APPENDIX-XIV

GIS

THE STUDY ON SABO AND FLOOD CONTROL
FOR WESTERN RIVER BASINS OF MOUNT PINATUBO
IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

SUPPORTING REPORT

APPENDIX XIV GIS

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CHAPTER 1 GIS DATABASE

1.1 Outline of GIS

GIS is a method to visualize, analyze, and display spatial data. It is a tool of linking a database with the map.

For Example, there are land-use data, streets data, district data and geological data, so many data are linked with the map in GIS, and it can be analyzed relationship of all the data. Figure1.1.1 is actual screen of Arcview GIS 3.2. This figure shows the relationship between map and table. For example, the figure shows locality of "San Narciso" including data of province, municipality, area, population, and number of houses.

The three basic data models that GIS uses are vector, raster, and TIN (Triangulated Irregular Network). Figure1.1.2 shows example of raster and vector data.

One way of representing geographic phenomena is with points, lines, and polygons. This kind of representation of the world is generally called a vector data model.

<u>Vector</u>

Points are pairs of x, y coordinates. Lines are sets of coordinates that define a shape. Polygons are sets of coordinates to define the boundaries that enclose areas.

GIS stores vector data in feature classes and collections of topologically related feature classes. The attributes associated with the features are stored in data tables.

<u>Raster</u>

In a raster model, the earth is represented as a surface that is divided into a regular grid of cells. The x, y coordinates of at least one corner of the raster are known, so it can be located in geographic space. Raster data includes image and grids images, such as an aerial photograph, a satellite image, or a scanned map, are often used for generating GIS data. Grids represent derived data and are often used analysis and modeling. They can be created from sample points, such as for a surface of chemical concentrations in the soil, or based on classification of images, such as for a land cover grid. Grids can also be created by converting vector data.

<u>TIN</u>

In a Triangulated Irregular Network model, the earth is represented as a network of linked triangles drawn between irregularly spaced points with x, y, and z values. TINs are an efficient way to store and analyze surfaces.

<u>Tabular data</u>

Any table of data can be joined to an existing feature class (vector) or raster dataset if they share an attribute.

1.2 Coordinate System of GIS

The coordinate systems of GIS are geographic coordinate system and projected coordinate system. A geographic coordinate system uses a three-dimensional spherical surface to define location on the earth. A point is referred to its latitude and longitude, (unit degree).

A projected coordinate system is defined on a flat, two-dimensional surface. Unlike a geographic coordinate system, a projected coordinate system has constant lengths, angles, and areas across the two-dimensions. A projected coordinate system is always based on a geographic coordinate system that is based on a sphere or spheroid. Projected coordinate is referenced X coordinate and Y coordinate, (unit almost meter).

Standard geographic coordinate in the Philippine is "Luzon 1911", Spheroid Clark1866.

General projected coordinate system is UTM (Universal Transverse Mercator projection) and PTM (The Philippine Transverse Mercator Projection). PTM is the Philippine standard map projection, and UTM is the most popular map projection in the world.

Universal Transverse Mercator projection

The earth is divided into 60 north and south zone by six degree wide. "Transverse Mercator" method is projected as baseline that center of each zone. Each zone has a scale factor of 0.9996 and a false easting of 5000,000 meters. Zones south of the equator have a false northing of 10,000,000 meters to ensure that all values are positive. The Philippine is included in the zone50North and the zone51North.

The Philippine Transverse Mercator Projection

The Philippine is divided into 5 zone two degrees wide. As well as UTM, "Transverse Mercator" method is projected as baseline that center of each zone. Zambales province is included zone3. Database of the Geographic Information System (GIS) for this study, the projection is PTM (Philippine Transverse Mercator projection) zone 3.

Figure 1.2.1 shows location of PTM and UTM zone. Figure1.2.2 shows major ellipsoid and coordinates of major points.

Detail of the PTM is enumerated below

1) Datum: Luzon 1911
2) Ellipsoid: Clarke of 1866

   (a=6378206.4 , b=6356583.8 ,1/f=294.978698214)
3) Projection: Transverse Mercator Projection
4) Latitude of Origin: 0N
5) Central Meridian: 117E (zone1), 119E (zone 2), 121E (zone 3), 123E (zone 4), 125E (zone 5)
6) False Northing: 0 (unit: m)
7) False Easting: 500,000 (unit: m)
8) Scale Factor: 0.99995

1.3 Construction of GIS Database in this Study

In this study, a comprehensive digital database has been developed for the topographic and socioeconomic information.

Contents of the GIS database are categorized by three major aspects namely; natural condition, social condition, and analysis. Natural and Social condition's are consisted of topographic information before and after the eruption.

The topographic information, before the eruption was taken from the National Mapping & Resource Information Authority (NAMRIA). The topographic information covers to elevation contours, rivers, roads, administrative boundary with a scale 1:50,000.

On the other hand, the topographic information, after the eruption was obtained from the aerial photographs taken in 2002. The topographic information includes elevation contours, rivers with a scale 1:10,000 for the study area. The study area is covered by 40 map sheets each with a size 60cm X 60cm.

Social condition consists of topographic information by aerial photographs and barangay information. Social condition includes roads, houses, land use, barangay boundaries, and other public facilities.

Analysis data consists of the result of inundation analysis and the satellite image analysis made JICA study team.

The contents of the digital database are given in Table 1.3.1 and Table1.3.2.

The data before the eruption

Natural condition and social conditions data set before the eruption such as elevation line, river line, basin areas, coastline, road and municipality boundary are brought from converting raster data (scanned NAMRIA map) to vector data. And then, elevation line data converted 50m mesh elevation grid data on GIS. Slope grid data was created from elevation grid data through GIS.

The data after the eruption

The study team developed topographic map (dxf file format) and digital elevation model data (asc format). Dxf file was imported to GIS, data sets after the eruption such as elevation line, river line, canal, coastline, land-use, house, bridge and road are brought from dxf topographic map and aerial photograph on GIS. Digital elevation model data (Ascii format file) is imported as 40m mesh elevation grid data to GIS. Slope grid data was developed from elevation grid data through GIS.

The study team collected barangay location map from each municipality, and inputted to GIS database. Other field survey data set in this study are the same.

Analysis data

The results of inundation analysis and satellite image analysis are inputted to GIS. These two datasets are grid data. Results of inundation analysis datasets are 3 area (the Bucao, the Maloma and the Sto. Tomas river basins), and seven cases of probability years (2,5,10,20,30,50, and 100 years). These data sets have a flood inundation water depth data for each area and probability years.

The results of satellite image analysis datasets are for 4 years, before and after the eruption, 1990, 1992, 1993 and 2001. These data sets include the information of land-use, NDVI (degree of vegetation activity) and changing rivers.

CHAPTER 2 GIS ANALYSIS / ASSESSMENT

2.1 Basic Assessment through GIS Database

In this study, the applied software for GIS is Arcview 3.2 and Arcview 8.2 include extension special analyst.

2.1.1 Changes in River Course

The following table is shown changes of rivers before and after the Mt. Pinatubo eruption. River Length, Gradient and River Bed Elevation calculated from the GIS data, Elevation and rivers were created GIS data as poly-line data and grid data. These data source were NAMRIA map (1977) and topographic map in this study (2002).

NAMRIA map was scanned into computer as raster image, and converted vector data (GIS poly-line data).

The river area before the eruption was estimated from satellite image (Landsat5) to polygon data. The river area after the eruption was estimated from the aerial photograph in this study.

Figure 2.1.1 shows river area before and after the eruption.

River Conditions before and after Eruption

River System	Stretch	River Length (m)		Gradient		Average Bed Elevation (Lower End)		Average Bed Elevation (Upper End)		River Area (ha)		Lahar Deposit Volume (mil.m3)	
		1977	2002	1977	2002	1977	2002	1977	2002	1990	2002	1977	2002
Bucao	Mouth ~ Bucao Bridge	3000	2600	1/470	1/500	0	0.4	4.9	5	91	217	-	1
	Bucao Bridge ~ Baquilan	7600	7300	1/330	1/260	4.9	5	24.7	30	860	1,454	-	65
	Baquilan ~ Malomboy	3500	3400	1/340	1/190	24.7	30	35.4	49.2	300	710	-	53
	Upper Bucao	23100	22700	1/90	1/90	39.3	49.8	271.7	285.9	1,160	3,288	-	400
	Balin Baquero	24200	21300	1/80	1/100	31.5	48.6	300	260.6	699	2,975	-	324
	TOTAL									3,110	8,644		843
Maloma	Mouth ~ Maloma Bridge	2600	2400	-	1/800	0	0.8	-	3.8	29	44	-	1
	Maloma Bridge ~ Maloma / Gorongoro Confluence	4800	4600		1/800	-	3.8	-	8.9	58	173	-	2
	TOTAL									87	217		3
Santo Tomas	Mouth ~ Maculcol Bridge	1600	1400	1/400	1/580	0	2.2	3.6	4.7	61	151	-	1
	Maculcol Bridge ~ Umaya	7700	7800	1/580	1/340	3.6	4.7	16.1	26.2	305	449	-	30
	Umaya ~ Vega Hill	4100	4500	1/300	1/240	16.1	26.2	29.7	43.1	184	510	-	68
	Vega Hill ~ Mt.Bagang	13300	12300	1/130	1/130	29.7	43.1	110.5	129.6	303	2,610	-	390
	Marella River	7100	6800	1/50	1/60	110.5	129.6	233.5	232.8	56	794	-	260
	Mapanuepe River	13700	11500	1/320	1/1800	110.5	129.6	129.6	132.9	113	305	-	69
	TOTAL									1,022	4,819		818

2.1.2 Estimation of Lahar Deposit Volume along the River

The pyroclastic material was transported down the western slope of Mount Pinatubo and deposited mainly in the Bucao and Sto. Tomas River basins. The lahar volume along the rivers could be estimated by comparison before eruption elevation and after eruption elevation. Using data was below.

Elevation before the eruption (Elevation 1977)

NAMRIA map was scanned into computer as raster image. The contour lines converted vector data (GIS poly-line data). In GIS, poly-line elevation data can be converted point data using "script poly-line to point". Then, 50 m mesh grid data created from the point elevation data. This function is available only for extension special analyst.

Elevation after the eruption (Elevation 2002)

In this study, 40m mesh Digital Topographic Map was developed from aerial photo. This DTM data was converted to 40m mesh grid data.

A method of estimation of lahar deposit volume along the river is as follows:

The difference of elevation between before and after the eruption along the river is subtraction elevation grid 1977 from elevation grid 2002, on the GIS. This difference is shown the depth of lahar deposit. In this time, new difference of elevation grid size is 50 m mesh, as same as bigger mesh size in comparison to the two grids.

All the deposition depth volume is the total of new difference of elevation grid value inside river area polygon. The lahar deposit volume along the River is all the deposition depth times 50 m times 50 m. Figure 2.1.2 shows the method and results.

2.1.3 Change in Topographic Condition at Maraunot Notch due to Collapse in July 2002

The crater lake water level fell down about 20m, due to the collapse of Maraunot Notch in July 2002. The study team developed the topographic map before(May 2002) and after (Jan 2003). This is to discuss change in topographic condition at Maraunot Notch before and after the collapse.

The procedures are as follows:

1. In GIS, poly-line elevation data can be converted into point data using "script poly-line to point". Then, 2.5m mesh grid data was developed from the point elevation data. This function is available only for extension special analyst.
2. The difference of elevation before and after the collapse is the subtracted elevation grid 2003 from elevation grid 2002, on the GIS. This difference is shown the depth of the notch washed out, along the river.
3. The difference of elevation was displayed 3D image (Figure.2.1.3) by 3D visualized software "Surfer". To display 3D image on the GIS, "extension 3D analyst" is required.

Figure 2.1.3 shows changes in topographic condition at Maraunot Notch before and after the collapse. After the collapse at Maraunot Notch, the riverbed was deeply scored along the Maraunot River. The erosion depth was 60 m over and the crater lake water level was fallen down.

This result have minor discrepancy, because there are difference precisions between 2002 topographic map (5 m) and 2003 topographic map (1 m). But, it is clear that erosion along the river and crater lake water level down was over 20m.

2.1.4 Estimation of Probable Flood Damages

Input the present condition

Topographic map was inputted to the GIS. Topographic map's file format was dxf. Then, GIS data created from topographic map. Create data was roads as poly-line, houses and land-use as polygon.

Road data have an attribute that National road or others. Land-use polygon data have an attribute that divided 6 kinds, Paddy, Upland, Orchard, Fishpond, Lake and Swamp.

Input inundation analysis result

Inundation analysis result was inputted into GIS as grid data. Result file format is ascii format. And these data sets have inundation depth data at inundation each area and the probable years. Inundation area polygon was developed by inundation depth grid data.

Extract inundation area and count affect houses, roads and agriculture land

Inundation area data lapped over the road data, the house data and the land-use data, and extracted and counted roads length, the number of houses and area of land-use within inundation area.

Figure 2.1.4 shows the method of the estimation the amount of damage from inundation analysis. Figures 2.1.5, and 2.1.6 shows results.

2.1.5 Trend of Land Use Condition from 1990 to 2002

The study team analyzed the land use trend, using the satellite image data to discuss the change of land-use before and after the eruption. Applied satellite image was below.

Observation Year	Satellite	note
1990	Landsat-5	116-050: 20 Jan 1990 117-050: 28 Feb 1990
1992	Landsat-5	116-050: 2 Feb 1992 117-050: 11 Feb 1992
1993	Landsat-5	116-050: 16 Feb 1993 117-050: 20 Feb 1993
2001	Landsat-7	116-050: 10 Jan 2001 117-049: 20 Mar 2001

Satellite image was analyzed through another software, and this result inputted into GIS. On the GIS, this result lapped another GIS data (Ex. municipality, barangay, basin etc), calculated area each municipality, each basin.

1. Result of satellite image analysis was outputted as "bil" file format. This file should be provided the same coordinates with GIS.
2. To import bil files into GIS converted land-use grid data. (this work is required the extension special analyst.)
3. Land-use grid data lapped municipality file (polygon). Relationship of this two-data was given land-use areas each municipality.

The results are shown in Figures 2.1.7, and 2.1.8.

Forest areas in Botolan and San Marcelino decreased from 1990 to 1992. Cultivated Area in the study area except San Marcelino decreased after eruption. But, it increased from 1990 to 2001.

Lahar and Pyroclastic flow deposit are mainly located Botolan and San Marcelino.

2.2 Poverty Assessment based on Barangay Database

2.2.1 Introduction and Objective

In this section, the evaluation analysis technique using GIS and multivariate statistic analysis are introduced. The target of analysis is to identify poverty level of each barangays in the study area.

Objective of the Barangay comparative study are as follows:

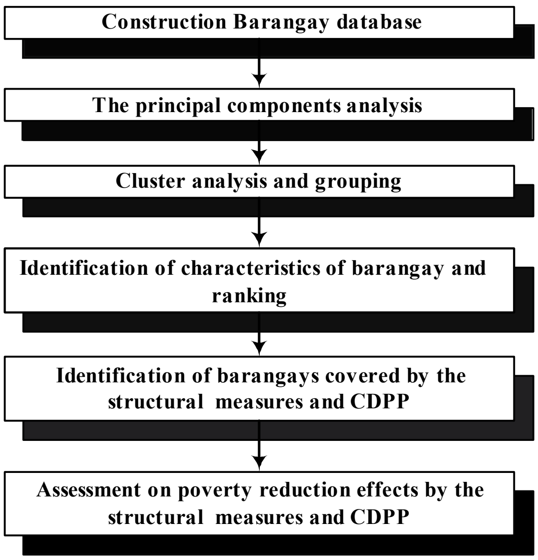
1) To identify the characteristics of the barangays,

2) To select the location of CDPP site, which is focusing poverty reduction for severely affected communities due to the events of the eruption of Mount Pinatubo and series of lahar.

In this section, only the procedures of analysis technique are introduces. The result and the CDPP plan are described in Appendix IX.

2.2.2 Methodology

The following figure is the flow chart of the Barangay comparative study, for which the multivariate statistic analysis was applied:



1) Construction of Barangay Database

Firstly, barangay database was constructed. The data source is "INTEGRATED RURAL ACCESSIBILITY PLANNING information system ACCESSIBILITY DATABASE 2001" by International Labor Organization, Department of the Interior and Local Government, and Royal Government of the Netherlands. The study team chose evaluation data for barangay comparison analysis, from the barangay database.

On the other hand, GIS data was extracted for barangay comparison analysis. From two databases, the 15 kinds of data were used for multivariate statistic analysis.

2) The Principal Component Analysis

After then, the Principal Component analysis (PC analysis) was conducted. PC analysis is a statistical technique applied to plural sets of variables to discover similarities and positioning of variables. In the Principal Component analysis, variables are the 15 kinds of data.

This technique involves a mathematical procedure that transforms a number of correlated variables into a number of uncorrelated (independent) variables called principal components. In other word, meaningful and independent new information is abstracted from an amount of data sets. In this study, six principal components were extracted from the 15 kinds of data.

3) The Cluster Analysis and Grouping

After the PC analysis, the Cluster analysis was applied for the grouping of 122 barangay. The Cluster analysis is a multivariate analysis technique that seeks to organize information about variables by which the relatively homogeneous groups will be identified. In this study, the variables are the score of respective principal components.

4) Identification of Characteristic of Barangay and Ranking

Based on the score of respective principal components, the barangays which marked the similar scoring pattern of respective principal component are grouped, and the characteristics of the each group are assessed.

The barangay ranking is determined based on the accumulated total score of PC analysis.

2.2.3 Applied Data

The target barangays are shown in the following table.

Municipality	Number of Barangay (Number of analysis barangay)	note
Iba	14(11)	Exclude : San Aguatin, Amungan, Bangan talinga, due to out of project area
Botolarn	31(31)	
Cabangan	22(22)	
San Felipe	11(11)	
San Narciso	17(17)	
Castellijos	14(12)	Exclude :Balaybay, Del Pilar, due to out of project area
San Marcelino	19(18)	Exclude : Negrito reservation, due to No barangay database
Total	128(122)	

For barangay comparative study, the 15 kinds of barangay information were used as listed below:

No.	Data Name	Unit	Source, Note
1	Total Area	Hectare	GIS calculate
2	Plain Area/Total Area	Hectare	GIS calculate Plain area = Slope < 10 degree
3	Mountain Area/Total Area	Hectare	Mountain area = Slope >=10 degree, Exclude River area
4	FarmLand	Hectare	GIS calculate (Land use data)
5	Road length	Meter	GIS calculate
6	Distance to Pob(min)	Minutes	GIS calculate Car road = 30km/hour , Walk road = 4 km/hour Ship = 10 km/hour (Mapanuepe Lake)
7	Population(Total year2001)	Number	Accessibility database
8	Water % of HHs Served Directly	%	Accessibility database
9	Population/Area	Number/ Hectare	Accessibility database and GIS calculate
10	IRA/Population	Pesos/Number	investigation
11	Farmland/population	Ha/Number	Accessibility database and GIS calculate
12	Built-up Area/Total Area	-	GIS calculate
13	Farmland /Total Area	-	GIS calculate
14	% of School children	%	Accessibility database
15	IRA/Total Area	Pesos/Hectares	investigation

Data sets for PC analysis has different units. Therefore, analysis datasets was standardized.

A formula of standardization is shown follow:

Standardization “Z” = $(X - \underline{X}) / S_x$

X = variables, $\underline{X}$ = average of variables,

S_x = standard deviation of variables “X”

2.2.4 Result of the Principal Component Analysis

Based on PC analysis of the 15 kinds of data, 6 principal components were extracted. The accumulated contribution ratio is calculated at 85%, which is judged as sufficient to the reliability of the analysis.

The calculated contribution ratio of each principal component is summarized as follows:

Principal Component No.	Value	Contribution Ratio (%)	Accumulated contribution ration (%)	Characteristics
PC-1	4.36	29.07	29.07	Degree of urbanization
PC-2	3.54	23.62	52.70	Suitability on agriculture
PC-3	1.71	11.41	64.10	Accessibility for Development
PC-4	1.30	8.67	72.77	Sufficiency of Social Infrastructure
PC-5	1.03	6.86	79.64	Accessibility to education opportunity
PC-6	0.82	5.49	85.13	Degree of subsidence of government

The calculated factors of variables (PC data sets) toward principal components are summarized as follows and shown in Figures 2.2.1.

PC data sets	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6
Total Area(ha)	-0.3459	-0.0083	0.1970	0.0362	-0.4245	-0.1025
Farm Land(ha)	0.0706	0.4197	0.1692	0.3056	-0.2666	-0.1265
Road(car)	0.0107	0.3309	0.4031	0.2695	-0.0711	0.1725
Distance to Pob(min)	-0.3543	-0.1459	-0.1988	0.1448	-0.1741	-0.2019
Population(Total year 2001)	-0.0937	0.1580	0.5713	-0.1353	0.1155	0.0427
% of HHs Served Directly	0.2737	0.0492	0.2194	-0.3093	-0.1543	0.5007
Pop/Area(Number/ha)	0.2665	-0.3634	0.2106	0.0632	-0.1592	-0.2707
IRA/pop	0.0684	-0.1595	-0.2882	0.4643	-0.0562	0.6654
Farmland/pop	0.1160	0.3696	-0.1848	0.3482	-0.2987	-0.0798
Build-up area/Total Area	0.2277	-0.3668	0.2090	0.1844	-0.2062	-0.1019
FarmLand/Total Area	0.2663	0.2835	-0.3041	-0.1015	-0.1176	-0.2600
% of School children	0.1204	0.0250	0.1407	0.4792	0.6747	-0.1846
IRA/Area	0.2521	-0.3739	0.1638	0.2253	-0.2165	-0.0693
Mountain/Total Area	-0.4273	-0.0924	0.0576	0.1508	0.0010	0.0688
Plain/Total Area	0.4398	0.0871	-0.0916	-0.0968	-0.0066	-0.0807

Score of each principal component is calculated as follows:

Example: PC-1 score =

-0.3459 * Total Area(ha)+0.0706* Farm Land(ha)+0.0107* Road(car)+-0.3543* Distance to Pob(min)+-0.0937* Population(Total year2001)+0.2737*% of HHs Served Directly+0.2665* Pop/Area(Number/ha)+0.0684* IRA/pop+0.1160* Farmland/pop+0.2277* Build-up area/Total Area+0.2663* FarmLand/Total Area+0.1204*% of School children+0.2521* IRA/Area+-0.4273* Mountain/Total Area+0.4398* Plain/Total Area

(the number from calculated factor of variables)

Total score of principal components are shown:

Total Point = 0.2917*PC-1 Point + 0.2362*PC-2 Point + 0.1141*PC-3 Point + 0.0867*PC-4 Point + 0.0686*PC-5 Point + 0.0549*PC-6 Point (number from Contribution Ratio (%))

The characteristics of the six principal components are as follows:

1) PC-1: Degree of Urbanization

PC-1 is in proportion to flat area ratio, % of water, population/area, IRA/area, and urban area. It is then characterized as "Degree of Urbanization".

2) PC-2: Suitability on Agriculture

PC-2 is in proportion to farm land ratio, flat area, and is in inverse proportion to urban area. Accordingly, this component is characterized as "Suitability on Agriculture".

3) PC-3: Accessibility for Development

PC-3 is proportion to in population, roads length, % of water, population/area, urban area, and is in inverse proportion to farm land ratio, IRA/ population, distance from municipality center. PC-3 is therefore characterized as "Accessibility for further development".

4) PC-4: Sufficiency of Social Infrastructure

PC-4 is in proportion to per capita IRA (Internal Revenue of Allotment) and per capita farm land and school admission ratio. It would be characterized as “Sufficiency of Social Infrastructure”.

5) PC-5: Accessibility to Education Opportunities

PC-5 is in proportion to school admission ratio. This is therefore characterized as “Accessibility to Education Opportunity”.

6) PC-6: Degree of Subsidence from Government

PC-6 is in proportion to per capita IRA and is in inverse proportion to ratio of farm land. This is considered to be characterized as “Degree of subsidence from the Government”.

Figures 2.2.2, and 2.2.3 show the score of each principal component and total score of principal components.

2.2.5 Barangay Ranking

Based on the results of principal components analysis, barangay ranking is calculated by accumulating values of respective components. Table2.2.1 compiled the results. The location map of Barangay Ranking is shown in Figure2.2.3.

It is concluded that the barangays located near the municipal center, and had wide agriculture land marked relatively high ranking. On the other hand, the barangays with mountain topography and large area are generally marked low ranking. The result is not directly meaning poverty level of barangay, but it is reflected to the differences of living condition of the barangays.

2.2.6 Barangay Classification

Cluster analysis was conducted to classify the barangay characteristics. This is carried out based on the value distribution on each principal component of respective barangay (PC-1 – 6 score). The barangays which have similar scoring pattern in respective principal component are grouped. As the results, the barangays were classified into 6 clusters as shown in Figures 2.2.4, through Figure 2.2.6 and summarized below:

<u>Cluster-1: Agriculture Based Barangays-1</u>

66 barangays are classified into Cluster-1. The characteristics of this group are that all scores of each principal component exclude mountain area barangay are average, by which it can be defined that Cluster-1 is agriculture based barangays. The ranking in this cluster is between 10th and 92nd. It can be also defined that the Cluster-1 is typical barangay in the study area.

<u>Cluster-2: Urbanized agriculture barangay</u>

18 barangays are classified into Cluster-2. The characteristics of this group are that PC-1: Degree of urbanization and PC-2: Suitability of Agriculture is high. They are defined that the suitable Agriculture Barangay that located nearly the center of municipalities. The ranking of respective barangay in this cluster is between 5th and 71st .

<u>Cluster-3: Less potential development barangay</u>

16 barangays are classified into Cluster-3. This cluster is characterized as low Sufficiency of Social Infrastructure. This group can be defined that do not have developing space in plain area barangay, or do not have plain area (suitable agriculture) in mountain area barangay. The ranking of respective barangay in this cluster is between 60th and 122nd.

Cluster-4: Potential development barangay

11 barangays are classified into Cluster-4. This cluster is characterized as high accessibility for development. They can be defined as wide barangays, located near from the center of municipalities. The ranking of respective barangay in this cluster is between 19th and 109th.

Cluster-5: Urban Barangay

7 barangays are classified into Cluster-5. This cluster is characterized as high urbanization and high sufficiency of social infrastructure, and low Suitability on Agriculture. All the barangays in this cluster is located in center of municipality. These barangays are not depended on agriculture for their income sources. The ranking of respective barangay in this cluster is between 74th and 94th. But, in this study, meaning urban factor is only one as "Build-up area/Total Area" in data sets for PC analysis. Therefore, urban barangay is low ranking.

Cluster-6: High potential development barangay

4 barangays are classified into Cluster-6. This cluster is characterized as high accessibility for development and agriculture suitability. They can be defined as wide barangays suitable agriculture, located near from the center of municipalities. The ranking of respective barangay in this cluster is between 1st and 26th.

2.2.7 Conclusions on Poverty Assessment

Based on the cluster analysis, poverty assessment in the study area is carried out. In this study, the principal components for the assessment are 1) degree of urbanization, 2) suitability for agriculture, 3) accessibility for development, 4) degree of infrastructure, 5) degree of education opportunity, and 6) per capita input from the government. Therefore, the poverty assessment will be limited only in the view of the six principal components mentioned above. In fact, the poverty structure is quite complex and not easy to quantify.

Based on the assessment in this study, the degree of poverty is assessed as the following orders:

Order	Cluster	Characters	Nos. of Barangay	Poverty degree
1	Cluster-3	Less potential development barangay	16	Relatively High (Mountain area : High)
2	Cluster-1	Agriculture Based Barangay-1	66	Medium (Mountain area : High)
3	Cluster-4	Potential development barangay	11	Medium
4	Cluster-5	Urban Barangay	7	Medium
5	Cluster-2	Urbanized agriculture barangay	18	Relatively Low
6	Cluster-6	High potential development barangay	4	Low

Based on the assessment above, the barangays which are identified as high or relatively high degree of poverty are generally suitable for agriculture development. Income source should be well studied taking into account the location and topography. Basically, the 11 lower ranking barangays by PC analysis, belong to clusters-1and 3 are located in the mountain area located far from the center of municipalities.

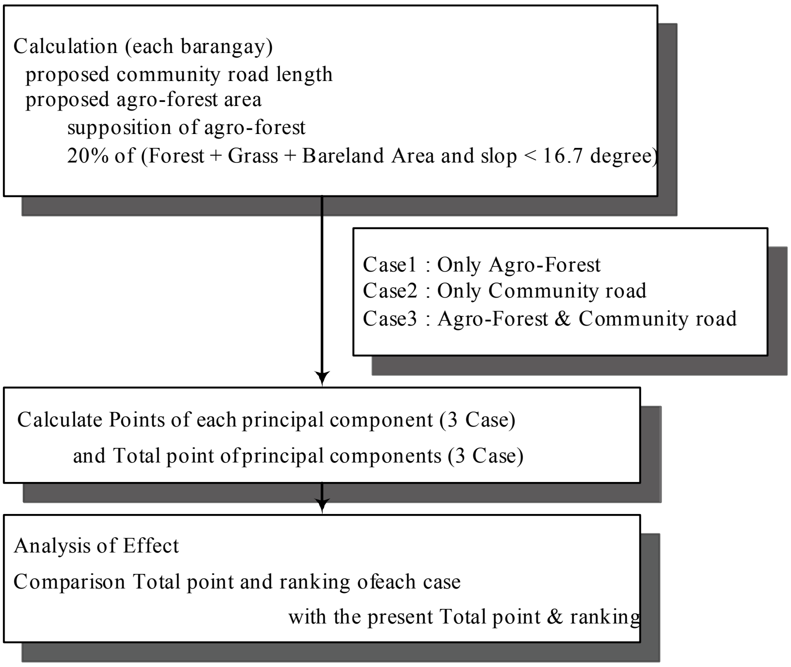
The slope agriculture, agro-forestry and community road development are proposed as CDPP measures (Appendix IX)

2.2.8 The Effects on Poverty Reduction by Proposed Community Roads and Agro-forestry

The 11 lower ranked barangays by PC analysis are located on the western slope of Mt. Pinatubo. This area affected by the Mt. Pinatubo eruption, road was disconnected and farmlands were buried under lahar.

In this section, the effects on the poverty reduction by the proposed community roads and agro-forestry (changing to Orchard) are assessed.

The following is the flow chart of the effects on the poverty reduction in the study area by the proposed community roads and agro-forestry.



Methodology

1) At first, the study team planned community roads and agro-forestry development areas. Proposed agro-forestry areas are that the present land-use conditions are forest, grass or bare land by Landsat image and their slops are less then 16.7 degrees. In the analysis, 20% of the total forest area will change to orchard.Figure2.2.7 shows location of proposed roads and proposed forest.

2) New community roads lengths values and new farmland areas (agro-forest areas) value were calculated each barangay. And then, travel times to the municipality center (min) are changed to new value with new community roads length. Assumption of times from center of municipality are that speed of car is 30 km/hour, speed of walk is 4 km/hour, and speed of ship is 10 km/hour (in Mapanuepe Lake).

3) Score of each principal component and total score of principal components were calculated each case.

4) Points of each principal component and total point of principal components was compared with the present points and ranking.

Result

The results are shown in Figure2.2.8 and 2.2.9 and Table 2.2.2. The summarized results area as follows:

All the score and ranking of the 11 lower ranked barangays are upgraded by community roads and agro-forest plan. Therefore, proposed agro-forestry and community road development plan would have a great effects on the poverty reduction.

Barangay Name	Difference present and plan			Present Point	Additional score			Present Ranking	Up-great rank		
	Farmland (ha)	Road(m)	Distance to Pob (min)		Case 1	Case 2	Case 3		Case 1	Case2	Case3
Maguisguis	544		-237	-2.62	1.09	0.40	1.49	122	8	1	11
Moraza	281	3126	-373	-2.27	0.87	0.68	1.54	121	9	6	11
Villar	149	3648	-382	-2.20	0.27	0.70	0.97	120	3	6	8
Poonbato	564	20969	-229	-2.18	0.94	0.67	1.62	119	7	5	12
Palis	149		-324	-2.14	0.71	0.55	1.26	118	5	3	8
Nacolcol	229	332	-344	-2.11	0.99	0.59	1.58	117	6	3	11
Belbel	48		-173	-1.84	0.14	0.30	0.43	116	1	2	3
Burgos	104	4710	-262	-1.74	0.36	0.51	0.87	115	3	3	5
Owaog-Nebloc	96	4107	-135	-1.55	0.51	0.29	0.80	114	4	2	4
Cabatuan	29		-37	-1.49	0.09	0.06	0.15	113	1	0	1
Sta.Fe	1027	14803		-1.41	1.83	0.20	2.04	112	79	0	95

2.3 Flood hazard mapping by using GIS

In this section, the procedure of flood hazard mapping by using GIS is introduced.

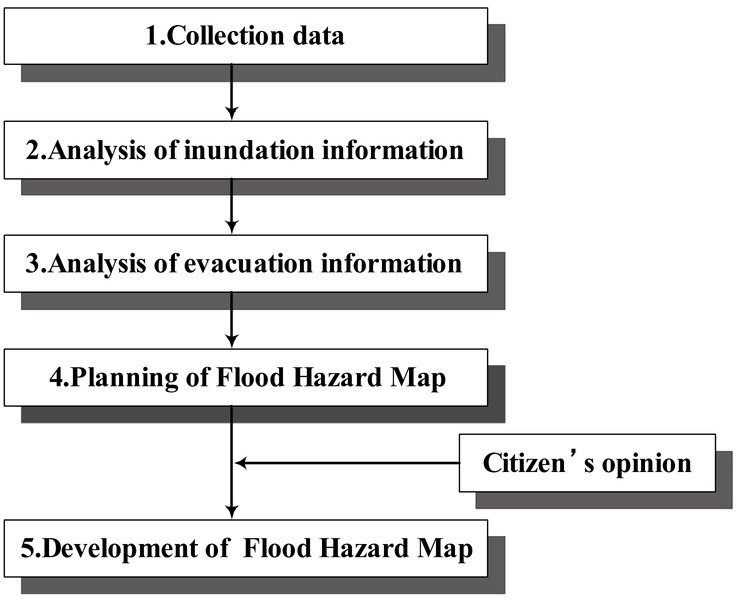
Flood hazard map presented the following aspects:

1) Information of Inundation by breached dike during Flood.
2) Information of the evacuating route from flooding area to the safety area

   Ex. : safety location, area, and route

Working flowchart of flood hazard mapping is shown below.

Working flowchart of Flood Hazard Map



2.3.1 Collection of Data

The following three kinds of data were collected.

1) Basic Map

2) Inundation information or expectation

3) Evacuation information

Basic map scale is good 1 / 25,000 to 1 / 2,500 for hazard map, because this scale map can be identified houses one by one.

As inundation information or expectation, the study Team collected “Pinatubo lahar and flood hazard zones map”, developed by PHIVOLCS. This map was divided by five zone degree of susceptibility.

Evacuation information was collected such as evacuation centers, schools, barangay boundaries, and population of each barangay.

Evacuation center data was collected from Department of Education, Region 3 Division of Zambales, Iba. School data was collected from the basic map.

Barangay maps and population of barangays was collected from each municipality.

2.3.2 Analysis of Inundation Information

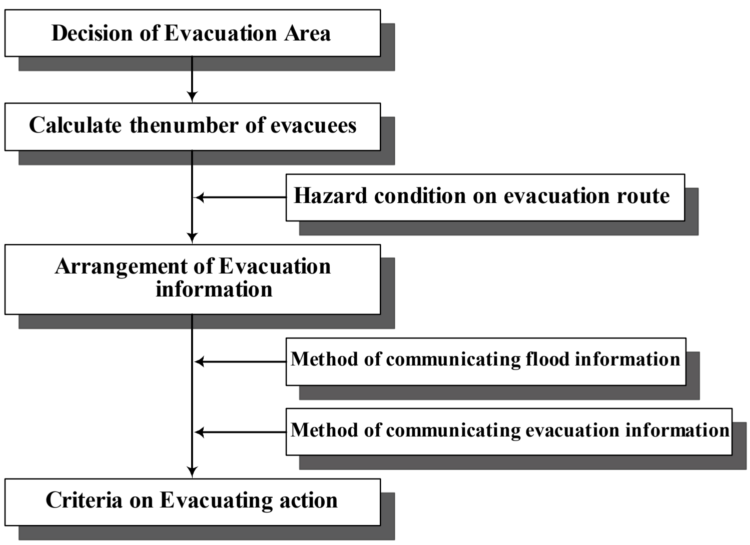
Inundation Analysis was conducted by the study team. Figure 2.3.1 shows the results of inundation analysis, which shows the flood water depth and flood area in the case of breached dike. In the Santo Tomas River basin, the study team assumed three points of dike breaches.

Generally, when flood water depth is over one meter, peoples can not evacuate safety.

2.3.3 Analysis of Evacuation Information

Working flowchart of evacuation information analysis is shown below.

Analysis of evacuation information



This is working flowchart of evacuation information analysis. In this section, there is shown until arrangement of evacuation information. The criteria on evacuating action are contained in Appendix IX.

The study Team planed for arrangement of evacuation center by location and number of evacuees.

On this study, the study team decided that evacuation area is all inundation area probability 100 years, because there is possibility of in expected heavy rain.

2.3.4 The Number of Evacuees

In this section, calculation procedures on evacuees using GIS are introduced.

At first, the number of houses were calculated each mesh on GIS. These meshes are the same size as inundation analysis result.

The house data was obtained from the basic map developed by JICA. Figure 2.3.2 (upper), brown shapes shows the individual houses. This brown shape converted to point data by GIS and counted the number of house points in each mesh.

The result is shown Figure2.3.2,which shows that a red mesh's number of house is only one, and a light blue mesh's number of houses is 5 to 10.

A formula of population each mesh is shown follow:

Population each mesh = (number of house) X (population/ house)

The value of population/ house was calculated from barangay database. These values were usually IV to VI. Figure 2.3.3 shows population each mesh.

And then, the study team selected population mesh inside inundation area and counted population as evacuees, each barangays. The result shows in Figure 2.3.4

2.3.5 Hazard Condition on Evacuation Route

Examples of hazard on evacuation route are steep slope area, landslide area and bridges. In this study, the bridges are applies, because during flood and inundation, the river water level would be higher and it is dangerous for passage peoples.

Therefore, the bridge that inundation water depth is more than about 1 meter was decided no passage during flood.

2.3.6 Result

These inundation and evacuation information were lapped on GIS, the study team planed evacuation center for each barangays and safety escape route.

1) Result of inundation analysis was lapped over the basic map, and the bridges were extracted as hazard on evacuation route.
2) Barangays were divided into the smaller zones by roads and rivers. Because, during flood and inundation, the river water level would be higher and it is dangerous for passage peoples. And, evacuation center's capacity are insufficient to contain all evacuees in the existing evacuation centers.
3) Safety route from small zone to evacuation center is shown in the map. The distance from house to evacuation center is set within 2 kilometers, because peoples moving speed by walk is about 4 kilometers per 1 hour in clear weather, therefore the study team decided 2 kilometers per 1 hour as moving speed in bad weather.

Figure 2.3.5 shows example of flood hazard map. This figure shows inundation water depth, inundation area, and small zones for evacuation in barangay, evacuation centers, and safety route to evacuation center.

CHAPTER 3 BEGINNERS MANUAL FOR GIS APPLICATION

3.1 Applied Software

The study team is using ArcMap 8.1 software. This is a world famous GIS software. In this section, there is a first step manual for beginners. This manual is based on the GIS seminar last Feb. 2003.

3.2 Contents

Contents are below:

1) ArcMap Basic Tools
2) Edit a layer

   Adding a layer to a map

   Changing the way features are drawn

   Adding Labels

   Working with the map Layout

   Saving a map

   Printing a map

3.3 Start ArcMap

Start ArcMap

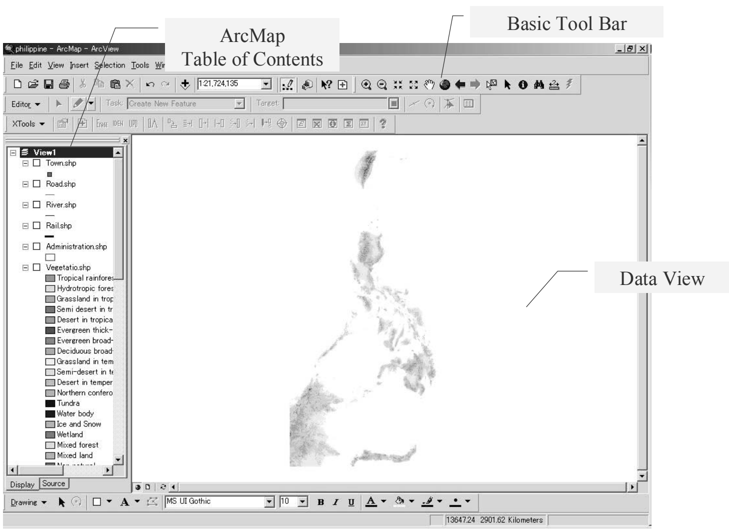
   Start Manu→ Program→ ArcGIS→ ArcMap

Open Existing GIS Database

   File →Open → C:/Example /Example.mxd

   “mxd” file is ArcMap basic file.

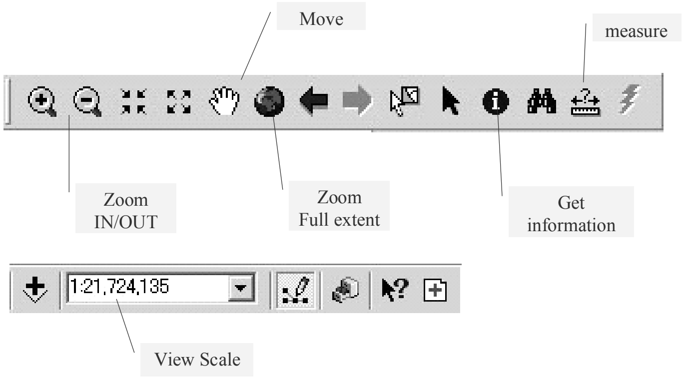
3.4 ArcMap Basic Tools



This figure is an actual screen of ArcMap8.1.In the left side, there is a “Table of contents”. The layers in this map are listed in the table of contents. Each layer has a check box that turn on or off.

In the upper side, there is a “Basic Tool Bar”. And in the center, there is a data view frame.

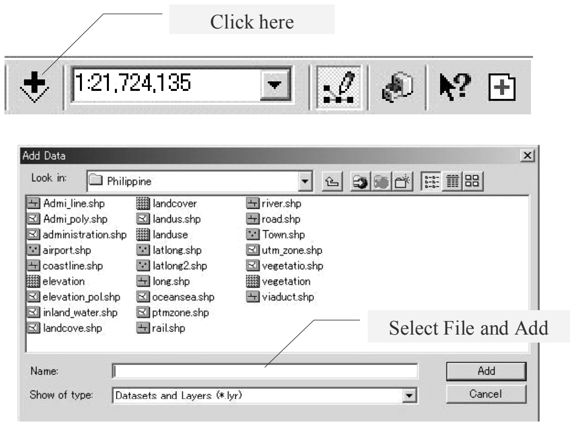
ArcMap Basic Tools



This is Basic Tools. "View Scale" tool shows the present "data view" scale.

3.5 Edit a Layer

Edit a layer
Adding a layer to a map

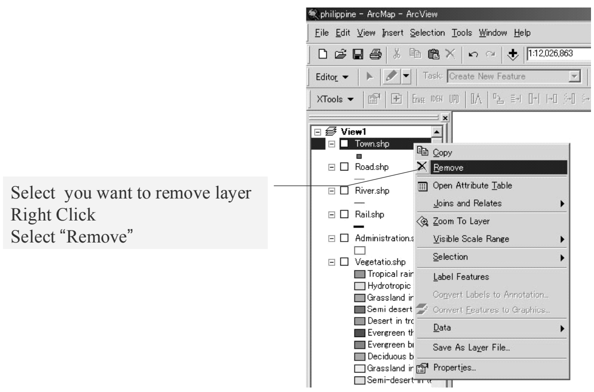


This is how to add a new layer.

When plus button is clicked in basic tools, we can see "Add Data" property dialog box.

You can select already existing file and push add button.

Removing a layer from a map



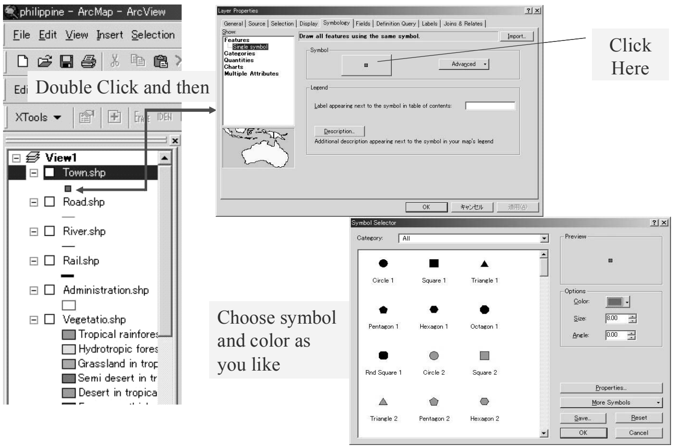
This is how to remove a existing layer.

1. At table of contents, you select a layer that you wish.

2. right click layer

3. you can select "Remove" from dialog box.

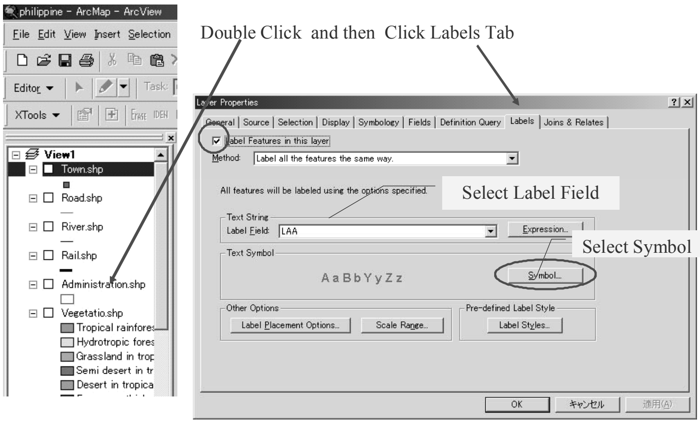
Changing the way features are drawn



1. Double click a layer to change symbol in table of contents and click symbol bottom.

2. You can see symbol selector. You can choose form, color, size, angle.

Adding Labels

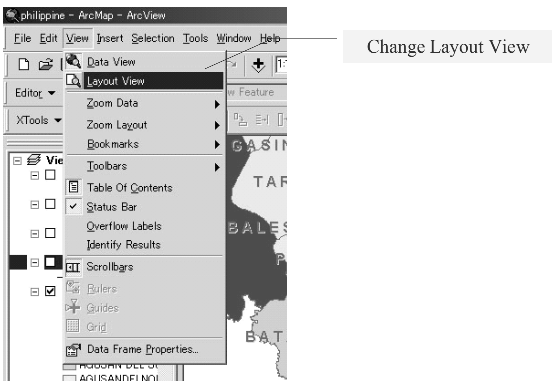


1. Double click a layer in table of contents.

2. Click the "Labels" tab in dialog box.

3. Check label features in this layer. Select label field dropdown list and text symbol.

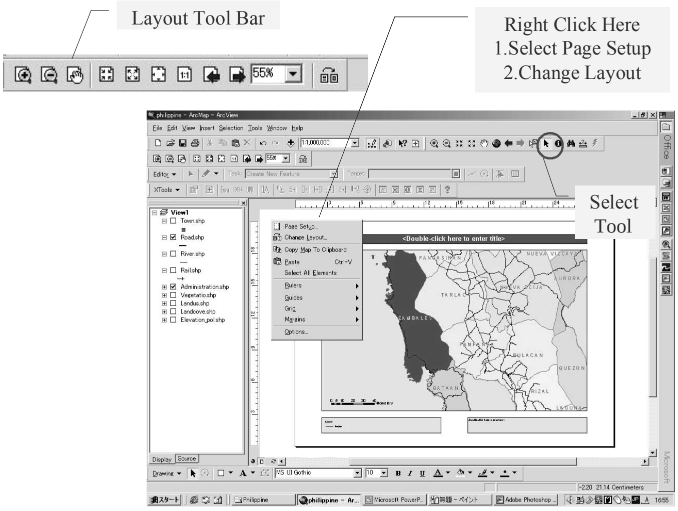
Working with the map layout



The map that you are making will be printed in color an A4 paper.

Click view and click layout view.

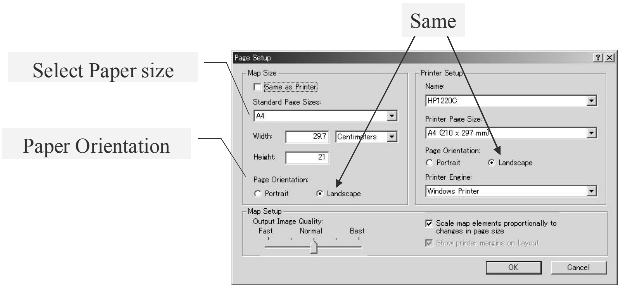
Now, you can see the map on a virtual page.

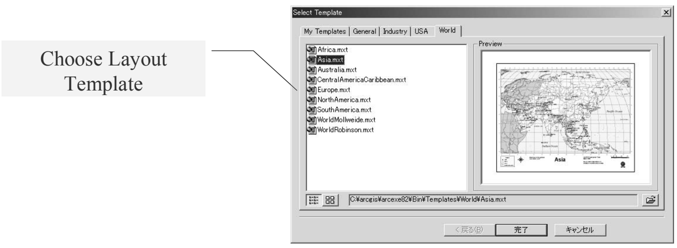


This is Layout Tool bar.

You can use the tool bar on the Layout toolbar to change the size and position of the virtual page on your screen or to zoom in or out of the virtual page.

Right click on the page and choose page setup.



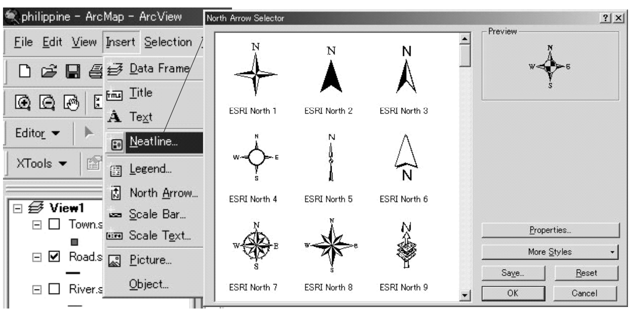


1. Select paper size, and paper orientation.

2. In this time, You change page orientation of printer, as same as paper orientation.

3. If you want change layout, you can select change layout and choose from so many templates.

Add a scale bar & North Arrow

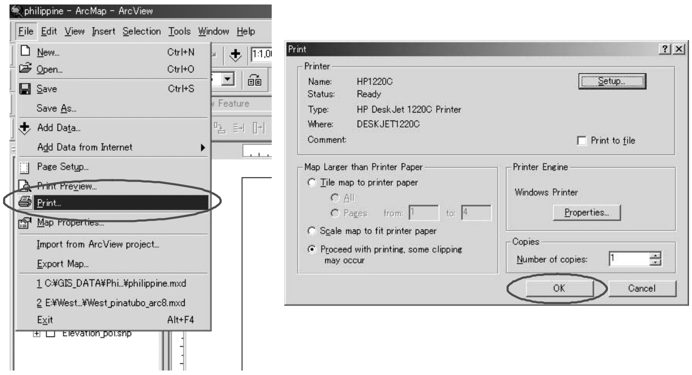


This is how to add a scale bar and North arrow on layout view.

On the Insert menu, click Scale bar. You can choose Scale bar that you need.

And then, On the Insert menu, click North Arrow. You can choose North Arrow that you like.

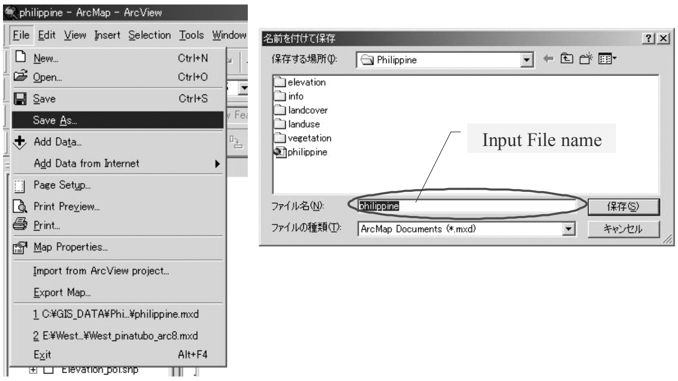
Printing a map



Click file menu and choose print. The print dialog box appears.

Click OK.

Saving a map



1. Click file menu and choose Save as.
2. Input new file name as you like.
3. Click save.

Tables

Table 1.3.1 Contents of GIS (1/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
Elevation1977line	contour line	Elevation	Elev	number	20.000 - 1740.000	530
Elev1977	Elevation1977	Elevation1977(m)	Value	number		10
River1977	River line	Name	Name	text		Mambog Creek
Basin1977	Basin1977	Id	Id	number		1
		Basin name in this study	Name	text		M2
		Area	Hectares	number		3959.841
Slope1977	Slope1977	Slope(degree)	gridcode	number		10
Coastline77	Coastline		Type	text		coast line
River_area1990	River area 1990	Id	Id	number		1
		Area(m2)	Area	number		906313
		Area(ha)	Area(ha)	number		91
vegetation	data from NIA	type of vegetation	type	text		Mangrove
Geology 1987	Geological map	Mapping symbol	description	text	QVP : Recent Allubium , Recent-Quaternary QV : Pyroclastic , Quaternary N3+Q1 : Quaternary volcanic rocks , Quaternary Ls : Unconsolidated conglomerate and agglomerate , Pliocene-Pleistocene N2 : Limestone , Miocene UC : Ultrabasic camplex , Cretaceous-Paleogene N2V : Andesite/basalt series , Cretaceous-Paleocene	R
		Area	Hectares	number		453.248
Elevation2002line	contour line	Elevation	Elev	number		530
Elev2002	Elevation2002	Elevation2002(m)	Value	number		10
River2002	River	River name	Name	text		Sto.Tomas
		Length	Length	number		4723
		Basin	Basin	text		S2
Basin2002	Basin 2002	Id	Id	number		1
		Basin name in this study	Name	text		M2
		Area	Hectares	number		3959.841
Slope2002	Slope2002	Slope(degree)	Value	number		10
Soil Class	degree of stability on slope area	Basin_name	Basin_name	text		M1
		Area_m2	Area_m2	number		206725
		condition	condition	text	Stable/Moderately Stable/unstable/River bank erosion area	unstable
Coastline02	Coastline		Id	number	1-5	1
Canal2002	Canal	id	id	number		0
River_area2002	River area 2002	Id	Id	number		1
		Area(m2)	Area	number		906313
Mountain area	classification of topography	Plain/Mountain/River	Type	text	Plain/Mountain/River, Plain=Slope<10 degrees	Plain
Damed lake	Damed lake by lahar deposits	Id	Id	number		1
		Area	Area	number		6868481
		Area(km2)	Area(km2)	number		6.8

Table 1.3.1 Contents of GIS (2/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
PHIVOLCS	Hazard map by PHIVOLCS	clacification	Hazard zone	text	Zone1 Areas at high susceptibility to lahars, sediment-laden stream flows and flash floods Zone2 Areas at moderate susceptibility to lahars, sediment-laden stream flows and flash floods, San Marcelino and San Narsico, was included. Zone3 Areas at low susceptibility to lahars, sediment-laden stream flows and flash floods, San Felipe and San Antonio was included. Zone4 Areas safe from lahars but prone to excessive siltation and flooding Zone5 Areas safe from lahars but prone to persistent (> 1 week) or recurrent floding And/or backlooding related to river processes involving the 1991 eruption deposits of Pinatubo Volcano	zone5
		Area	hectares	number		1061.489
Municipality_bnd	Municipality boundary	Id	Id	number	1-9	1
		Province name	Province	text		Zambales
		Municipality name	Municipality	text		Iba
		Area	hectares	number		17003.485
		number of population	population	number		34678
		number of house	House_nos	number		7260
Barangay_org	Basic information of barangay	Id	Id	number		1
		Municipality name	Name	text		Iba
		Barangay name	Barangay	text		San Aguatin
		Barangay ID	Id_new	number		70060
		Total Area(ha)	Hectares	number		200
		Plain Area(ha)	Plain_area	number		20
		Mountain Area(ha)	Mountain_are a	number		20
		River Area(ha)	River area	number		20
		Farmland Area(ha)	Fam_area	number		20
		Build-up Area(ha)	Build-up area	number		20
		Car road length(m)	Car_road(m)	number		20
		number of population	population	number		2000
		IRA(peso)	IRA(peso)	number		400000
		% of School children	% of Sch.Child	number		100
		Distance from Pob.(min)	Dis_from pob	number		10
Baran_analysis	Result of barangay analysis	Id	Id	number		1
		Municipality name	Name	text		Iba
		Barangay name	Barangay	text		San Aguatin
		Barangay ID	Id_new	number		70060

Table 1.3.1 Contents of GIS (3/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
Baran_analysis	Result of barangay analysis	Total score of PC analysis	Total	number	"-9999" : No data	0.052
		Ranking of PC analysis	Rank	number	"-9999" : No data	83
		Result of Cluster analysis	Class	number	1-6	1
		PC-1 score	Urban	number		0.2
		PC-2 score	Agri	number		0.3
		PC-3 score	Develop	number		1.2
		PC-4 score	Social	number		0.2
		PC-5 score	Educ	number		0.3
		PC-6 score	Gov	number		1.2
Landuse2002	Land-use from Topographic map in this study	Landuse	Legend	text	Build-up/Paddy/Up-land/Orchard/Fishpond/Swamp/lake	Build-up
Road77	Road from NMRIA map	Road condition	Type	text		Light_Surface_2_or_more_Lanes
Road2002	Road	National road/Not national road	Legend	text	National/Non-National	National
		Car road/Walk road	Legend2	text	Car/Walk	Car
Bridge	road bridge	Bridge type	type	text		Road_Bridge
Ex_dike	Existing dike in 2002	Id	Id	number	1-5	1
house	shape of house	Id	Id	number		0
house_pnt	point of house	x coordinate on PTM zone3	X	number		399810.86
		y coordinate on PTM zone3	Y	number		1665913.76
School	School data from topographic map and evacuation ce ter data	Municipality name	Municipality	text		Iba,Botolan, Cabangan, San Felipe, San Narciso, San Marcelino, San Antonio, Castillejos
		Barangay name	Barangay	text		San Rafael
		School name	Name of school	text		San Rafael Elem. Sch.
evac_center	EVACUATION CENTER DURING CALAMITIES (Department of Education, Region III Division of Zambales, Iba)	Municipality name	Municipality	text		Iba,Botolan, Cabangan, San Felipe, San Narciso, San Marcelino, San Antonio, Castillejos
		Barangay name	Barangay	text		San Rafael
		Evacuation center name	Name of school	text		San Rafael Elem. Sch.
		address of evacuation center	location	text		Brgy. San Rafael, San Felipe, Zambales
		longitude	x	number		120.55555
		latitude	y	number		14.99999
		elevation	elevation	number		25
		capacity	capacity	text		100 persons 3 rms used existing 9 rms. 5,466 sq. m.
		location of evacuation center	location_1	text		within the brgy.

Table 1.3.1 Contents of GIS (4/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
evac_center	EVACUATION CENTER DURING CALAMITIES (Department of Education, Region III Division of Zambales, Iba)	Storing against Emergency(Food, Water,etc. if any, quantities)	Storing	text	Water, Electricity, Lavatory	W: Ok, El:Ok, CR:OK, 1 unit/rm for evacuatuon: CR not available to the 3 room
		Utilized in (month, year and No. of Evacuees)	Utilized	text		1991 every flash flood almost yearly except this year
		Remarks (Budget, etc.)	remarks	text		3 room building needs basic facilities and repair
		Initial Assessment	initial	text		poor
		capacity of Cellular phone receiving	globe_no	number	1-4	1
		capacity of Cellular phone receiving	smart_no	number	1-4	1
Public_facility	public facility from NMRIA map	type of public facility	type	text	Church,school,office-municipality,cemetery,Mine_active	Church
Aeta	Aeta's village from interview	ID	ID	number		1
		Village name	Name	text		Naban
		Number of family	Family	number		33
CADC_CBFMA	Certificate of Ancestral Domain Clain-Community Based Forest Management Agreement	Id	Id	number		1
		Area name	Ancestral	number		Prop Ances. Dom. Claim of Batiawan
		area	Hectares	number		1843.662
ISFP	Integrated Social Forestry Program	Id	Id	number		1
		Project name	Project	number		CCFS Project of Binoclutan
		area	Hectares	number		71.69
Boring	Fiele survey boring point	point name	Name	text		SR-1
		longitude	X	number		402831.3546
		latitude	Y	number		1662704
		elevation	Z	number		27
		x coordinate on PTM zone3	Pxcenter	number		402831.355
		y coordinate on PTM zone3	Pycenter	number		1662703.753
Weather_obs	Obsavation point	longitude	X	number		120.3125
		latitude	Y	number		15.2405
		ID 2001	Station ID	text		flow-8
		ID 1994	id_94	text		8
		ID 1993	id_93	text		4
		Satation name	Name	text		Upper Bucao
		location	location	text		North-Northeast
		observation contents	Station	text		flow94
		management	Management	text		PAGASA
GWl_sample	souce from field survey in this study, point of groundwater quality analysis	well id	Sampling_p	text		1(15A)
		Barangay name	Barangay	text		San Rafael
		Municipality name	Municipality	text		San Marcelino
		latitude	N	number		14.9999

Table 1.3.1 Contents of GIS (5/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
GWl_sample	souce from field survey in this study, point of groundwater quality analysis	longitude	E	number		120.219999
		sampling date	Date	text		March 5,2003/3:30 pm
		x coordinate on PTM zone3	Pxcenter	number		415063.498
		y coordinate on PTM zone3	Pycenter	number		1656143.66
Gwl_well	for aguriculture well, souce from field survey in this study	Id	Id	text		1-A
		Province	Province	text		Zambales
		longitude	X	number		120.08995
		latitude	Y	number		15.281483
		Elevation from GPS	Elev_gps	number		30
		well age	Age	number		5
		Municipality name	Municipality	text		Botolan
		Barangay Name	Barangayname	text		Baquilan
		Elevation from DTM(this Study)	Elev_m	number		33.6
		Ground water level(elevation)	Gwl_el	number		25.6
		well depth(m)	well_depth	number		36.58
		Ground water level(Ground level -)	Gwldepth	number		8
Celpohone_result	Field survey result capacity of cellular phone	Municipality name	Municipality	text		San Felipe
		Barangay name	Barangay	text		Maloma
		kind of building	Item	text	Evacuation center, monitoring station, rain and water gage	WaterLevel RainGages
		Site name	Site_name	text		Maloma Bridge
		Location	Location	text		Along National Hi-way, Maloma, San Felipe, Zambales
		longitude	X	number		120.062417
		latitude	Y	number		15.1165
		intensity of Globe phone	Globe_no	number	1-4	4
		GSM Signal	Globe_sign	number		-72
		intensity of Smart phone	Smart_no	number	1-4	3
		GSM Signal	Smart_sign	number		-93
Soil sampling	Fiele survey point of soilsampling	ID number	ID	number	1-20	1
Lahar deposit	Lahar deposit along the river	Id	Id	number		1
		Area(m2)	Area	number		570641.7
		Total lahar depth in area	Depth	number		433
		Number of Total mesh(50mx50m) in area	Count	number		229
		Lahar dposit volume(Mil.m3)	Volume	number		1
Sttomas2y - 100y	inundation analysis result	inundation water depth	Value	number		0.1
Maloma2y - 100y	inundation analysis result	inundation water depth	Value	number		0.1
Bucao2y - 100y	inundation analysis result	inundation water depth	Value	number		0.1

Table 1.3.1 Contents of GIS (6/6)

File Name	definition	Attributes	field name	field type	value type / codes	value discription or example
NDVI	'Normalized Differential Vegetation Index' Satellite image analysis	NDVI value	Value	number	0-210	1
Landuse	Land-use Satellite image analysis	Gridcode	Value	number	1 Forest Area 2 Grass 3 Bareland 4 Cultivated area 5 Lahar floe deposit 6 River 7 Town 8 Pyroclastic flow deposits 9 Cloud 10 Cloud shadow 11 Sea Area 13 Suspended sea Area(Low-concentarated) 14 Suspended sea Area(MIddle-concentarated) 15 Suspended sea Area(HIgh-concentarated) 16 Resoivoir 17 Dammed lake	1
Riv_chg	River change Satellite image analysis	Gridcode	Value	number	1:exist deposit, 2:new deposit, 3:recovery area	1
Diversiondam	data from NIA	NIS area name	Nis_name	text		Sto. Tomas
		stracture name	Str_name	text		Diversion Dam
Checkgate	data from NIA	NIS area name	Nis_name	text		Bucao
		stracture name	Str_name	text		Intake
Intake_nia	Intake point , data from NIA	NIS area name	Nis_name	text		Sto. Tomas
		stracture name	Str_name	text		Checkgate (Barrage)
Exist_lateralanal	Existing lateral canal , data from NIA	Nis_name	Nis_name	text		Sto.Tomas
		Canal name	Canal_name	text		LATERAL B-1
		Stracture name	Str_name	text		Lateral
		Condition	Condition	text		use
Exist_maincanal	Existing main canal , data from NIA	Nis_name	Nis_name	text		Sto.Tomas
		Canal name	Canal_name	text		Main Canal
		Stracture name	Str_name	text		Main Canal
Proposed Canal	Proposed canal , data from NIA	Nis_name	Nis_name	text		Mapanuepe Lake Irrigation Project
		Canal name	Canal_name	text		Main Canal
		Stracture name	Str_name	text		Main Canal
Nis	National Irrigation system , data from NIA	Name	Nis_name	text		Sto. Tomas
		Type	Type	text		NIS
Nip	data from NIA	Name	Nip_name	text		Mapanuepe Lake Irrigation Project
		Type	Type	text		NIPP

Table 1.3.2 List of GIS Database (1/2)

No	dataname	Location	file format	reference year(source data)	item	data type	data source	base unit	amount	data unit	description
1. Bibliography											
	Bibliography	/Pinatubo_GIS/	Excel	this study		Table		-	-	-	List of collected documents
2. Map											
	Map 1977	/Pinatubo_GIS/Pinatubo_Map	Jpeg	1977		Image	NMARIA		7sheets		image
	Ortho Photo	/Pinatubo_GIS/Pinatubo_Map	Tiff	this study		Image	produced		40sheets		image
	Ortho Map	/Pinatubo_GIS/Pinatubo_Map	Tiff	this study		Image	produced		40sheets		image
	Topographic Map	/Pinatubo_GIS/Pinatubo_Map	Dwg	this study		Cad	produced		40sheets		
	DTM	/Pinatubo_GIS/Pinatubo_Map	Asc	this study		evaluate	produced		40 data	m	
	Cross Section	/Pinatubo_GIS/Pinatubo_Map	Dwg	this study		Cad	produced		102 section		
3. Natural Condition & Social Condition											
Natural Condition (Before Eruption)											
	Elevation1977line	/Pinatubo_GIS/natural_condition	Arc View	1977	Elevation	Polyline	produced from NMARIA Map			m	Contour map of elevation
	Elevation1977	/Pinatubo_GIS/natural_condition	Arc View	NMARIA Map(1977)	Elevation	Grid	produced from NMARIA Map	Mesh	1414×1406cells	m	50m Mesh elevation
	River1977	/Pinatubo_GIS/natural_condition	Arc View	NMARIA Map(1977)	River	Polyline	produced from NMARIA Map			-	
	Basin1977	/Pinatubo_GIS/natural_condition	Arc View	NMARIA Map(1977)	Basin	Polygon	produced from NMARIA Map		27basins	-	
	Slope1977	/Pinatubo_GIS/natural_condition	Arc View	NMARIA Map(1977)	Slope	Grid	produced from NMARIA Map	Mesh	1414×1406cells	degree	50m Mesh slop
	Coastline77	/Pinatubo_GIS/natural_condition	Arc View	NMARIA Map(1977)	Coastline	Polyline	produced from NMARIA Map			-	
	River_area1990	/Pinatubo_GIS/natural_condition	Arc View	1990	River Area	Polygon	Landsat			-	
	Vegetation	/Pinatubo_GIS/natural_condition	Arc View		Vegatation	Polygon	NIA			-	
	Geology1987	/Pinatubo_GIS/natural_condition	Arc View	1987	Geology data	Polygon	Bureau oh Soils and Water Management				
Natural Condition (After Eruption)											
	Elevation2002line	/Pinatubo_GIS/natural_condition	Arc View	this study	Elevation	Polyline	produced from TopoMap&OrthoPhoto			m	Contour map of elevation
	Elevation2002	/Pinatubo_GIS/natural_condition	Arc View	this study	Elevation	Grid	produced from DTM	Mesh	1201×1201cells	m	40m Mesh elevation
	River2002	/Pinatubo_GIS/natural_condition	Arc View	this study	River	Polyline	produced from TopoMap&OrthoPhoto				
	Basin2002	/Pinatubo_GIS/natural_condition	Arc View	this study	Basin	Polygon	produced from TopoMap&OrthoPhoto		27basins		
	Slope2002	/Pinatubo_GIS/natural_condition	Arc View	this study	Slope gradient	Grid	produced from DTM	Mesh	1201×1201cells	degree	40m Mesh Slope gradient
	Soil_class	/Pinatubo_GIS/natural_condition	Arc View	this study	degree of stability on slope area	Polygon	produced				
	Coastline02	/Pinatubo_GIS/natural_condition	Arc View	this study	Coastline	Polyline	produced from TopoMap&OrthoPhoto				
	Canal	/Pinatubo_GIS/natural_condition	Arc View	this study	Canal	Polyline	produced from TopoMap&OrthoPhoto				
	River_area2002	/Pinatubo_GIS/natural_condition	Arc View	this study	River Area	Polygon	produced from TopoMap&OrthoPhoto				
	Mountain_area	/Pinatubo_GIS/natural_condition	Arc View	this study	Plain/Mountain/River Area	Polygon	produced from DTM				
	Damed_lake	/Pinatubo_GIS/natural_condition	Arc View	this study	Damed_lake	Polygon	produced from TopoMap&OrthoPhoto				
	PHIVOLCS	/Pinatubo_GIS/natural_condition	Arc View	2002	Hazard map	Polygon	PHIVOLCS				
	Landsat Image1990	/Pinatubo_GIS/Analysis/Landsat	Tiff	this study	Satelite image	Image	produced from Landsat Analysis				
	Landsat Image1992	/Pinatubo_GIS/Analysis/Landsat	Tiff	this study	Satelite image	Image	produced from Landsat Analysis				
	Landsat Image1993	/Pinatubo_GIS/Analysis/Landsat	Tiff	this study	Satelite image	Image	produced from Landsat Analysis				
	Landsat Image2001	/Pinatubo_GIS/Analysis/Landsat	Tiff	this study	Satelite image	Image	produced from Landsat Analysis				
Social Condition											
	Administrative boundary										
	Municipality	/Pinatubo_GIS/social_condition	Arc View	1977	Municipality	Polygon	produced from NMARIA Map		7 Municipality		
	Barangay_org	/Pinatubo_GIS/social_condition	Arc View		Barangay	Polygon	Barangay Map		142 Barangay		
	Barangay_analysis	/Pinatubo_GIS/social_condition	Arc View		Barangay	Polygon	Barangay Map		100 Barangay		
	Landuse2002	/Pinatubo_GIS/social_condition	Arc View	this study	Landuse	Polygon	produced from TopoMap&OrthoPhoto				
	Infrastructure										
	Road77	/Pinatubo_GIS/social_condition	Arc View	1977	Road	Polyline	produced from NMARIA Map				
	Road2002	/Pinatubo_GIS/social_condition	Arc View	this study	Road	Polyline	produced from TopoMap&OrthoPhoto				
	Bridge	/Pinatubo_GIS/social_condition	Arc View	this study	Bridge	Polyline	produced from TopoMap&OrthoPhoto				
	Ex_dike	/Pinatubo_GIS/social_condition	Arc View	this study	Existing Dike	Polyline	produced from TopoMap&OrthoPhoto				
	Building distribution										
	House	/Pinatubo_GIS/social_condition	Arc View	this study	House	Polygon	produced from TopoMap&OrthoPhoto		53273Houses		
	House_pnt	/Pinatubo_GIS/social_condition	Arc View	this study	House	Point	produced from TopoMap&OrthoPhoto		53273 points		
	Public facilities distribution										
	School	/Pinatubo_GIS/social_condition	Arc View		School	Point	produced from TopoMap&OrthoPhoto		81 School		
	Public facility	/Pinatubo_GIS/social_condition	Arc View	1977	Public facility	Point	produced from NMARIA Map		213 points		
	Evac_center	/Pinatubo_GIS/social_condition	Arc View		Evacuation center	Point	Department of Education, Region III Division of Zambales, Iba				
	Aeta	/Pinatubo_GIS/social_condition	Arc View	this study	location of Aeta residencial place	Point	Produced from interview		21Area		
	CADC_CBFMA	/Pinatubo_GIS/social_condition	Arc View	this study	Certificate of Ancestral Domain Clain-Community Based Forest Management Agreement	Polygon					
	ISFP	/Pinatubo_GIS/social_condition	Arc View	this study	Integrated Social Forestry	Polygon					
4.Field Survey											
	Boring_point	/Pinatubo_GIS/Field_survey	Arc View	this study	Boring points	Point	Produced from Field Survey		13 points		
	weather_obs	/Pinatubo_GIS/Field_survey	Arc View	this study	Weather observation point	Point	Produced from Field Survey		61 points		
	Gwl_sample	/Pinatubo_GIS/Field_survey	Arc View	this study	Ground water sampling point	Point	Produced from Field Survey		6 points		
	Gwl_well	/Pinatubo_GIS/Field_survey	Arc View	this study	Ground water level examined	Point	Produced from Field Survey		46 points		
	Cellphone_result	/Pinatubo_GIS/Field_survey	Arc View	this study	capacity of cellular phone	Point	Produced from Field Survey		14 points		

Table 1.3.2 List of GIS Database (2/2)

No	dataname	Location	file format	reference year(source data)	item	data type	data source	base unit	amount	data unit	description
	soil sampling	/Pinatubo GIS/Field survey	Arc View	this study	Soil sampling point	Point	Produced from Field Survey		20points		
5.Analysis											
	Lahar deposit						produced from TopoMap&NMRIA map				
	Inundation Simulation Bucao River										
	Return Period 2years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 5years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 10years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 20years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 30years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 50years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 100years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Inundation Simulation Maloma River										
	Return Period 2years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 5years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 10years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 20years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 30years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 50years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 100years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Inundation Simulation Sto.Tomas River										
	Return Period 2years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 5years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 10years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 20years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 30years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 50years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Return Period 100years	/Pinatubo GIS/Analysis/inundation	Arc View	this study	water depth	Grid	produced from inundation simulation	Mesh	40m mesh	water depth(m)	
	Landsat Analysis										
	landuse1990	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	Landuse1990	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	landuse1992	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	Landuse1992	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	landuse1993	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	Landuse1993	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	landuse2001	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	Landuse2001	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	ndvi1990	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	NDVI1990	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	ndvi1992	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	NDVI1992	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	ndvi1993	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	NDVI1993	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	ndvi2001	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	NDVI2001	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	riv chg0193	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	River Change from 1993 to 2001	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	riv chg9290	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	River Change from 1990 to 1992	Grid	produced from Landsat Analysis	Mesh	30m mesh		
	riv chg9392	/Pinatubo GIS/Analysis/Landsat	Arc View	this study	River Change from 1992 to 1993	Grid	produced from Landsat Analysis	Mesh	30m mesh		
6.NIA											
	Proposed canal	/Pinatubo GIS/NIA	Arc View		Proposed canal	Polyline	NIA				
	Nis	/Pinatubo GIS/NIA	Arc View		Nis	Polygon	NIA		2 polygon		
	Nip	/Pinatubo GIS/NIA	Arc View		Nip	Polygon	NIA		1 polygon		
	Intake nia	/Pinatubo GIS/NIA	Arc View		Intake	Point	NIA		6 point		
	Exist mailcanal	/Pinatubo GIS/NIA	Arc View		Exist Mail Canal	Polyline	NIA				
	Exist lateralcanal	/Pinatubo GIS/NIA	Arc View		Exist Lateral Canal	Polyline	NIA				
	Diversiondam	/Pinatubo GIS/NIA	Arc View		Diversion Dam	Point	NIA		2 point		
	Checkgate	/Pinatubo GIS/NIA	Arc View		Check gate	Point	NIA		2 point		

Table 2.2.1 Result of Principal Component Analysis (1/2)

Municipality Name	Barangay Name	Degree of Urbanization	Suitability on Agriculture	Accessibility for Development	Sufficiency of Social Infrastructure	Accessibility to Education Opportunities	Degree of Subsidence from Government	Total score	Ranking	Cluster result
Botolan	Bancal	1.28	0.69	-1.40	-0.45	0.20	-0.35	0.34	40	1
Botolan	Bangan	-0.67	-0.74	-0.26	-2.70	-1.27	1.00	-0.67	108	3
Botolan	Batonlapoc	0.83	1.01	-0.89	0.10	0.21	-0.76	0.36	37	1
Botolan	Belbel	-4.76	-1.76	-1.24	1.34	0.77	-1.27	-1.84	116	1
Botolan	Beneg	1.44	0.26	-0.55	-0.81	0.57	-0.53	0.36	38	1
Botolan	Binuclutan	-1.68	-0.12	0.15	0.34	0.74	0.85	-0.37	103	1
Botolan	Burgos	-4.18	-1.86	-1.81	1.29	0.86	-0.82	-1.73	115	1
Botolan	Cabatuan	-3.97	-1.57	-1.09	1.26	1.23	-0.66	-1.49	113	1
Botolan	Capayawan	1.35	0.07	-1.34	-0.56	0.43	-0.24	0.23	46	1
Botolan	Carael	0.52	1.23	0.42	-0.15	0.49	0.08	0.51	22	1
Botolan	Danacbunga	0.40	0.91	0.74	-0.55	0.67	-0.10	0.41	33	1
Botolan	Maguisguis	-6.27	-1.63	-0.49	-0.94	-3.04	-1.26	-2.62	122	3
Botolan	Malomboy	-3.34	0.12	1.75	0.35	1.40	-1.47	-0.71	109	4
Botolan	Mambog	-1.82	0.77	0.39	1.30	1.09	-1.12	-0.18	91	4
Botolan	Moraza	-5.63	-2.00	-1.45	1.43	-0.43	-1.52	-2.26	121	1
Botolan	Nacolcol	-4.33	-2.18	-2.08	-0.48	-2.38	2.03	-2.10	117	3
Botolan	Owaog-Nebloc	-3.80	-2.06	-2.23	2.16	0.80	0.86	-1.54	114	1
Botolan	Paco	1.58	-0.84	0.79	-0.85	0.58	-0.80	0.27	43	1
Botolan	Palis	-5.04	-2.42	-2.65	2.23	0.35	-0.42	-2.13	118	1
Botolan	Panan	-2.64	-0.30	1.06	-0.18	0.64	0.60	-0.66	107	4
Botolan	Parel	0.69	0.01	-1.18	-0.05	0.90	-0.22	0.12	59	1
Botolan	Paudpod	1.33	1.97	-1.33	1.43	-0.47	0.63	0.83	9	2
Botolan	Poonbato	-5.42	-1.19	0.86	-2.12	-3.34	-0.09	-2.18	119	3
Botolan	Porac	-1.68	0.32	1.51	0.01	0.89	0.68	-0.15	88	4
Botolan	San Isidro	1.17	0.59	-0.65	-0.50	0.58	-0.17	0.40	34	1
Botolan	San Juan	-2.72	0.74	1.95	0.89	0.12	0.66	-0.28	98	4
Botolan	San Miguel	0.76	0.61	-1.91	-1.96	-1.98	-0.20	-0.16	90	3
Botolan	Santiago	1.21	1.88	-0.24	0.02	0.14	-0.68	0.74	13	2
Botolan	Tampo	1.54	0.90	-1.12	-0.49	0.33	-0.48	0.49	25	1
Botolan	Taugtog	-1.84	0.96	3.81	-0.26	1.38	0.84	0.23	47	4
Botolan	Villar	-6.02	-1.61	-0.15	0.97	-0.14	-2.39	-2.21	120	1
San Felipe	Amagna	0.96	-0.27	1.31	0.21	0.59	0.61	0.45	28	4
San Felipe	Apostol	0.58	3.20	1.26	1.53	-0.56	0.20	1.17	4	2
San Felipe	Balincaguing	0.93	0.74	-0.70	0.11	0.49	0.45	0.44	31	1
San Felipe	Faranal	-0.91	-0.45	0.46	-0.60	1.23	0.56	-0.26	97	1
San Felipe	Feria	-1.39	-0.03	-0.31	0.46	0.99	0.02	-0.34	101	1
San Felipe	Maloma	-2.74	3.14	4.19	1.85	-1.43	0.00	0.47	26	6
San Felipe	Manglicmot	-0.04	1.19	1.33	0.49	0.68	1.13	0.56	19	4
San Felipe	Rosete	-1.71	-0.68	0.22	-0.18	1.22	0.93	-0.51	105	1
San Felipe	San Rafael	0.33	0.30	-0.06	-1.20	1.05	-0.57	0.10	65	1
San Felipe	Sindol	-0.59	0.96	0.41	-0.53	-1.07	1.25	0.05	71	2
San Felipe	Sto.Nino	0.35	-0.58	2.07	-1.27	1.22	-0.37	0.15	56	4
Cabangan	Anonang	0.15	0.74	-1.14	0.36	0.18	0.16	0.14	57	1
Cabangan	Apo-Apo	0.92	-0.44	-1.51	-1.88	-1.37	0.72	-0.22	93	3
Cabangan	Arew	0.73	-0.05	-0.99	-0.53	0.66	-0.62	0.06	69	1
Cabangan	Banuanbayo(pob.)	1.39	-2.09	-1.39	1.40	0.46	2.61	0.05	70	1
Cabangan	Cadmang-Reserva	-1.36	-0.79	-0.33	-0.10	1.51	-0.07	-0.53	106	1
Cabangan	Camiing	0.29	-0.10	-0.27	-0.78	0.68	-0.47	-0.02	79	1
Cabangan	Casabaan	1.59	-0.75	-1.31	-0.67	-0.16	-0.16	0.06	68	1
Cabangan	Del carmen	0.84	-1.53	-1.01	0.32	0.96	1.78	-0.04	80	1
Cabangan	Dolores	0.30	1.55	-1.44	1.16	-0.16	-0.36	0.37	36	2
Cabangan	Felmida-Diaz	0.23	-0.54	-2.03	0.72	0.84	0.17	-0.15	89	1
Cabangan	Laoag	-0.09	0.37	-1.05	0.79	1.08	-1.00	0.03	72	1
Cabangan	Lomboy	1.15	0.18	-1.60	-0.20	0.01	0.51	0.21	49	1
Cabangan	Longos	-0.07	0.41	-0.79	0.33	0.57	0.39	0.08	66	1
Cabangan	Mabanglit	0.03	0.59	-1.04	-1.46	-1.20	-0.13	-0.18	92	3
Cabangan	New San Juan	-1.08	-0.91	-0.33	-0.18	1.43	0.38	-0.46	104	1
Cabangan	San Antonio	0.86	-0.43	-0.69	-0.54	0.92	0.38	0.11	62	1
Cabangan	San Isidro	1.00	1.17	-0.19	-0.39	0.47	-0.38	0.52	21	1
Cabangan	San Juan(pob)	-0.84	-0.58	0.40	-0.76	1.37	0.49	-0.28	99	1
Cabangan	San Rafael	0.04	-0.33	-0.89	-0.28	0.58	0.91	-0.10	87	1
Cabangan	Sta.Rita	0.44	0.00	-0.10	-0.73	0.89	-0.08	0.11	61	1
Cabangan	Sto.Nino	-0.33	-0.25	-0.47	-1.79	-0.69	1.08	-0.35	102	3
Cabangan	Tondo	1.08	-0.30	-1.18	-0.79	0.15	-0.86	0.01	76	1
San Narciso	Alusiis	0.52	0.55	-0.69	0.22	0.94	-0.92	0.24	45	1
San Narciso	Beddeng	1.27	5.24	2.13	2.32	-1.48	-0.63	1.90	1	6
San Narciso	Candelaria	2.41	-2.63	0.52	0.14	-0.24	-0.56	0.10	64	1

Table 2.2.1 Result of Principal Component Analysis (2/2)

Municipality Name	Barangay Name	Degree of Urbanization	Suitability on Agriculture	Accessibility for Development	Sufficiency of Social Infrastructure	Accessibility to Education Opportunities	Degree of Subsidence from Government	Total score	Ranking	Cluster result
San Narciso	Dallipawen	1.67	3.09	-1.89	1.58	-1.12	-0.79	1.03	6	2
San Narciso	Grullo	0.95	2.30	0.08	0.49	-0.23	-0.45	0.83	10	2
San Narciso	La Paz	1.68	-1.26	0.18	3.66	-0.01	5.23	0.82	11	1
San Narciso	Libertad	3.44	-5.28	1.68	1.45	-1.06	-0.63	-0.04	81	5
San Narciso	Namatacan	1.29	2.91	-0.46	0.51	-1.20	-0.50	0.95	7	2
San Narciso	Natividad	0.78	0.41	0.19	-0.42	0.82	0.26	0.38	35	1
San Narciso	Omaya	-1.83	0.23	-0.02	1.06	0.31	1.02	-0.31	100	1
San Narciso	Paite	1.51	2.69	-2.03	2.52	-1.50	1.08	1.03	5	2
San Narciso	Patro cinio	0.99	0.98	0.40	-0.55	0.59	-0.32	0.54	20	1
San Narciso	San Jose	3.52	-5.60	1.58	1.87	-1.15	-0.71	-0.08	86	5
San Narciso	San Juan	0.78	-0.13	-0.24	-0.66	0.64	0.05	0.16	55	1
San Narciso	San Pascual	0.84	0.20	-0.35	-0.47	0.31	-1.25	0.17	53	1
San Narciso	San Rafael	1.50	-0.98	0.13	-0.65	0.43	-0.35	0.17	51	1
San Narciso	Simminublan	1.63	4.87	-0.24	2.56	-1.78	-1.29	1.63	2	6
Castillejos	Buenayista	0.67	2.72	-2.27	2.44	-0.88	-1.52	0.66	14	2
Castillejos	Looc	0.86	1.19	-0.49	-0.34	0.10	-0.19	0.44	29	1
Castillejos	Magsaysay	0.71	1.37	0.97	-0.80	0.18	-0.06	0.57	18	1
Castillejos	Nagbayan	0.50	1.29	0.16	-0.21	0.11	0.00	0.46	27	1
Castillejos	Nagbunga	1.13	-0.03	-0.39	-0.82	0.47	-0.07	0.24	44	1
Castillejos	San Agustin	0.71	1.14	1.68	-0.60	0.75	-0.25	0.64	16	1
Castillejos	San Jose	0.70	0.51	0.87	-0.48	0.83	0.13	0.44	30	1
Castillejos	San Juan	1.52	-0.89	-0.52	0.01	0.31	-0.05	0.19	50	1
Castillejos	San Nicolas	0.51	-0.60	0.34	-2.55	-1.14	0.06	-0.25	96	3
Castillejos	San Pablo	-2.79	1.13	3.93	-0.21	0.71	0.45	-0.06	84	4
Castillejos	San Roque	1.26	-1.95	0.64	-0.13	0.55	0.12	0.01	73	1
Castillejos	Sta.Maria	1.20	0.25	-0.28	-0.87	0.53	-0.39	0.32	42	1
Iba	Dirita	0.47	1.95	1.30	-0.95	-0.65	0.11	0.62	17	2
Iba	Lipay Dingin	0.57	-0.46	0.43	-0.92	0.95	-0.27	0.08	67	1
Iba	Palanginan	0.35	3.58	3.50	0.88	-0.26	-0.24	1.38	3	6
Iba	Sta Barbara	0.03	1.97	1.27	0.44	0.23	-0.39	0.65	15	2
Iba	Sto Rosario	0.50	-0.94	1.07	-1.01	0.75	-1.05	-0.05	83	1
Iba	Zone1	1.12	-0.66	0.23	-0.59	0.79	-0.66	0.16	54	1
Iba	Zone2	4.27	-6.01	2.09	1.50	-1.54	-1.56	0.00	78	5
Iba	Zone3	3.38	-4.92	0.72	1.85	-1.00	0.26	0.01	77	5
Iba	Zone4	3.90	-5.44	1.37	1.62	-1.32	-0.80	0.01	75	5
Iba	Zone5	2.78	-4.07	2.05	0.34	-0.43	-1.17	0.01	74	5
Iba	Zone6	1.25	-0.41	-0.94	0.04	0.54	0.19	0.21	48	1
San Marcelino	Aglao	-2.93	-0.94	0.40	-1.56	-0.14	0.47	-1.15	111	3
San Marcelino	Buhawen	-2.84	-1.26	0.41	-1.14	-0.08	1.44	-1.10	110	3
San Marcelino	Burgos	0.47	-0.18	0.59	-0.73	1.00	0.12	0.17	52	1
San Marcelino	Central(pob.)	2.09	-3.61	0.75	0.04	-1.44	0.49	-0.23	94	5
San Marcelino	Consuelo Norte	0.68	0.45	-0.51	-1.36	-0.45	0.38	0.12	60	3
San Marcelino	Consuelo Sur	1.25	-1.24	0.09	-1.23	-0.66	0.14	-0.06	85	3
San Marcelino	La Paz	1.11	0.16	-0.96	-1.32	-0.64	0.18	0.11	63	3
San Marcelino	Laoag	-0.06	0.57	0.33	-0.73	0.49	0.00	0.12	58	1
San Marcelino	Linasin	0.90	0.67	0.07	-1.16	0.25	-0.26	0.33	41	1
San Marcelino	Linusungan	1.40	2.53	-1.03	-0.07	-1.33	-0.49	0.77	12	2
San Marcelino	Lucero	0.58	-0.30	-0.11	-1.29	-0.44	0.18	-0.05	82	3
San Marcelino	Nagbunga	0.91	2.06	0.51	0.80	0.06	0.55	0.91	8	2
San Marcelino	Rabanes	0.22	1.57	0.08	0.44	-0.57	0.98	0.50	23	2
San Marcelino	Rizal	1.14	1.02	-1.16	-0.65	-1.01	0.45	0.34	39	2
San Marcelino	San Guillermo	1.37	1.40	-1.50	-0.56	-1.26	0.14	0.43	32	2
San Marcelino	San Isidro	1.16	1.64	-0.70	-0.87	-1.09	-0.04	0.49	24	2
San Marcelino	San Rafael	-2.56	0.92	1.60	1.07	0.09	0.27	-0.24	95	4
San Marcelino	Sta.Fe	-4.81	0.06	2.23	-0.89	-3.53	0.78	-1.42	112	3

Table 2.2.2 Hypothetical Condition and Estimated Effect on the Principal Components Analysis

Municipality Name	Barangay Name	Farm Land(ha)	Farm Land(ha) Proposed	Difference (ha)	Road(car)	Road(car) Proposed	Difference (m)	Distance to Pob(min)	Distance to Pob(min) proposed	Difference (min)	Present Point	Case1 difference of Point	Case2 difference of Point	Case3 difference of Point	Present Ranking	Case1 Ranking(to Present)	Case2 Ranking(to Present)	Case3 Ranking(to Present)
Botolan	Belbel	0	48	48	0	0		315	142	-173	-1.84	0.14	0.30	0.43	116	1	2	3
Botolan	Binuclutan	68	109	41	10896	10896		20	20		-0.37	0.11	0.00	0.11	103	5	0	5
Botolan	Burgos	0	104	104	0	4710	4710	333	71	-262	-1.74	0.36	0.51	0.87	115	3	3	5
Botolan	Cabatuan	0	29	29	0	0		138	101	-37	-1.49	0.09	0.06	0.15	113	1	0	1
Botolan	Maguisguis	0	544	544	0	0		340	103	-237	-2.62	1.09	0.40	1.49	122	8	1	11
Botolan	Malomboy	37	229	192	19183	30842	11660	88	37	-51	-0.70	0.31	0.24	0.55	109	5	5	20
Botolan	Mambog	175	197	22	16763	16763		10	10		-0.18	0.05	0.00	0.05	91	3	0	3
Botolan	Moraza	0	281	281	0	3126	3126	458	85	-373	-2.27	0.87	0.68	1.54	121	9	6	11
Botolan	Nacolcol	0	229	229	0	332	332	434	90	-344	-2.11	0.99	0.59	1.58	117	6	3	11
Botolan	Owaog-Nebloc	0	96	96	0	4107	4107	191	56	-135	-1.55	0.51	0.29	0.80	114	4	2	4
Botolan	Palis	0	149	149	0	0		535	211	-324	-2.14	0.71	0.55	1.26	118	5	3	8
Botolan	Panan	76	217	141	3997	3997		20	20		-0.66	0.26	0.00	0.26	107	3	0	3
Botolan	Poonbato	0	564	564	0	20969	20969	295	66	-229	-2.18	0.94	0.67	1.62	119	7	5	12
Botolan	Porac	50	108	58	24516	24516		15	15		-0.14	0.11	0.00	0.11	88	8	0	8
Botolan	San Juan	172	381	209	22396	23264	868	10	10		-0.27	0.36	0.01	0.37	98	32	0	33
Botolan	Taugtog	98	118	20	24199	24199		10	10		0.24	0.03	0.00	0.03	44	1	0	1
Botolan	Villar	0	149	149	0	3648	3648	458	76	-382	-2.20	0.27	0.70	0.97	120	3	6	8
San Felipe	Apostol	345	352	7	42755	42755		5	5		1.17	0.02	0.00	0.02	4	0	0	0
San Felipe	Faranal	26	37	10	5041	5041		5	5		-0.26	0.03	0.00	0.03	97	3	0	3
San Felipe	Feria	85	99	14	6274	6274		10	10		-0.34	0.04	0.00	0.04	101	1	0	1
San Felipe	Maloma	511	891	380	40800	40800		15	15		0.49	0.58	0.00	0.58	26	21	0	21
San Felipe	Rosete	22	40	18	5012	5012		5	5		-0.51	0.05	0.00	0.05	105	1	0	1
San Felipe	Sindol	124	133	9	28671	28671		5	5		0.05	0.02	0.00	0.02	70	2	0	2
Cabangan	Anonang	113	116	2	6166	6166		10	10		0.14	0.01	0.00	0.01	57	0	0	0
Cabangan	Cadmang-Reserva	6	28	22	2810	2810		35	35		-0.53	0.06	0.00	0.06	106	1	0	1
Cabangan	Dolores	211	226	15	2701	2701		10	10		0.36	0.05	0.00	0.05	36	3	0	3
Cabangan	Longos	91	98	7	7270	7270		10	10		0.08	0.03	0.00	0.03	67	2	0	2
Cabangan	Mabanglit	130	131	1	3733	3733		15	15		-0.19	0.00	0.00	0.00	92	0	0	0
Cabangan	San Juan(pob)	10	14	4	3180	3180		10	10		-0.28	0.01	0.00	0.01	99	1	0	1
Cabangan	San Rafael	37	43	6	3396	3396		10	10		-0.10	0.03	0.00	0.03	87	1	0	1
Cabangan	Sta.Rita	57	58	1	3485	3485		10	10		0.11	0.00	0.00	0.00	61	0	0	0
Cabangan	Sto.Nino	29	31	2	8258	8258		10	10		-0.35	0.01	0.00	0.01	102	0	0	0
San Narciso	Omaya	107	141	33	12782	12782		25	25		-0.31	0.10	0.00	0.10	100	7	0	7
Castellejos	San Pablo	158	300	142	21763	21763		20	20		-0.04	0.21	0.00	0.21	81	28	0	28
San Marcelir	Aglao	0	110	110	0	0		115	115		-1.15	0.21	0.00	0.21	111	1	0	1
San Marcelir	Buhawen	0	48	48	0	0		85	85		-1.10	0.11	0.00	0.11	110	0	0	0
San Marcelir	San Rafael	72	171	99	47979	47979		15	15		-0.23	0.20	0.00	0.20	95	15	0	15
San Marcelir	Sta.Fe	76	1103	1027	21267	36070	14803	45	45		-1.41	1.83	0.20	2.04	112	79	0	95