about 40 km far from Phan Thiet toward north and about 25 km far from the river mouth. The catchment area is small among the four rivers.
La Nga	Ta Pao	Binh Thuan	The station is about 50 km far from Phan Thiet toward north-west. The catchment area is largel among the four rivers.

The result is summarized in Figure 1.1.9.

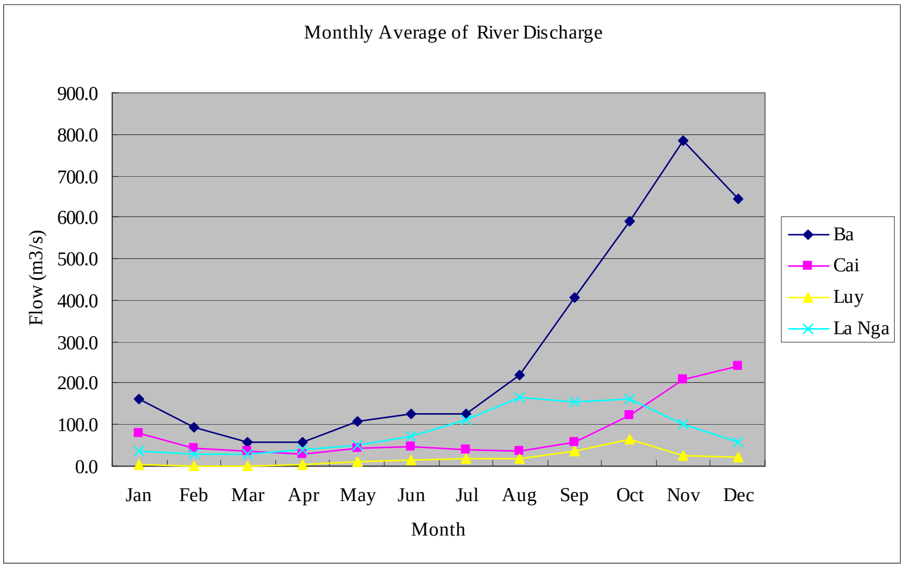


Figure 1.1.9 Monthly Average of River Discharges of Four Stations

The characteristics of each river discharges are as follows.

(1) Ba river

The tendency of monthly river discharge change is well corresponding to monthly precipitation change of Son Hoa meteorological station. The river discharge significantly increases during rainy season. The monthly discharge shows the highest value of 784 m^3/sec in November and the lowest value of 57 to 59 m^3/sec from March to April.

(2) Cai river

The tendency of monthly river discharge change is corresponding to monthly precipitation change of a meteorological station in Nha Trang. The river discharge increases during rainy season. The monthly discharge shows the highest value of 241 m^3/sec in December and the lowest value of 30 to 36 m^3/sec from March to April.

(3) Luy river

The river discharge increases during rainy season. The monthly discharge shows the highest value of 65 m^3/sec in October, and the lowest value of one to four m^3/sec from January to April. It gradually increases from May toward October. There is no meteorological data obtained at surrounding area.

(4) La Nga river

The tendency of monthly river discharge change is well corresponding to monthly precipitation change of Ta Pao meteorological station. The river discharge increases during rainy season. The monthly discharge shows the highest value of 154 to 167 m^3/sec during August to October, and the lowest value of 27 m^3/sec during February to March.

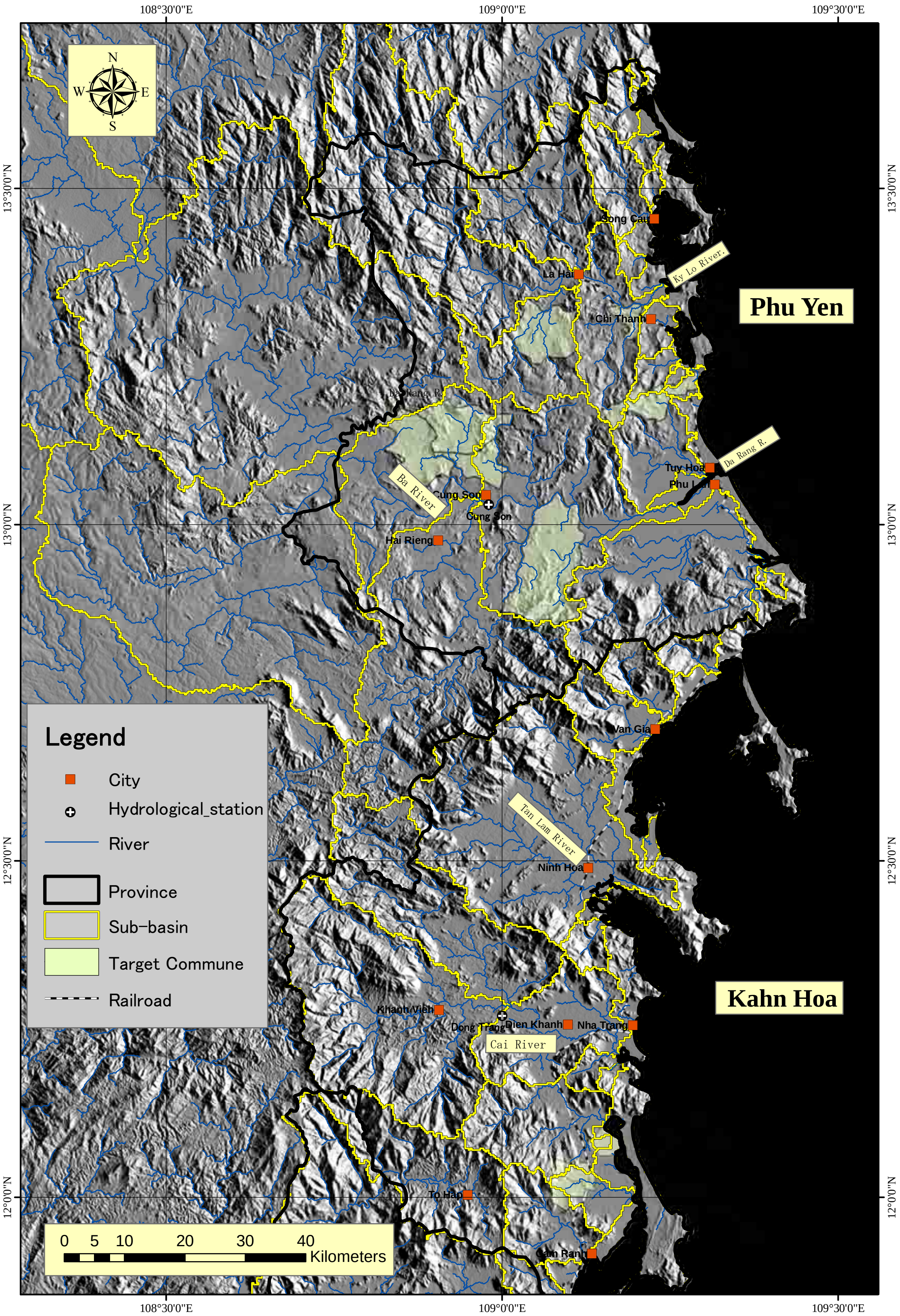


Figure 1.1.10 Location Map of Hydrological Stations (1)

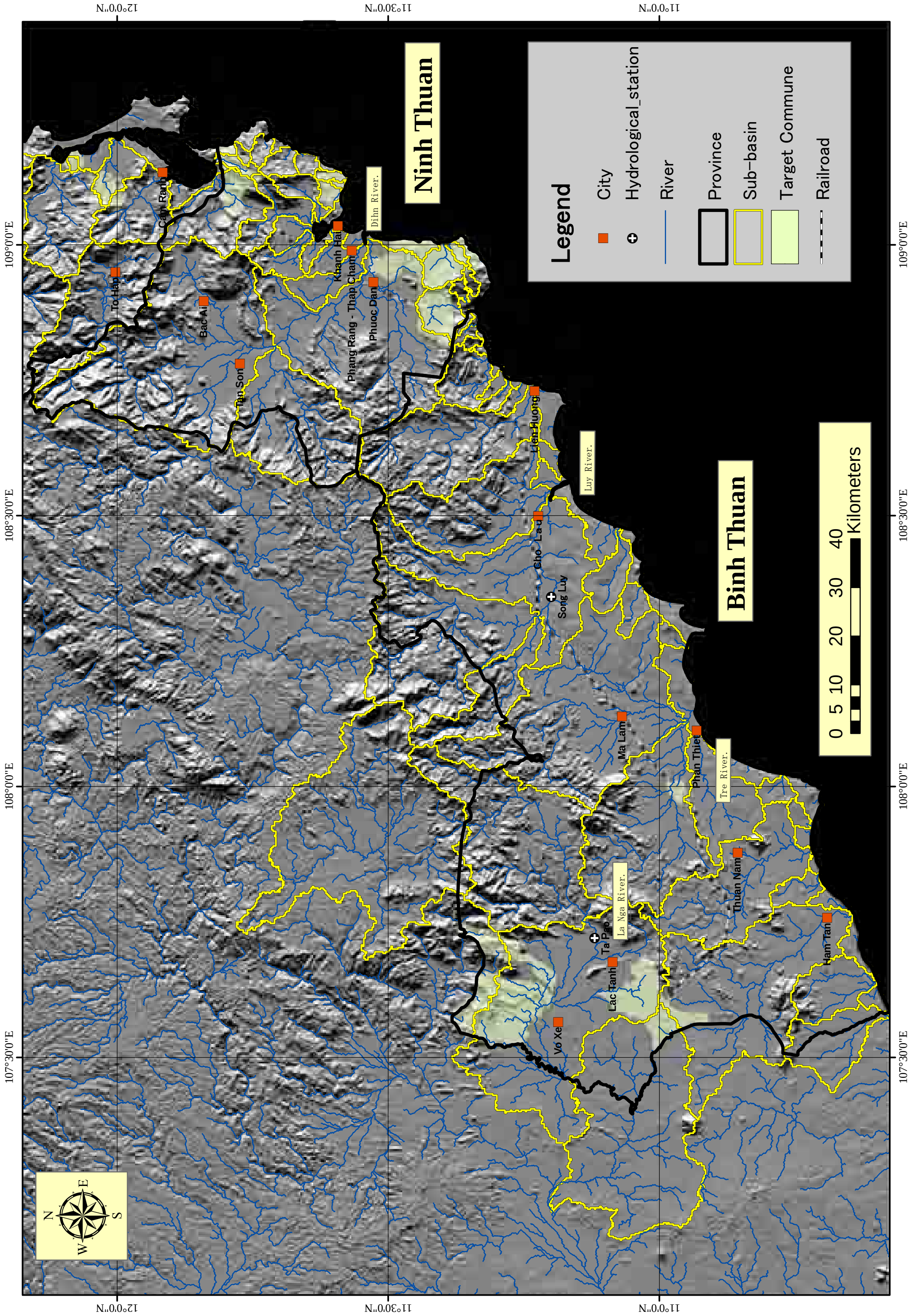


Figure 1.1.11 Location Map of Hydrological Stations (2)

CHAPTER 2

GEOMORPHOLOGY AND GEOLOGY

CHAPTER 2 GEOMORPHOLOGY AND GEOLOGY

2.1 Geomorphologic and Geologic Analyses by Remote Sensing Data

The geomorphologic and geologic analyses were conducted to understand the features of geomorphology, geology and land use by the remote sensing data obtained by the Earth Observation Satellite (EOS).

The remote sensing data used in the study are LANDSAT/ETM+, TERRA/ASTER and Space Shuttle/SRTM-3 data. The specifications, used data and methods of data processing of each remote sensing data are described bellow:

2.1.1 LANDSAT/ETM+

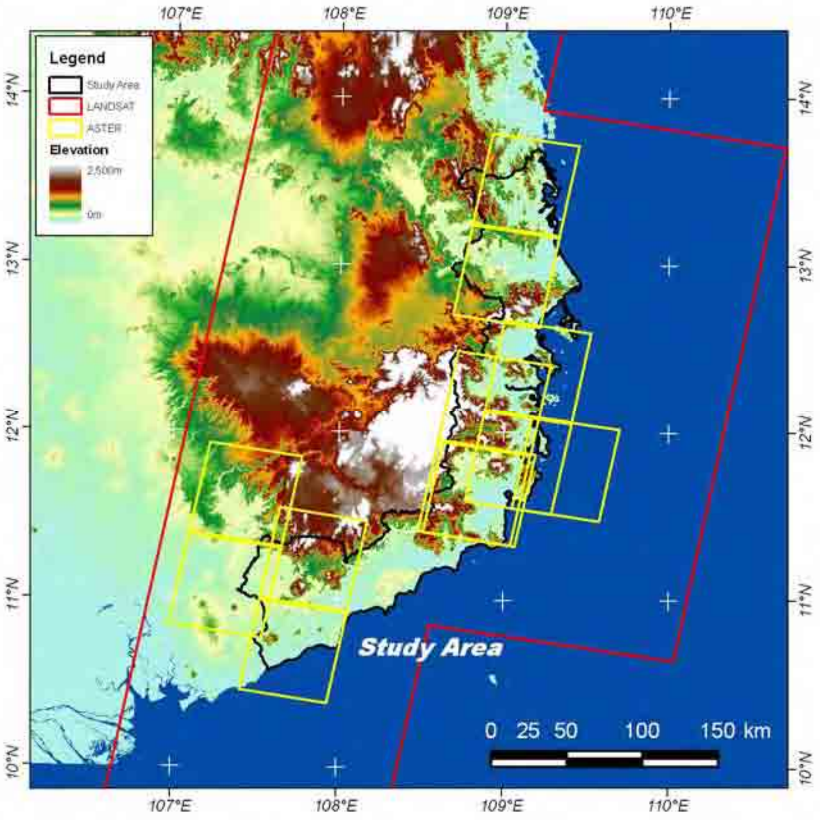
ETM+ (Enhanced Thematic Mapper Plus) is the sensor for observation programs in lands of the Earth, and was developed by the National Aeronautics and Space Administration (NASA) of the United States and mounted on the earth observation satellite LANDSAT of NASA. The ETM+ has 7 observation wavebands in the spectral region from visible ray, short wave infrared ray to thermal infrared ray and can acquire information about various phenomena on the Earth's surface (ex. Lithology, vegetation, soil, water, land cover, land use, atmosphere, volcano, etc.) on a local or a regional scale.

Six scenes of the ETM+ data, covering the whole study area, were purchased and utilized in the study. The list of the used ETM+ data is shown in Table 2.1.1 and the index map of these data is shown in Figure 2.1.1.

Table 2.1.1 List of used ETM+ Data

	Granule ID	Date	Level
1	7123051000309750	2003/04/07	Level 1G
2	7123052000309750	2003/04/07	Level 1G
3	7124050000006450	2000/03/04/	Level 1G
4	7124051000006450	2000/03/04/	Level 1G
5	7124052000308850	2003/03/29	Level 1G
6	7124053000308850	2003/03/29	Level 1G

Source: JICA Study Team



Source: JICA Study Team

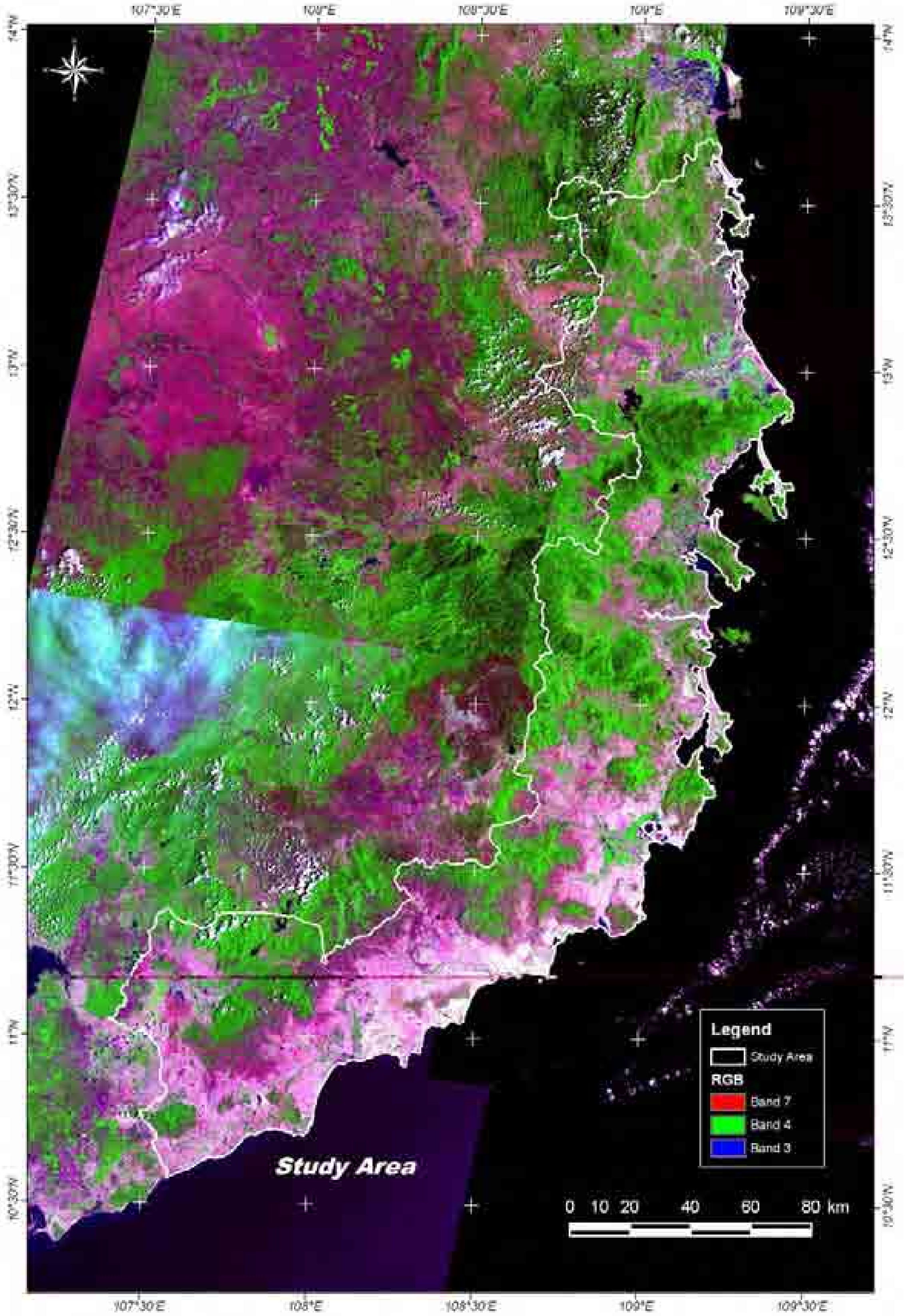
Figure 2.1.1 Index Map of Used Remote Sensing Data

Data processing of the ETM+ data were performed to extract information regarding geology and land use. The methods of data processing applied in the study are as follows:

- Color composite image
- Normalized difference vegetation index
- Vegetation – soil – water index

(1) Color Composite Image

Color composite image is a pseudo color image created by assigning primary colors (Blue, Green and Red: RGB) to radiance histograms of three optional wavebands. In the study, the color composite image was created by assigning blue to band 3 of the ETM+ data, green to band 4, and red to band 7. In the color composite image, the pixels that correspond to vegetation show greenish color. Similarly, rock is a reddish – pinkish color; water is a blackish – bluish color; soil is a pinkish – bright color; and man-made structures are a bluish color. The color composite image of the study area is shown in Figure 2.1.2.

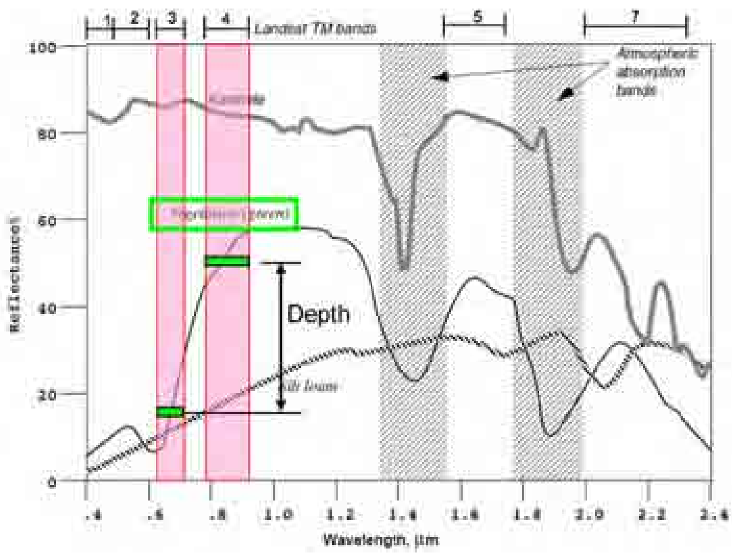


Source: JICA Study Team

Figure 2.1.2 False Color Image of the Study Area

(2) Normalized difference vegetation index

Vegetation displays a characteristic spectral signature; absorption in band 3 of the ETM+ and strong reflection in band 4 (Figure 2.1.3). As shown in Figure 3, the depth is difference of reflectance between band 3 and band 4. It is well known that the bigger the depth of absorption in band 3, the more abundant and the higher activity of vegetation. Vegetation index (VI) is used to determine a variation of abundant and an activity of vegetation by calculating the ratio of band 3 and 4 for obtaining the depth.



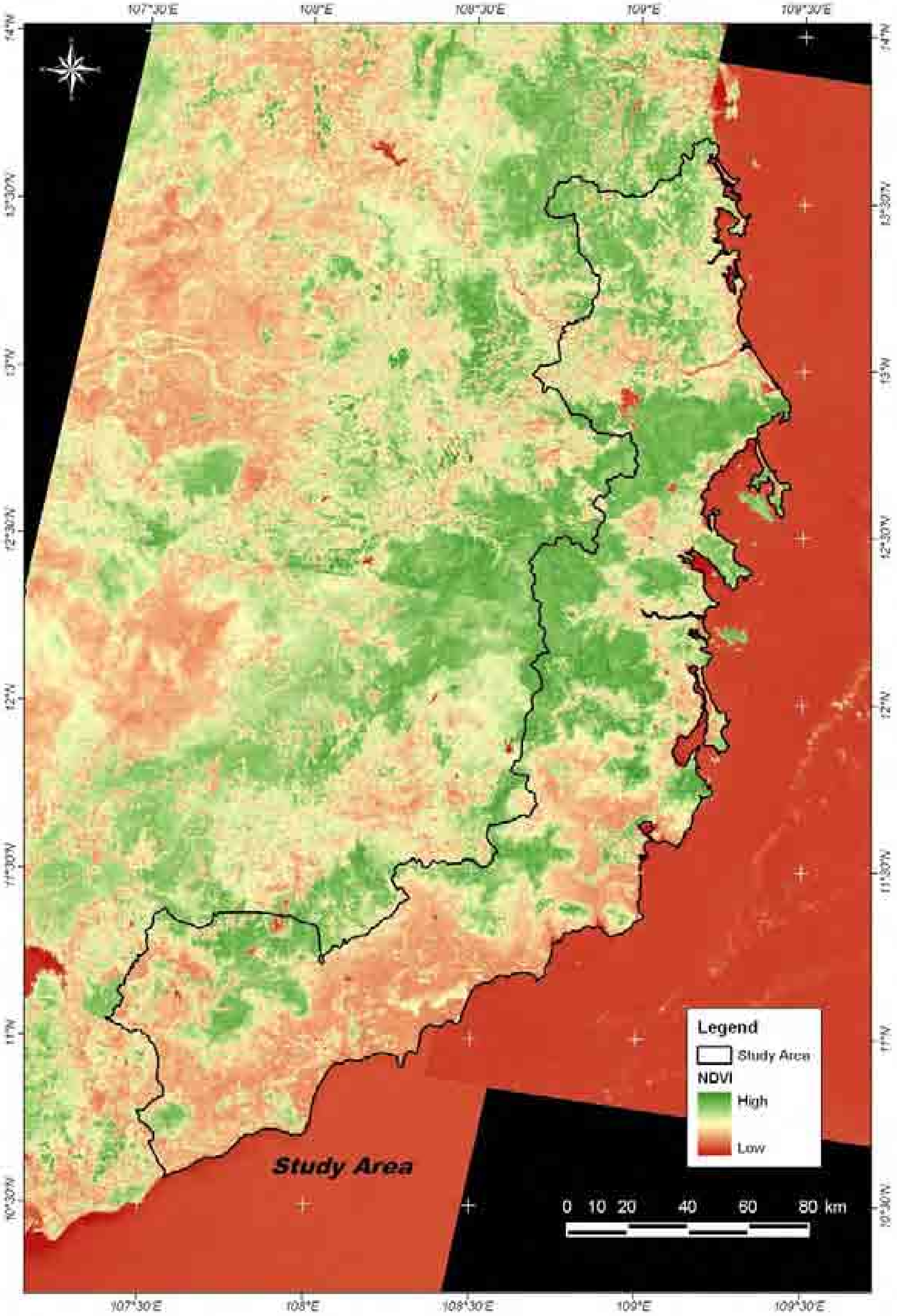
Source: ERDAS IMAGINE Field Guide (modified)

Figure 2.1.3 Principle of Vegetation Index

Normalized difference vegetation index (NDVI) is the most popular VI. NDVI is calculated by the following formula.

$$NDVI = \frac{R_{band4} - R_{band3}}{R_{band4} + R_{band3}}$$

Where, R_{band4} for radiance value of band 4; and R_{band3} for radiance value of band 3. The NDVI image of the study area is shown in Figure 2.1.4 with color-coding. The pixels of dense or high activity of vegetation are shown in green and the pixels of sparse or low activity in yellow to brown.



Source: JICA Study Team

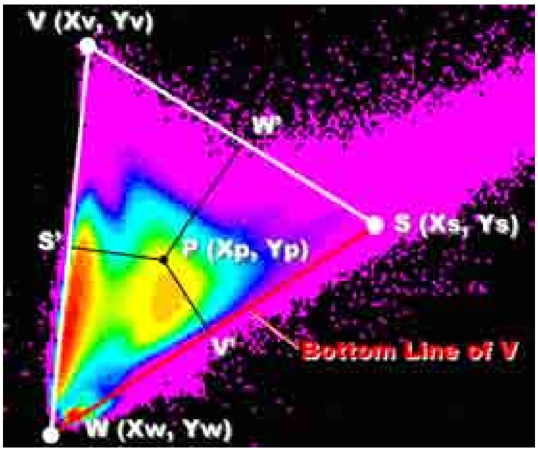
Figure 2.1.4 NDVI Image of the Study Area

(3) Vegetation – soil – water index

Vegetation – soil – water index (VSW index) is an advanced technique to calculate the ratio between vegetation, soil, and water at a particular pixel by using radiance values of band 3 and 4 of the ETM+ data.

Generally, a pixel of satellite image data consists of elements reflecting such as vegetation, soil, rock, moisture, water, man-made structure, and so on, because the ground resolution of satellite data is generally 15m to 30m (30m in the spectral regions of visible ray and short wave infrared ray of the ETM+ data). Such a feature of including various heterogeneous elements in a single pixel, is called a "mixel" (mixed pixel), and each element composing a mixel is called an "end member". The VSW index is obtained by calculation of the ratio of three end members; vegetation, soil, and water. Such a technique is generally called "unmixing".

When plotting radiance values of band 3 and 4 to a scatter diagram, the most radiance values are distributed over the area in a shape of triangle (left side image of Figure 2.1.5). The apexes of this triangle represent pixels of each end member; vegetation, soil, and water. In other words, the end members are pixels each of which consists of only vegetation (or soil, or water) and most pixels, distributed inside of the triangle, correspond to mixels. Therefore, the ratio of three end members of certain pixel (P in Figure 2.1.5) can be calculated by determining the ratio of distance between particular pixel and each end member (PV', PS', and PW' in Figure 2.1.5).



Bottom Line of Vegetation (S-W): ax + by + c = 0
a: $y_s - y_w$ b: $x_w - x_s$ c: $y_s * (x_s - x_w) + x_s * (y_w - y_s)$

Bottom Line of Soil (V-W): ax + by + c = 0
a: $y_v - y_w$ b: $x_w - x_v$ c: $y_v * (x_v - x_w) + x_v * (y_w - y_v)$

Bottom Line of Water (V-S): ax + by + c = 0
a: $y_v - y_s$ b: $x_s - x_v$ c: $y_v * (x_v - x_s) + x_v * (y_s - y_v)$

Distance between P (x_p, y_p) and Bottom Line of X

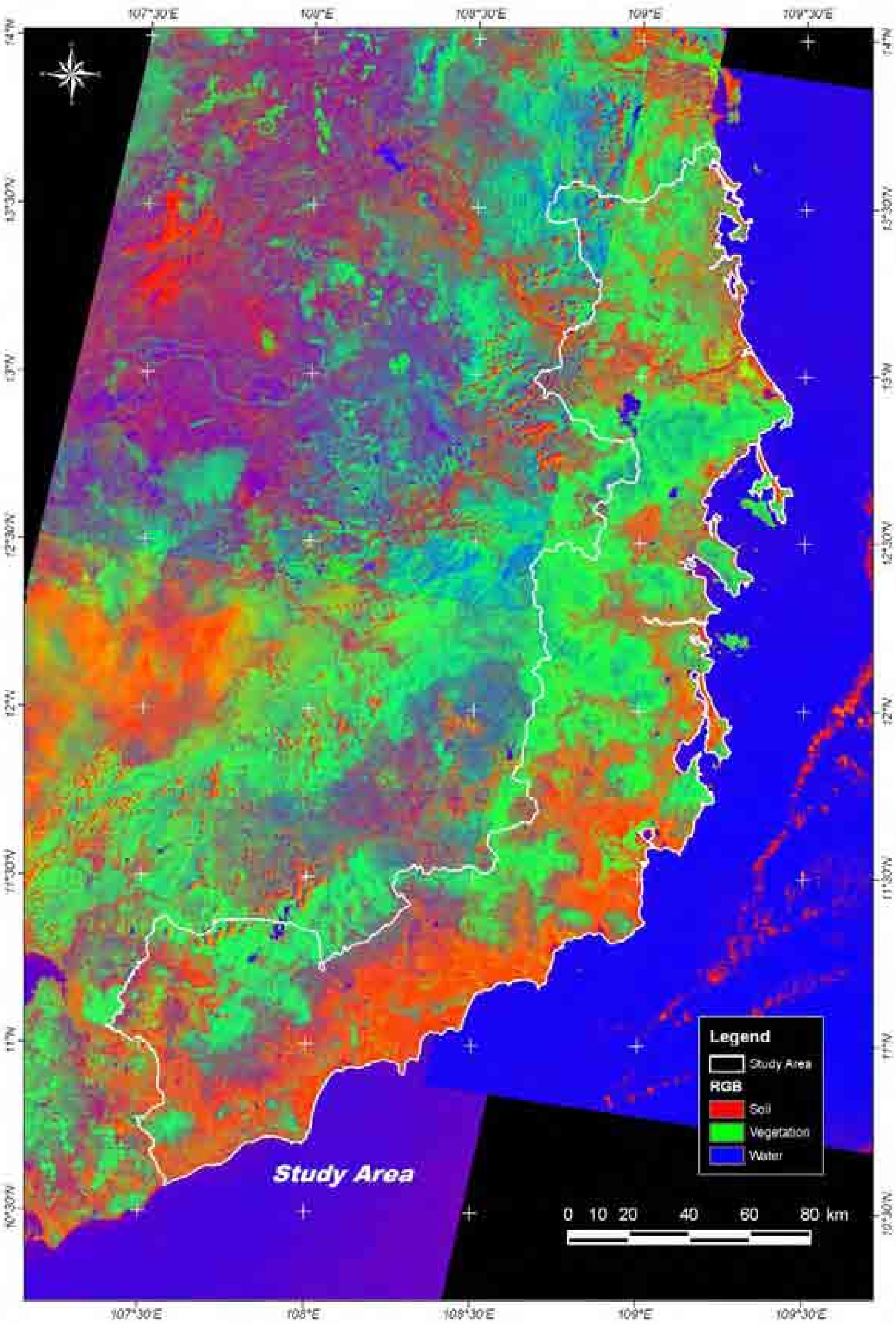
$$= PX' = sqrt [(a * x_p + b * y_p + c)^2 / (a + b)^2]$$

VSW Index of P (x_p, y_p)
Band 1: PW' / (PV' + PS' + PW') * 100
Band 2: PV' / (PV' + PS' + PW') * 100
Band 3: PS' / (PV' + PS' + PW') * 100
(Band 1 + Band 2 + Band 3 = 100%)

Source: JICA Study Team

Figure 2.1.5 Principle of VSW Index

The VSW index image, calculated from ETM+ data of the study area, is shown in Figure 2.1.6 with color-coding. The pixels of pure vegetation are shown in green, pure dried soil in red, pure water in blue.



Source: JICA Study Team

Figure 2.1.6 VSW Index Image of the Study Area

2.1.2 TERRA/ASTER

ASTER (Advanced Spaceborne Thermal Emission and Reflectance Radiometer) is the high-performance optical sensor developed by the Ministry of Economy, Trade and Industry of Japan (METI), and is mounted on the earth observation satellite TERRA of NASA. The ASTER has 14 observation wavebands in the spectral region from visible ray, short wave infrared ray to thermal infrared ray, especially there are 6 wavebands in the spectral region of short wave infrared ray (2 wavebands in ETM+) and 5 wavebands in the thermal wave infrared ray (1 waveband in ETM+).

Twelve scenes of the ASTER data, covering the target communes, were purchased and utilized in the study. The list of used ASTER data is shown in Table 2.1.2 and the index map of these data is shown in Figure 2.1.1.

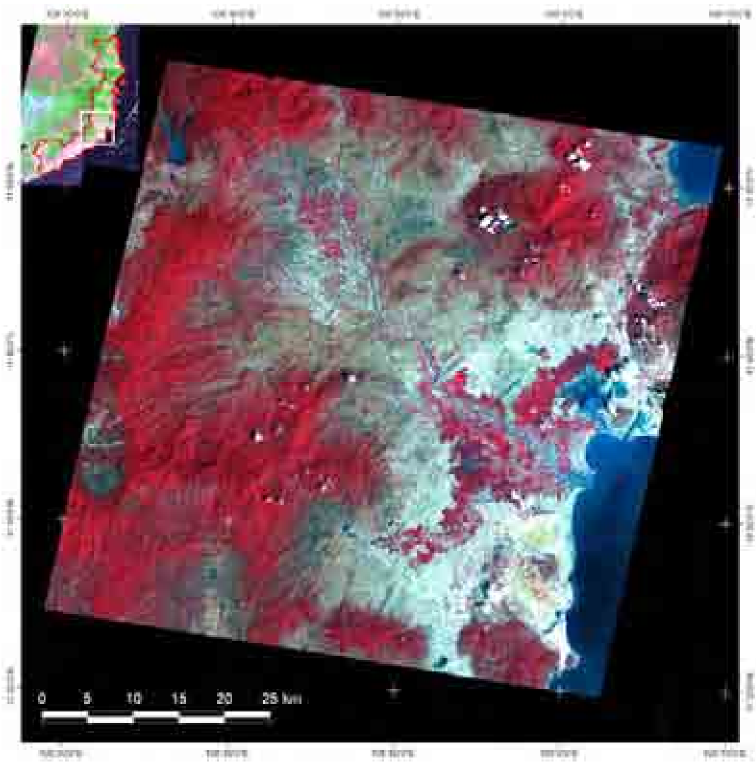
Table 2.1.2 List of used ASTER Data

	Granule ID	Date	Level
1	ASTL1A 0208100320110209180115	2002/08/10	Level 1B
2	ASTL1A 0208100320200209180116	2002/08/10	Level 1B
3	ASTL1A 0301080325570303170079	2003/01/08	Level 1B
4	ASTL1A 0301080326050303170080	2003/01/08	Level 1B
5	ASTL1A 0301240326070302100165	2003/01/24	Level 1B
6	ASTL1A 0304070319060306065718	2003/04/07	Level 1B
7	ASTL1A 0304070319150306065719	2003/04/07	Level 1B
8	ASTL1A 0402210319300403100192	2004/02/21	Level 1B
9	ASTL1A 0402280325280403170468	2004/02/28	Level 1B
10	ASTL1A 0402280325370403170469	2004/02/28	Level 1B
11	ASTL1A 0404070331000404200793	2004/04/07	Level 1B
12	ASTL1A 0404070331090404200794	2004/04/07	Level 1B

Source: JICA Study Team

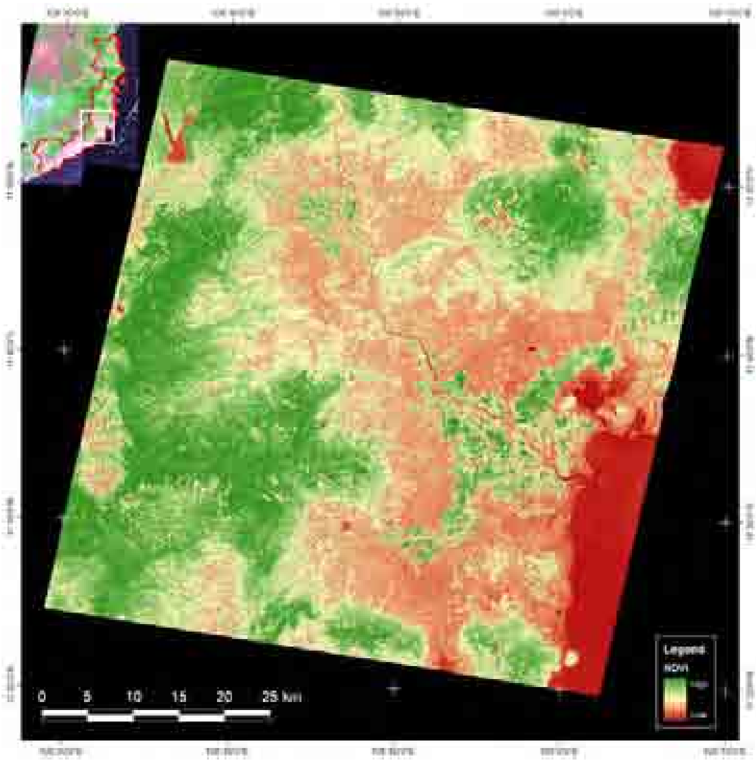
Data processing of the ASTER data was performed to extract detail information regarding geology. The methods of data processing applied for the ASTER in the study are the same as ETM+ data, color composite image, NDVI and VSW index. The example images of these methods are shown in Figure 2.1.7 to Figure 2.1.9.

Color composite images were created by assigning blue to band 1, green to band 2, and red to band 3 of ASTER data. In a color composite image, the pixels corresponding to vegetation are show in reddish color, and similarly, rock in bluish color; water in blackish to bluish color; soil in brownish to bright color; and man-made structures in light bluish to white color.



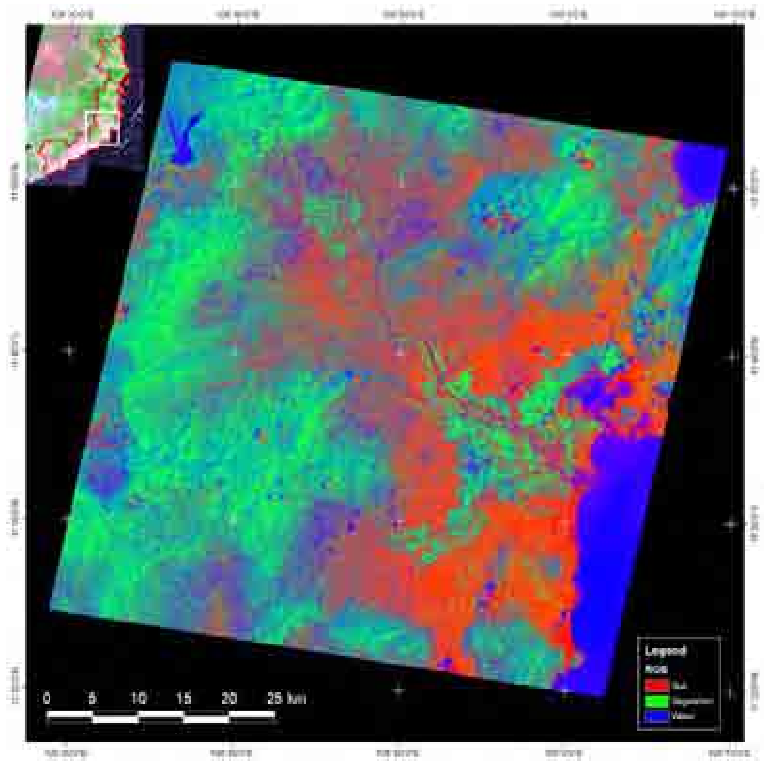
Source: JICA Study Team

Figure 2.1.7 Color composite image of ASTER Data



Source: JICA Study Team

Figure 2.1.8 NDVI Image of ASTER Data



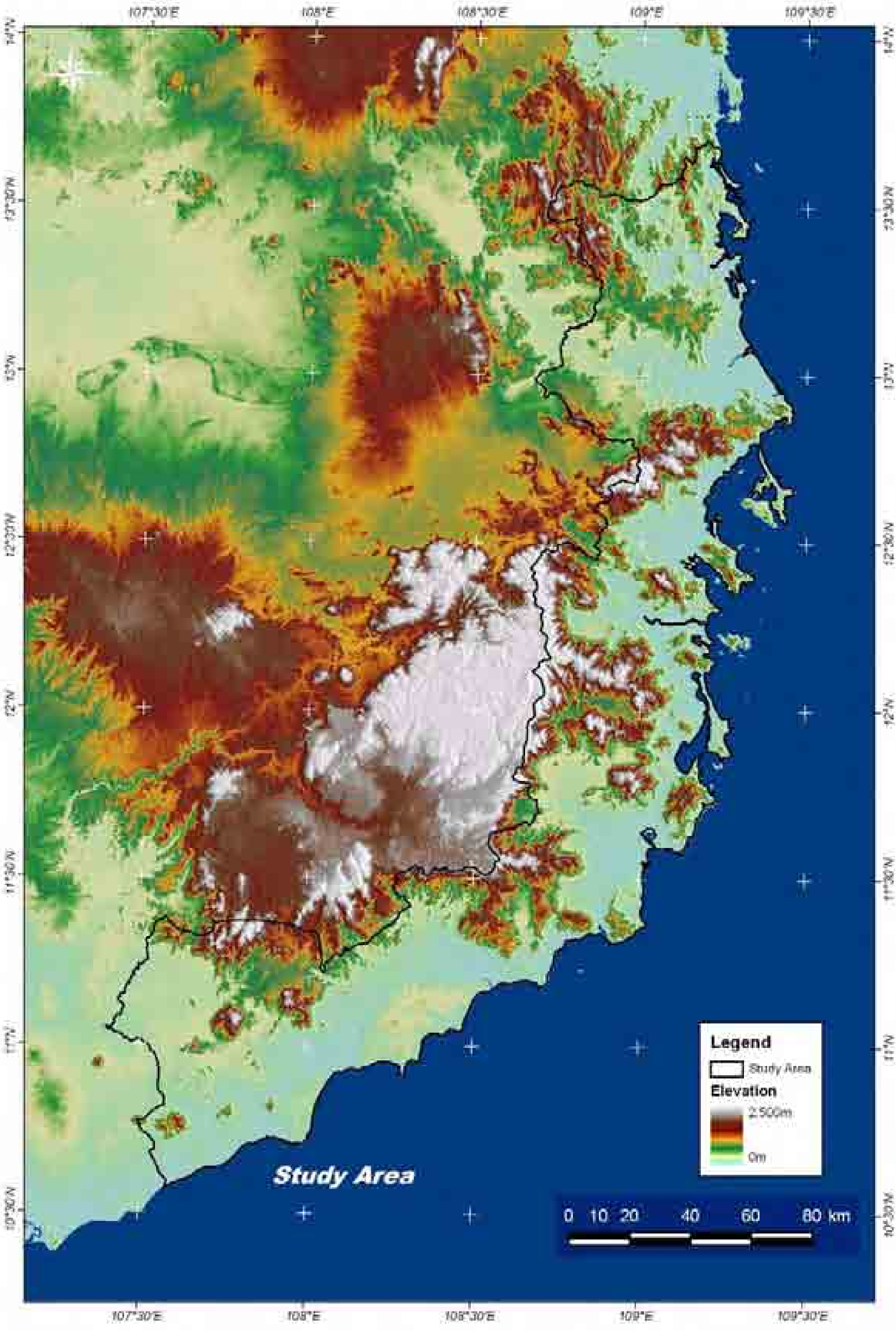
Source: JICA Study Team

Figure 2.1.9 VSW Index Image of ASTER Data

2.1.3 Space Shuttle/SRTM

SRTM (Shuttle Rader Topography Mission) obtained the elevation data on a near global scale to generate the most complete digital topographic database of the Earth by Space Shuttle. SRTM data is a digital elevation model (DEM) generated by the method of radar interferometry. The resolution of SRTM data is 1 arc-second (about 30m; SRTM-1) in the United States and 3 arc-seconds (about 90m; SRTM-3) in the World.

In the study, SRTM-3 data covering the area of 4 degrees laterally (106ºE to 109ºE) and 6 degrees vertically (10ºN to 16ºN), were acquired and utilized. The DEM image of SRTM data is shown in Figure 2.1.10.



Source: JICA Study Team

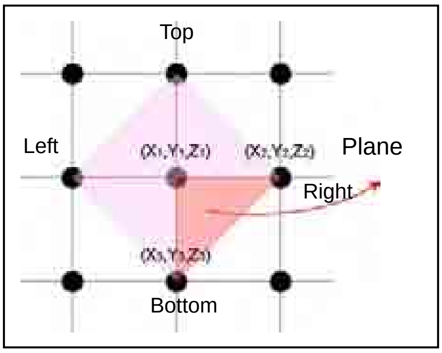
Figure 2.1.10 DEM Image of SRTM Data

Data processing of SRTM data were performed to extract information regarding geomorphology and geology. The methods of data processing applied in the study are as follows:

- Slope analysis
- Shade image
- Openness analysis

(1) Slope analysis

It is well known that slope image is an effective method for observations of geomorphology and geology. Slope of a certain optional pixel of DEM is calculated by the following procedures.

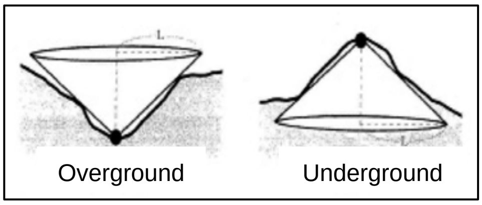


Source: JICA Study Team

Figure 2.1.11 Calculation of Planes

1) Determination of elevation values of a certain pixel and its neighboring 4 pixels (top, bottom, left and right; Figure 2.1.11).
2) Calculation of 4 planes and normal line vectors of each plane by elevation values.
3) Calculation of the slope value of a certain pixel by averaging 4 normal line vectors.

The slope image is shown in Figure 2.1.12.



Source: Yokoyama et al. (1991)

Figure 2.1.12 Concept of Openness

(2) Shade image

Shade image is also known as an effective method for observing features of geomorphology. Shade image is created by the following procedures.

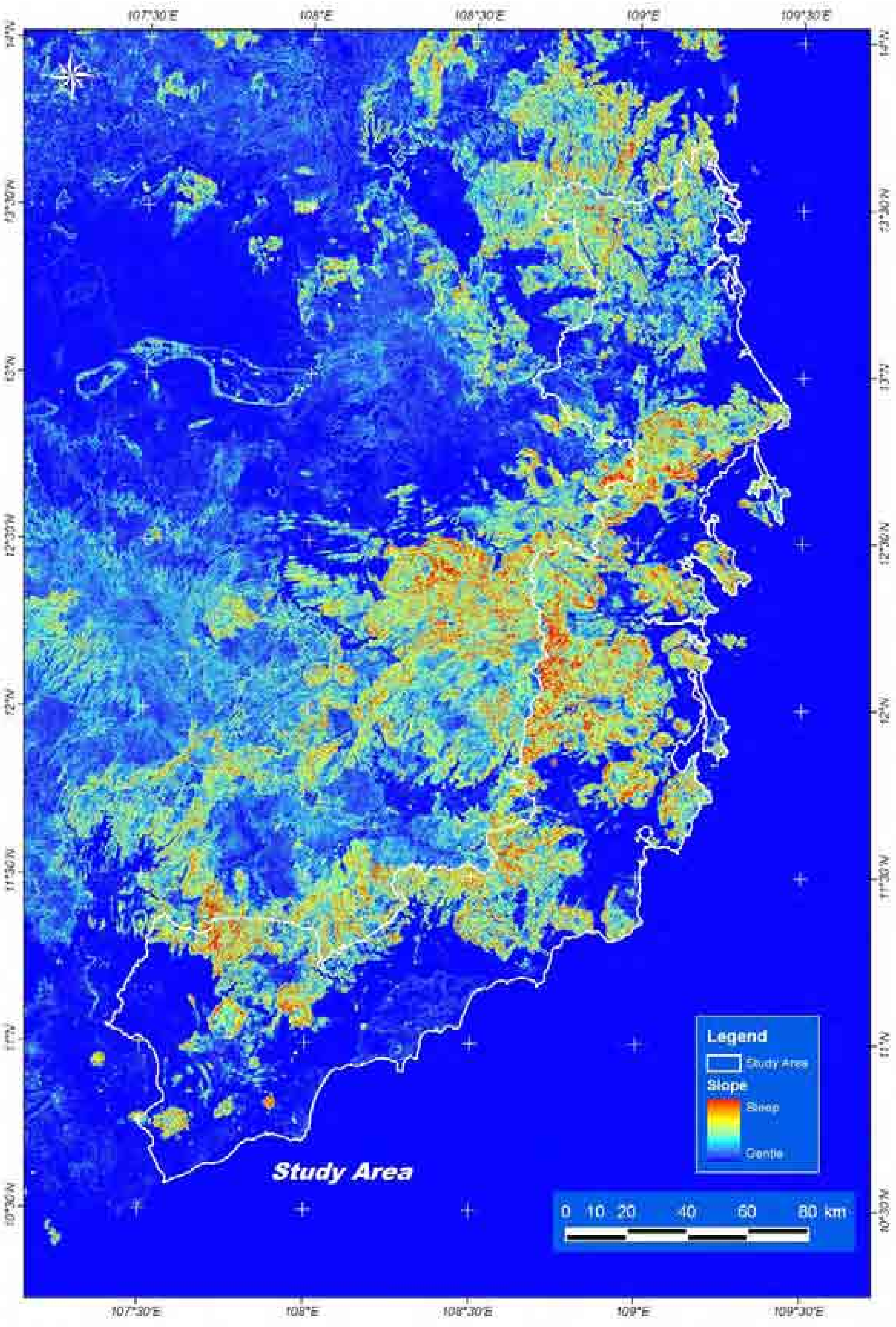
1) Determination of a certain position and elevation angle of light source.
2) Calculation of averaged normal line vectors of all pixels by the same method as slope analysis.
3) Calculation of angles between normal line vectors and the beam from the light source.

4) Creation of a gray scale image by assigning magnitudes of angles to the shade of color.

Shade image calculated from SRTM data is shown in Figure 2.1.13.

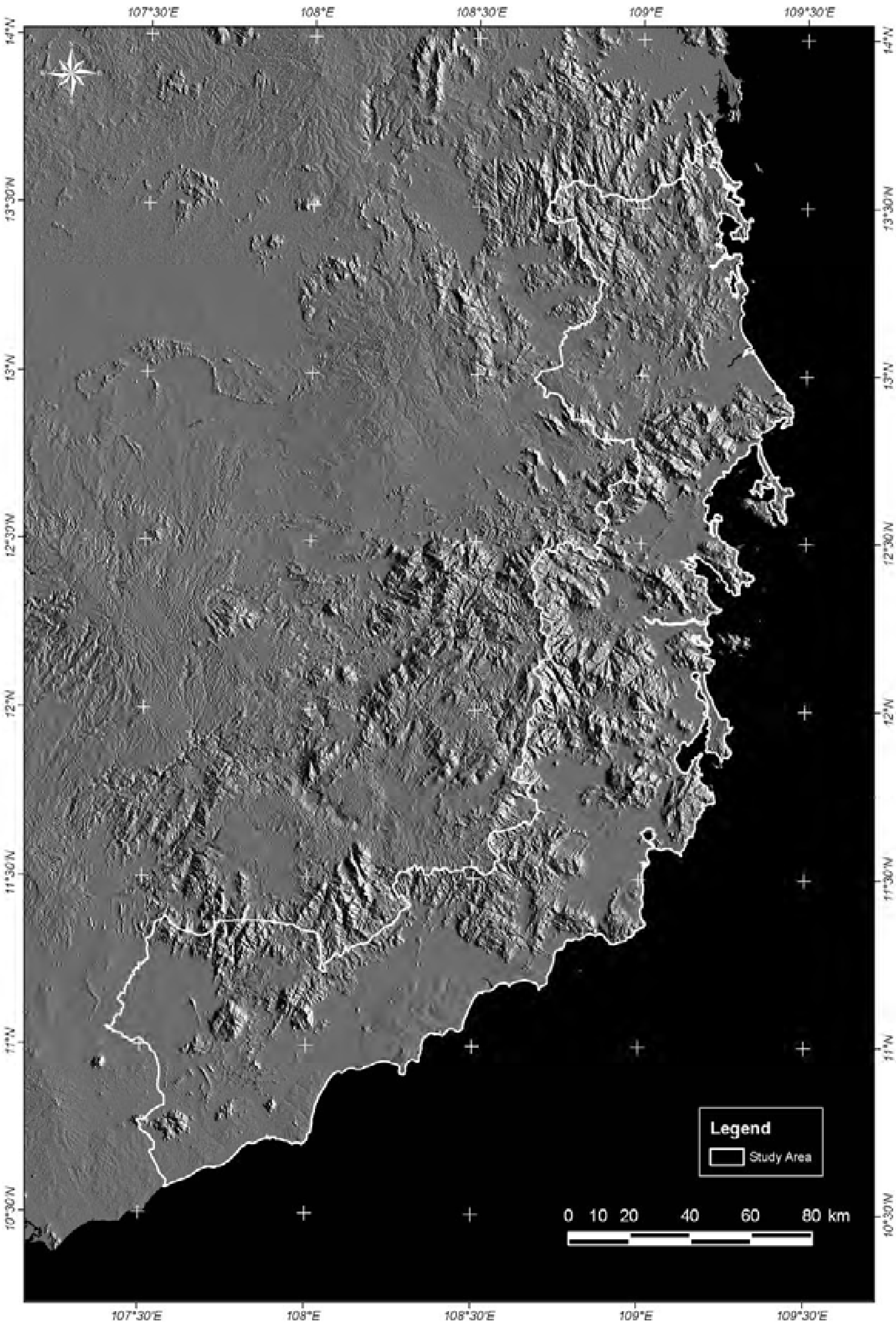
(3) Ground openness analysis

"Openness" is a new method of geomorphometry developed by Yokoyama et al. (1999) and it is useful to detect the relief information. Openness is an angular measure represented by the relation between surface relief and horizontal distance, and has two viewer perspectives; overground and underground. Overground is a characteristic quantity to describe the sky extent over an optional pixel. On the other hand, underground is to describe the underground extent over an optional pixel (Figure 2.1.14). Overground openness image calculated from the SRTM data is shown in Figure 2.1.15.



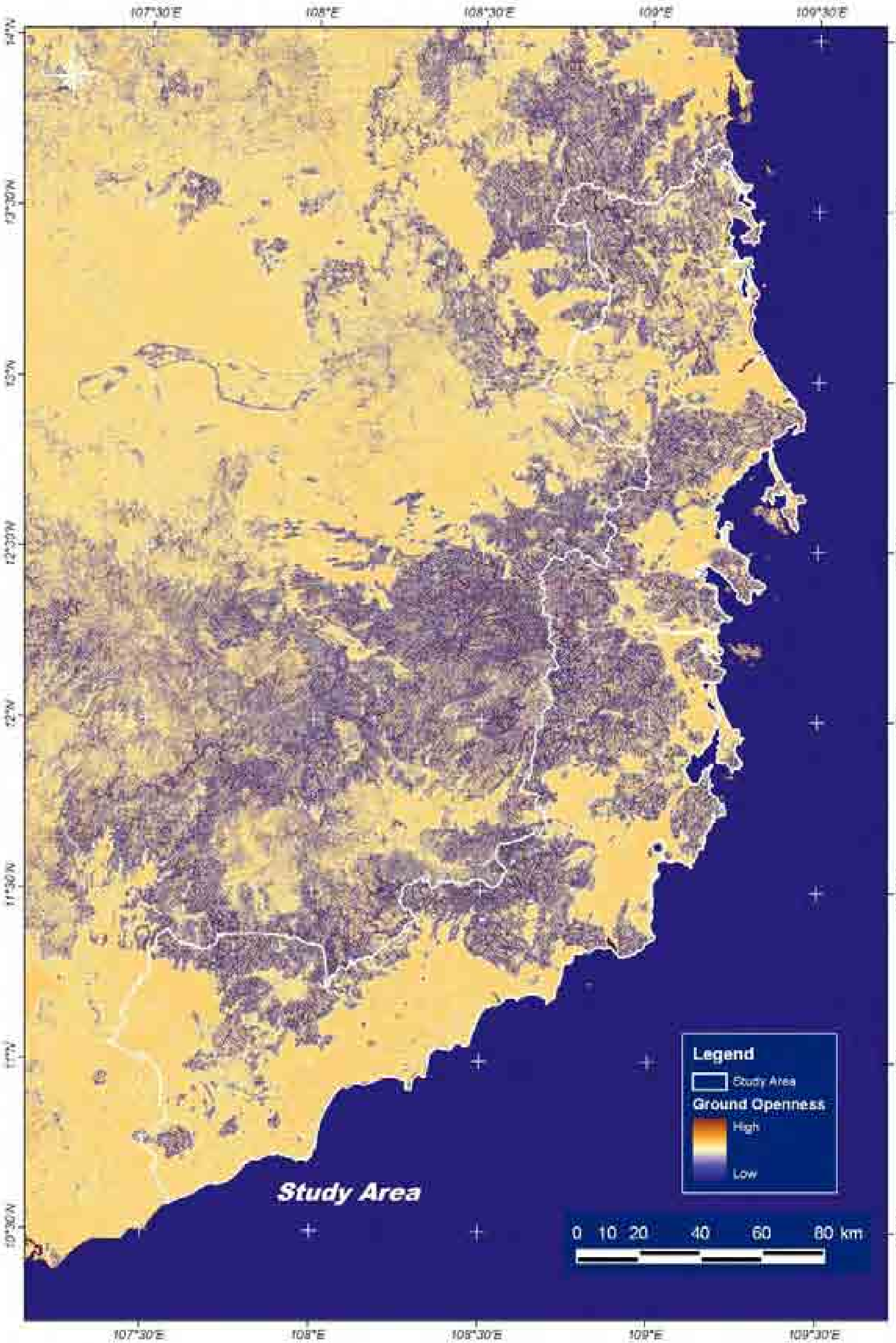
Source: JICA Study Team

Figure 2.1.13 Slope Image of SRTM Data



Source: JICA Study Team

Figure 2.1.14 Shaded Relief Image of SRTM Data



Source: JICA Study Team

Figure 2.1.15 Overground Openness Image of SRTM Data