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Attributes Classification for Elaborating the Information of Digital and Imaging Mapping

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***Abstract*— The rapid development of information has made it possible for everyone to obtain the latest information, complete and accurate, in real time, anytime, anywhere, all over the world. Any information is fine catching up by updated with the latest news and even detailed information on local conditions. With the same analogy, detailed information regarding land utilization, land containing, landscape provision, earth surface contour, etc., are required to inform and elaborate any appropriate decision needed. The Geographic information systems (GIS) is a recent technology commonly used by research in earth science to facilitate many layered detail information by one way to get up-to-date, detailed information. In this research, the GIS utilizes several types of imaging data such remote sensing images and digitize images. As the name suggests, this system captures detailed geographic information about a location or region. By inputting classified images of remote sensing results into a GIS database at regular intervals (adjusted as necessary, such as every year, every two years, every three years, etc.), the number of information sources that can be obtained increases. There are several reasons for that. First, remote sensing images are images that cover the entire surface of the Earth. Next, remote sensing images are images that contain information about the state of the earth's surface. Third, a variety of information can be obtained by performing appropriate image processing. Furthermore, this research could be elaborated by implementing an artificial intelligent algorithm to create a robust outcome.**

***Keywords*— Classification; image processing; imaging mapping; digital mapping.**

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I. Introduction

Some of the definitions of GIS have been put forward by experts. In general, GIS is a computer-based system to store and manipulate geographical information [1], [2], [3]. Geographic Information Systems are designed to collect, store, and analyses objects and phenomena in a geographical location that are important or critical to be analyzed [4], [5], [6]. Thus, a Geographic Information System is a computer system that has the following four capabilities in handling geographic reference data: inputting, managing (data storing and recalling), analyzing and manipulating, and outputting data [7], [8], [9]. GIS, as a computer-based system, must contain digital data [10], [11], [12]. More specifically, this digital GIS data is called spatial data. Spatial data is data with spatial reference [13], [14], [15]. It means that the measured data has a Geo-referenced or a location reference, whether it works with a standard system (coordinate system, reference area, or certain projections), or a local system [16], [17], [18]. Besides, the spatial data includes thematic information such as soil, water, land, forests, even spatially presented (mapped) socioeconomic data: population density, distribution of economic activities, and so on [19], [20], [21].

II. Materials and Method

There are two components of data taken for GIS: the graphic data component, and the non-graphic data component [22], [23], [24]. Both data components are in digital form. The two data components have specific characteristics, and each requires different handling in storing efficiency, processing, and outputting [25], [26], [27]. Graphical data in GIS is a digital statement of map elements or elements being mapped. Thus, the map principles defining the elements of cartography must be implemented correctly [28], [29], [30]. In GIS, graphic data is used in such a way that it can visualize maps or cartographic images on the monitor screen (soft copy), on hard copy paper, or other select-able presenting media [31], [32], [33]. Graphic data of GIS consists of two digital data formats: vector data format and raster data format. In the vector data format, the output of objects is in points or line segments. Whereas in the raster data format, all outputs of the objects are in the form of cells called pixels [34], [35].

Non-graphic data is a representation of nature/characteristics, quality, or spatial relationship between map elements and geographic locations [36], [37]. Non-graphic data is also called textual data or attribute data [38]. This data is taken separately from the GIS management system or directly by the system managing the GIS [39]. The relationship between graphic data and non-graphic data must be maintained in a GIS. A common way to link between the two is by giving identities (Id) and stored them in the system simultaneously. Identity (Id) is uniquely made, for example in the form of a systematic code number. One of the GIS functions is to improve the ability of integrated spatial analysis. The analysis tools include aggregation, classification, measurement, overlays, buffering, networks, and map algebra [40]. The GIS analysis function is shown in Figure 1.

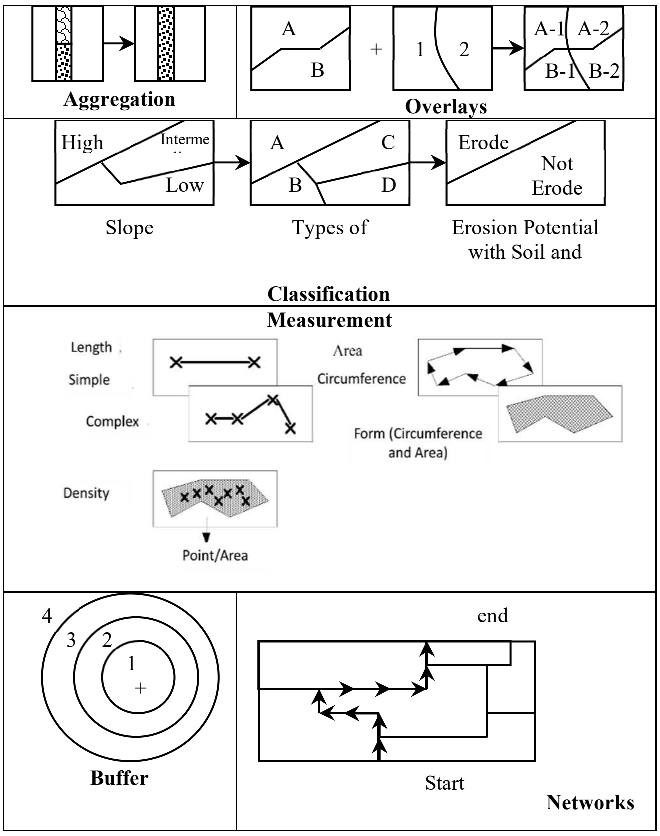

Fig. 1 Spatial Analysis in GIS

Before digitizing, it is necessary to establish a coordinate system to be used. In this study, all digital maps are in the UTM (Universal Transverse Mercator) coordinate system. The stages of digitizing using MapInfo software are as follows: Place the map sheet on the digitizing table, Set the projection to UTM 48 south zone, because the study area uses that projection, inputting the four map control points (tic), and digitize the features on the map. In general, the data processing flowchart in GIS can be seen in Fig.2.

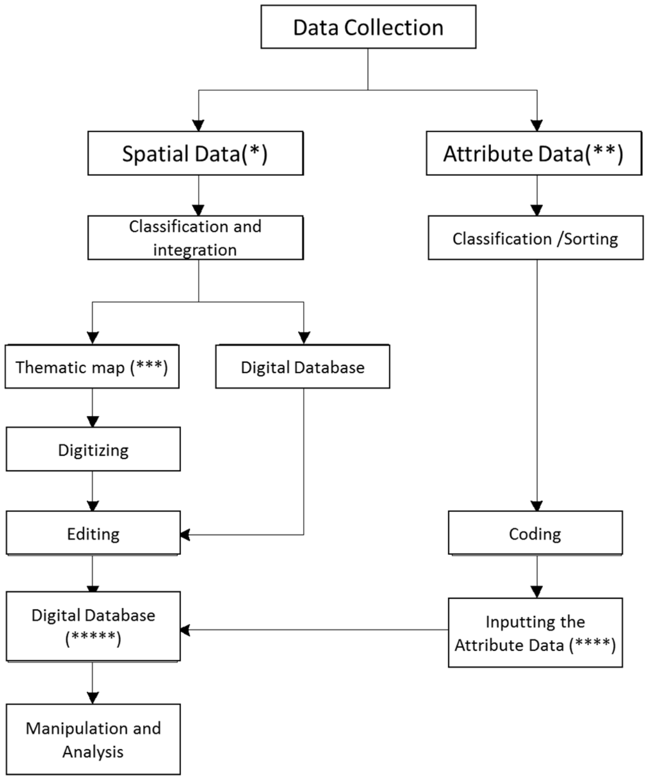

Fig. 2 Data Processing Flowchart in General

Description:
(*) = 1: 50,000 scale maps that have not been digitized
(**) = Table data such as population, pollutant concentration, etc.
(***) = 1: 50,000 scale maps such as land use maps, river flow pattern maps, etc., which have not yet been digitized

III. Results and Discussion

The editing process through three ways to edit digitally generated data:

1) *Combining objects, with following stages:*

a. Select an object from the layer as a target.
b. Select set target to define the target as the only edited target.
c. Select other objects to be combined.
d. Both objects are combined with the combine command in the Objects menu bar.

2) *Separating objects:*

a. Select an object from the layer as a target.
b. Select set target.
c. Select another object as a reference for separation.
d. Choose to split from bar Objects menu.

3) *Erasing Object:*

a. Select an object from the layer as a target.
b. Select set target.
c. Select another object as a reference for separation.
d. Choose Erase from bar Objects menu.

A. Inputting the Data Attribute

Attribute data (non-graphic data) is a tabular data file that is added for analysis and manipulation purposes. Besides, it provides information about graphic data. The types of attribute data are adjusted as the needs of the study. In this study, the type of attribute data needed are as follows:

- Attribute data of land use.
- Attribute data of Subdistrict administration.
- Attribute data of river basin.
- Attribute data of pollutant measurement point.
- Attribute data of simulation point.
- Attribute data of river.
- Attribute data of the Ciliwung River Basin Spatial Plan

Each attribute data classification above is adjusted to the classification in each of the graphic data. The process of inputting attribute data is done interactively through a keyboard.

1) Attribute Data of Land Use:

The land use attribute database obtained from the digital land use map is in Table 1.

TABLE I
ATTRIBUTES CLASSIFICATION OF LAND USE FOR ELABORATING THE INFORMATION

NID	Area	ID
L176	0.6627	Residences
L177	0.2027	Residences
L178	0.7773	Residences
L142	1.1756	Residences
L118	0.8271	Reeds
L042	0.2084	Mixed garden
L011	0.1543	Residences
L043	0.2188	Forest
L012	1.7750	Forest
L119	1.4061	Plantation
L044	2.0790	Bushes

Explanation:
NID=feature classification number; AREA=feature area (km^2); ID=Land use.

2) Attribute data of subdistrict administration:

In the subdistrict administration attribute database, there is an addition on the population density attribute (KPDT_PDD_JIWA), and the number of population attributes (JMLH_PDD_JIWA) into the district administrative digital map attribute data. The attributes of the addition can be seen in Table 2.

TABLE II
ATTRIBUTES CLASSIFICATION OF SUBDISTRICT FOR ELABORATING THE INFORMATION

NID	ID	Area	Density	Population
A20	SD_1	5.37898	5800	31198
A61	SD_2	4.38557	37909	166253
A04	SD_3	39.0877	895	34984
A13	SD_4	6.68464	552	3690
A29	SD_5	4.69846	2210	10384
A34	SD_6	18.1645	2787	50624
A35	SD_7	2.1001	9163	19243
A36	SD_8	24.4566	7159	175085
A40	SD_9	3.39411	4997	16960

Explanation:
NID=feature classification number; ID=feature's name; AREA=feature area (km^2); DENSITY=Population Density (Person); POPULATION=Population Number feature (Person).

3) Attribute data of River Basin:

Database of River Basin attributes, an attribute data from the digital map of watershed boundary, can be seen in Table 3.

TABLE IIII
ATTRIBUTES CLASSIFICATION OF WATERSHED FOR ELABORATING THE INFORMATION

Watershed	Area
3	24,8912
4	15,7066
7	22,0644
2	46,8946
8	34,9625
1	26,5904
5	6,6883
6	29,1183
10	44,9274
11	14,7069
12	40,2857
9	50,8741

Explanation:
WATERSHED=Watershed number feature; AREA = area feature (km^2).

4) Attribute data of pollutant measurement point:

Pollutant measurement point attribute database obtained from the digital map of measurement point 1 by entering temperature measurement data (TEMP) attributes, BOD pollutant measurement data (BOD_PPM), COD pollutant (COD_PPM), and NH4 pollutants (NH4_PPM) as in Table 4.

TABLE IIIV
ATTRIBUTES CLASSIFICATION OF POLLUTANT MEASUREMENT FOR ELABORATING THE INFORMATION

CODE	SEG	TEMP	BIO	CHEM	AMON
C-1	UPPER	21.80	2.7900	12.5700	0.0690
C-2	UPPER	23.80	2.1700	19.5200	0.0460
C-3	UPPER	23.40	2.8100	7.5900	0.4760
C-4	UPPER	25.70	2.3500	16.4800	0.6660
C-5	UPPER	28.10	1.5400	14.1000	0.1800
C-6	HULU	24.90	0.0000	0.0000	0.0000
C-7	UPPER	27.10	1.1800	19.5200	0.6560
C-8	UPPER	27.60	5.2900	22.9800	0.2320
C-9	UPPER	28.50	2.2300	16.2600	0.6560
C-10	MID	25.60	4.6700	39.0500	0.3560
C-11	MID	27.60	0.0000	0.0000	0.0000
C-12	MID	27.70	0.0000	0.0000	0.0000
C-13	MID	29.00	3.8800	17.3400	0.5040
C-14	MID	29.00	3.1300	38.5900	0.3790
C-15	MID	29.40	4.6400	26.0200	1.1880
C-16	MID	27.70	0.0000	0.0000	0.0000
D-30	DOWN-STREAM	20.00	75.7700	100.6200	0.0000
D-29	DOWN-STREAM	20.00	28.4000	45.8300	0.0000
D-3	DOWN-STREAM	20.00	18.8500	36.6200	1.6200
D-2A	DOWN-STREAM	20.00	16.9800	30.1800	1.3500
D-2	DOWN-STREAM	20.00	12.4800	26.1800	0.5100
D-1	DOWN-STREAM	20.00	15.4000	25.7500	0.3400

Explanation:
CODE=feature code; SEG=feature segment on Ciliwung River Basin; TEMP=temperature measurement (°C); BIO =BOD load (gram/liter); COD_PPM=COD load (gram/liter); AMON =NH4 load (gram/liter)

5) Attribute data of simulation point:

The database of the simulation points of the watershed is the attribute data from the digital map of the watershed boundary, as in Table 5.

TABLE V

ATTRIBUTES CLASSIFICATION OF SIMULATION POINT FOR ELABORATING THE INFORMATION

Point	Length
P1	113
P5	106
P6	102
P2	111
P3	109
P7	81
P8	74
P9	54
P4	107
P10	16
P11	-

Explanation:
POINT=*feature code;* LENGTH=*feature* distance from estuary (km).

6) Attribute Data of Rivers

Database of river attributes obtained from the digital river map simulation is in Table 6.

TABLE VIV

ATTRIBUTES CLASSIFICATION OF RIVERS FOR ELABORATING THE INFORMATION

ID	1	2	3	4	5	6	7	8	Length
	1	22							0.706520663
	1	26	14						1.123633014
	1	20	3						0.887926094
	1	20	3	1					0.393388126
Cipari	1	20							3.208703238
	1	26							3.049881854
	1	18							0.903471836
	1	16	3						0.806117800
	1	34	7	8	4				0.303763694
	1	34	7	8	4	10			0.217830539
	1	34	7	8	4	10	1		0.613967427
	1	34	7	8	4	10	1	1	0.610861886

Explanation:
ID=feature name; 1-8= River orde; LENGTH=River Length (km).

7) Attribute data of the Ciliwung River basin spatial plan:

The database of the attributes of the Ciliwung Watershed spatial plan are from the general plan digital map as in Table 7.

TABLE VIV

ATTRIBUTES CLASSIFICATION OF LAND USE FOR ELABORATING THE INFORMATION

NID	ID	Area
001	Mixed Residences / Public Buildings	0,1726
002	Mixed Residences / Public Buildings	0,0851
003	Mixed Residences / Public Buildings	0,4189
004	Mixed Residences / Public Buildings	0,8840
005	Mixed Residences / Public Buildings	0,6009
006	Mixed Residences / Public Buildings	0,2998
007	Green with no buildings	0,7925
008	Mixed Residences / Public Buildings	0,1970
009	Mixed Residences / Public Buildings	0,0676
010	Mixed Residences / Public Buildings	0,0510

Explanation:
NID=feature number; ID=feature identity; AREA=feature area(km^2)

B. Geographic Information System Data Analysis

The analysis is overlaying and buffering. Overlaying is done to get information about watershed from each data. Buffering is done to get to the border of the river.

1) Operation intersection to obtain watershed information:

There are two spatial data in the intersection overlaying operations to obtain watershed information from each feature in the spatial data: land use and sub-district administration.

TABLE VIIVI

ADDING LAND USE CLASSIFICATION FOR ELABORATING THE INFORMATION

NID	SUBD	Area	Percent	ID
L176	8	0.6627	1.8955	Housing
L177	8	0.2027	0.5798	Housing
L178	8	0.7773	2.2232	Housing
L142	7	1.1756	5.3280	Housing
L118	6	0.8271	2.8405	Greenland
L042	2	0.2084	0.4444	Mixed Garden
L011	1	0.1543	0.5803	Housing
L043	2	0.2188	0.4666	Forestry
L012	1	1.7750	6.6753	Forestry
L119	6	1.4061	4.8289	Planting
L044	2	2.0790	4.4333	Grass

Explanation:
NID=feature classification number; SUB=Watershed number feature; AREA=area feature (km^2); PERCENT=Percentage of area feature on Watershed; ID=Land Use.

TABLE VIIX

ADDING ADMINISTRATIVE CLASSIFICATION ATTRIBUTES FOR ELABORATING THE INFORMATION

NID	ID	Area	Density	Population	Watershed
A20	SD_1	5.37898	5800	31198	7
A61	SD_2	4.38557	37909	166253	12
A04	SD_3	39.0877	895	34984	2
A13	SD_4	6.68464	552	3690	5
A29	SD_5	4.69846	2210	10384	8
A34	SD_6	18.1645	2787	50624	9
A35	SD_7	2.1001	9163	19243	9
A36	SD_8	24.4566	7159	175085	9
A40	SD_9	3.39411	4997	16960	10

Explanation:
NID=feature classification number; ID=feature name; AREA=feature area (km^2); DENSITY=Population Density (Person); POPULATION=Population Number feature (Person); WATERSHED=watershed number feature.

TABLE X

ADDITION OF RIVER CLASSIFICATION ATTRIBUTES FOR ELABORATING THE INFORMATION

ID	SD	1	2	3	4	5	6	7	8	Length
	2	1	22							0.706520663
	3	1	26	14						1.123633014
	2	1	20	3						0.887926094
	2	1	20	3	1					0.393388126
	2	1	20							3.208703238
Cipari	3	1	26							3.049881854
	2	1	18							0.903471836
	2	1	16	3						0.806117800
	1	1	34	7	8	4				0.303763694
	1	1	34	7	8	4	10			0.217830539
	1	1	34	7	8	4	10	1		0.613967427
	1	1	34	7	8	4	10	1	1	0.610861886

Explanation:
ID=feature name; SD= watershed number feature; 1-8=river orde; LENGTH=river length (km)

Obtaining watershed information on simulated river spatial data requires union operations.

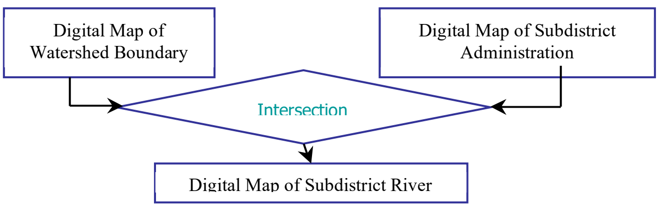

Fig. 3 Overlay Analysis for Getting Information of watershed

2) Buffer and union operations to obtain river border information:

Because we want to get the river border information, the spatial data taken for the buffering operation is the simulation river. Besides, the analysis of river boundary considerations of the general spatial plan is using union operations.

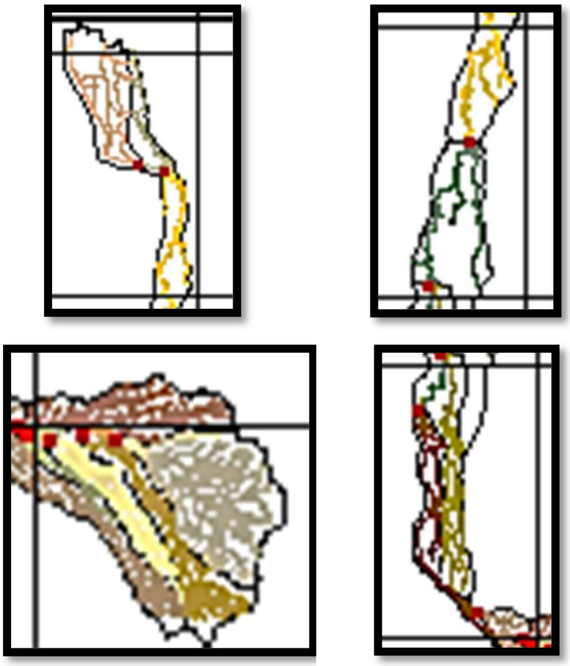

Fig. 5 Watershed Boundaries and Digital Map of Simulation River
Note: Clockwise: Up-Stream, Middle Up-Stream, Middle Down-Stream, Down-Stream.

Buffering operations for each river order are different, due to the different size of the river. The larger a river, the greater the influence of the river on the environment damage on either side.

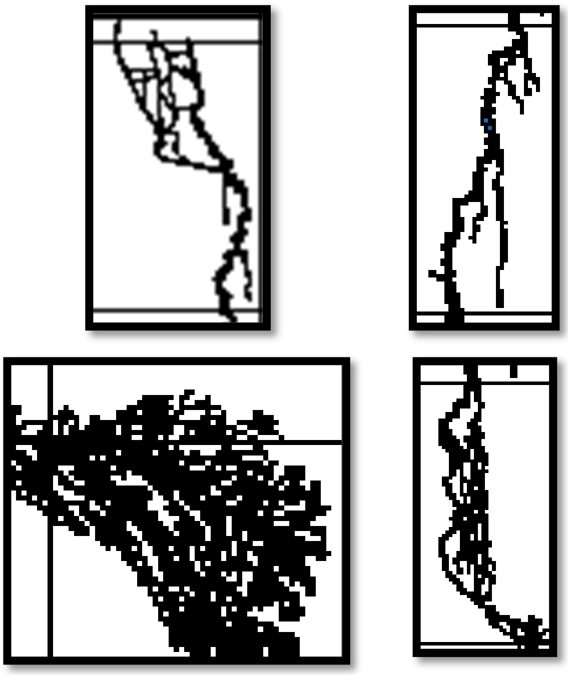

Fig. 6 Digital Map of Simulation2 Map and Digital Map of River Border Results of Buffer Operations
Note: Clockwise: Up-Stream, Middle Up-Stream, Middle Down-Stream, Down-Stream

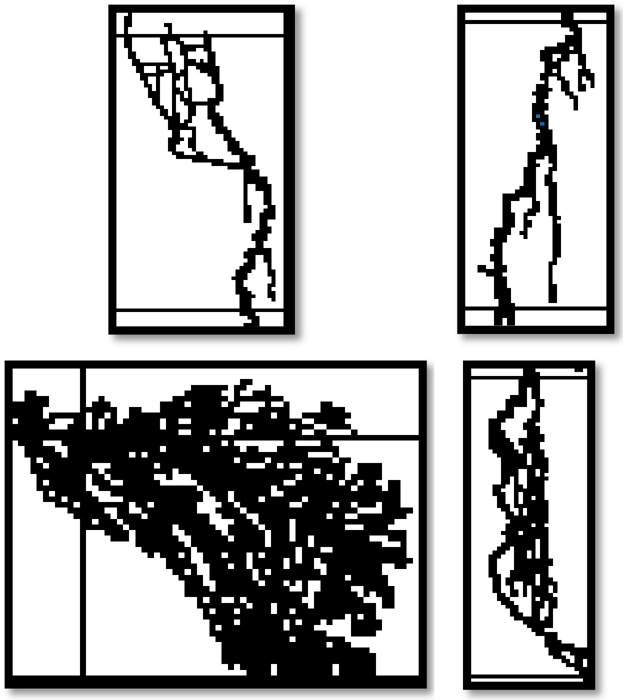

Fig. 7 Digital Map General Plan and Digital Map on River Border
Note: Clockwise: Up-Stream, Middle Up-Stream, Middle Down-Stream, Down-Stream

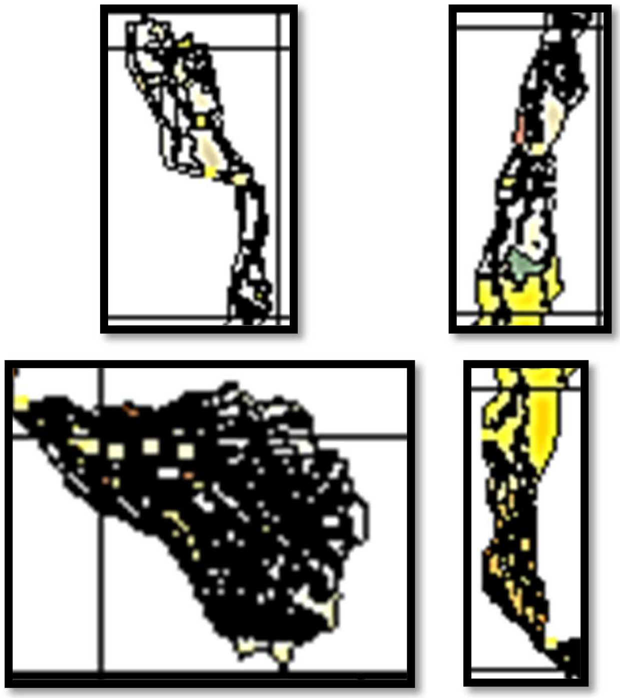

Fig. 8 Digital Map of Union Operation result between Digital Map of River Border and Digital Map of General Plan
Note: Clockwise: Up-Stream, Middle Up-Stream, Middle Down-Stream, Down-Stream.

IV. Conclusion

In general, digital image processing and image classification in this study showed relatively very good results. However, during the classification process, the process of overlaying digital maps with an image map when defining the training site has not been done. Thus, we cannot decide which technique produces a better classification image. For further research, other classification techniques need to be done.

Therefore, the results can be compared with the results of the techniques applied in this research.

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