

GEOGRAPHIC INFORMATION SYSTEM AND IMAGE CLASSIFICATION OF REMOTE SENSING SYNERGY FOR LAND-USE IDENTIFICATION

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ABSTRACT: Geographic Information System (GIS) is one of the ways to obtain updated information in detail. As the name suggests, GIS can perform detail information about geographical area or place. Moreover, transferring the classified imagery as the result of remote sensing obtained in each period of time (per one year, per two years, per three years, based on the needs) to the GIS database will increase the information resources. This is because; at first, the remote sensing image can cover the entire surface of this earth; second, remote sensing image contains information about the earth's surface. By doing an appropriate image processing procedure, rich information could be collected. For further research, other techniques of classification are necessary to be done so that the results can be compared with the results of the previous techniques. This research produces two different image date resources, i.e. digital maps of land use in watershed of Ciliwung downstream (accommodated raw data by Bakosurtanal/Coordinator for The National Survey and Mapping) and landsat TM image with 30 m resolution using RoI in Ciliwung downstream watershed (accommodated raw data by Geotek LIPI/Indonesian Institute of Sciences for Geological Technology at Sangkuriang, Bandung). Digital intersections of these two resources produce a varied classing land-use.

Keywords: GIS, Remote Sensing, Image Processing, Image Classification, Land-Use

1. INTRODUCTION

GIS is a computer-based system that is used to save and manipulate geographical information [1]. GIS was designed to collect, to save, and to analyze objects and phenomena with its geographical location as the most important and critical characteristics to be analyzed [2]. Thus, GIS is a computer system that has four capabilities in processing geographically referenced data; input, data management (storage and retrieval of data), analysis and manipulation of data, and output [3].

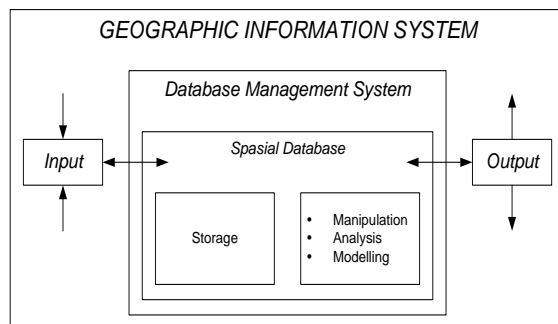


Fig.1 Components of GIS and Operational Process

Overall, the existing components in GIS and the relationship between each component to another can be seen in Fig.1. From the definition

and the picture, it can be stated that GIS components are as input, hardware, software, and output [4].

2. RELATED WORKS

GIS as a computer-based system must have digital data. Specifically, the digital GIS called spatial data. Spatial data is a referenced spatial data which means that the data is measurable and geo-referential or have a location reference, whether it is in accordance with the standardized system (i.e. coordinate system, reference field, specific projection) or local system [4]. Included in the definition of spatial data is thematic information such as soil, water, land, forests, and socio-economic data presented in spatial (mapped) such as; population density, distribution of economic activity, etc.

Data for GIS consists of two components; a graphical data component and a non-graphical data component, where these two components are in digital form. Both components have specific characteristics and each of them requires different treatment in the term of the efficiency of storage processing and the presentation of the graphical data in GIS is a digital representation of the elements of the map or mapped elements. Therefore, the rules of the map which defines the

cartographical elements have to be realized properly. In GIS, graphical data is used in such a way so that it can visualize the map or cartographical image on the display monitor (soft copy), on printed paper (hard copy), or in any other selected media of presentation [5].

Graphical data for GIS consists of two digital data format; vector data format and raster data format [6]. In vector data format, the object is presented as a point or line segments. Meanwhile, in raster data format all objects are presented in a form of cells called pixel.

On the other hand, non-graphical data is the representation of the characteristic, quality, or spatial relationship between the elements of the map and geographical location. Non-graphical data is also referred to as textual data or attribute data. The procurement of this data can be done separately from a GIS management system or can directly be done by the system that manages the GIS.

3. PROPOSED IDEA

The relationships between the graphical data and non-graphical data have to be maintained in a GIS. The common way to relate these two data is by giving identity (id) and store it the in the system simultaneously. The identity (id) is made uniquely, for example in a form of systematic code number [7].

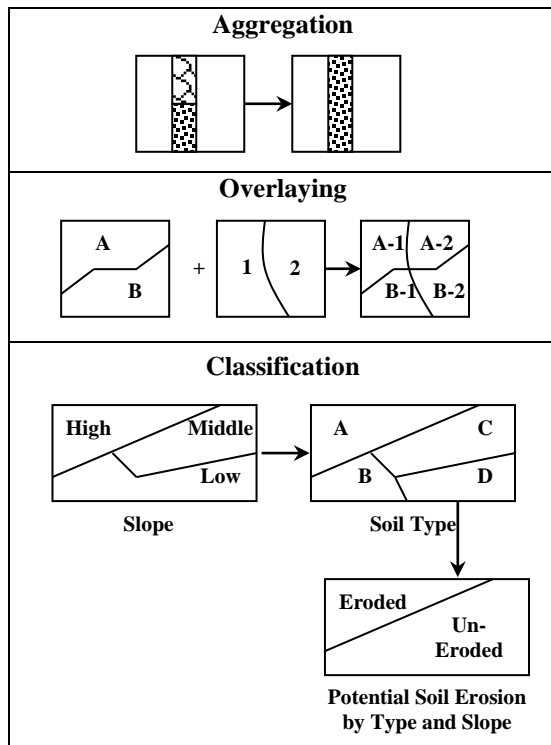


Fig.2a Spatial Analysis in GIS (Part 1)

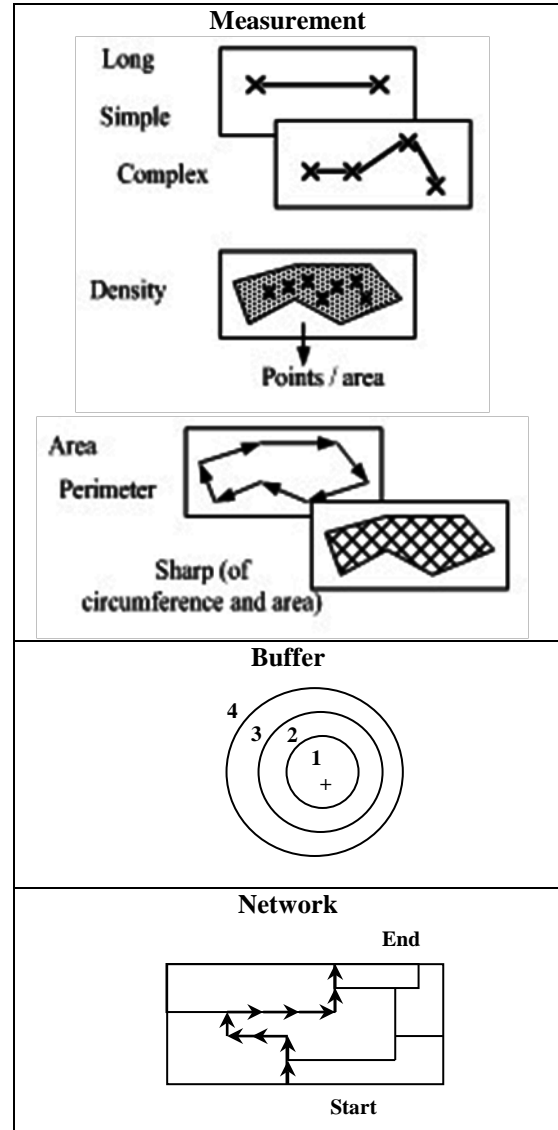


Fig.2b Spatial Analysis in GIS (Part 2)

One of the GIS functions is to increase spatial analysis capability in an integrated manner. The analysis tools including aggregation, classification, measurement, overlay, buffering, network, and algebra map [6]. GIS analysis functions are shown in Fig. 2.

3.1 Digitizing

Before conducting the digitizing process, the coordinate system that used was set. In this study, all digital maps were in UTM coordinate system (Universal Transverse Mercator).

Stages of digitizing using MapInfo 5.5 software are as follows [8]:

1. Place the sheets of the map on digitizer table.
2. Set the projection into UTM (WGS 84) zone 48 south, because the study area using this projection.

3. Enter the four map points control (TIC).
4. The digitized process of the existing feature on the map.

In general, the flowchart of data processing in GIS can be seen in Fig.3.

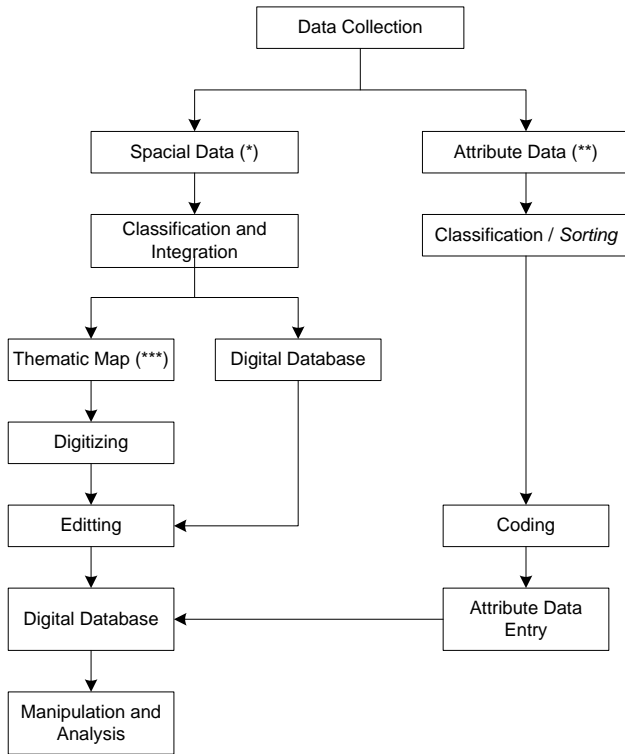


Fig.3 General Data Processing

Note :

- (*) = 1:50000 scale maps that have not been digitized
 (**) = table data such as total population, the concentration of pollutant, etc.
 (***) = 1:50000 scale maps such as land use maps, maps, river flow patterns, etc., that have not been digitized

3.2 Editing

Editing was done by using MapInfo 5.5 software. There are three ways of editing data digitations results, namely:

1. Combining object with the following stages:
 - a. Select one object from the layer that will be edited.
 - b. Select target setting to define the target as the only one that will be edited.
 - c. Select another object which will be combined.
 - d. Combining these two objects with the existing *combine* command on the menu bar Objects.
2. Separating the objects:

- a. Select one object from the layer that will be edited.
- b. Select the target setting.
- c. Select another object that will be used as a reference for the separation.
- d. Select *split* from the menu bar Objects.

3. Removing Objects:

- a. Select one object from the layer that will be edited.
- b. Select the target setting.
- c. Select another object that will be used as a reference for the separation.
- d. Select *erase* from the menu bar.

3.2 Entering Attribute Data

Attribute data (non-graphical data) is a tabular data file that can be added for analysis and manipulation purposes and have a role in giving information about graphical data. The types of attribute data adjusted with the research purposes. In this research, the types of attribute data needs are as follows [9]:

1. Attribute data of land use.
2. Attribute data of district administration.
3. Attribute data of watershed (DAS).
4. Attribute data of pollutant measurements points.
5. Attribute data of simulation points.
6. Attribute data of river.
7. Attribute data of General Spatial Plan (Rencana Umum Tata Ruang / RUTR) of Ciliwung watershed.

Each classification of attribute data above is adjusted with the classification of its graphical data. Entry process of attribute data was done interactively via the keyboard.

4. ANALYSIS

4.1 GIS Data System Analysis

Analysis performed was overlaying and buffering. Overlaying was conducted in order to get information of sub-watershed from each data while buffering was conducted to get riverine areas (Fig.4-6).

4.1.1 Intersection operation to obtain sub-watershed information

There were two spatial data to be the subjects of overlaying intersection in order to get sub-watershed information from each feature that exists in those spatial data, namely the land use and district administration (Fig.4, 5).

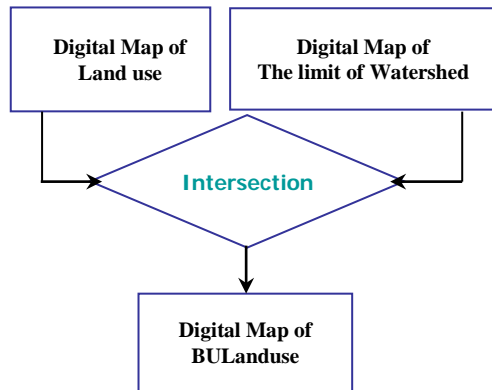


Fig.4 Overlay Analysis to Obtain Sub-Watershed Information

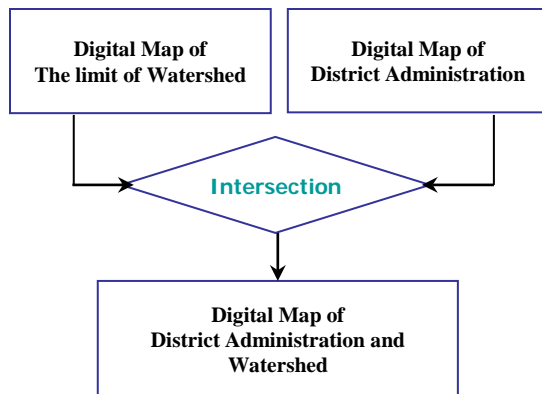


Fig.5 Overlay Analysis to Obtain Sub-River Area's Information

Meanwhile, to obtain sub-watershed information on spatial data of river simulation then union operation will be done.

4.1.2 Buffer and union operation to obtain riverside information

Buffering operation of each river order was different. This was due to the rivers different sizes. The largest the river, the greater impact it caused in the environmental damage on either side.

Since the goal was to obtain riverside information, then the spatial data that subjected buffering operation was the river simulation. While the analysis of consideration of riverside areas of general spatial plan charged a union operation (Fig.6).

Therefore, in this research, we utilize several different maps i.e. a map of a simulated river, a general plan map, and a riverside map. Each map provides different information those are united later to rich the initial resource attached on the three basic maps.

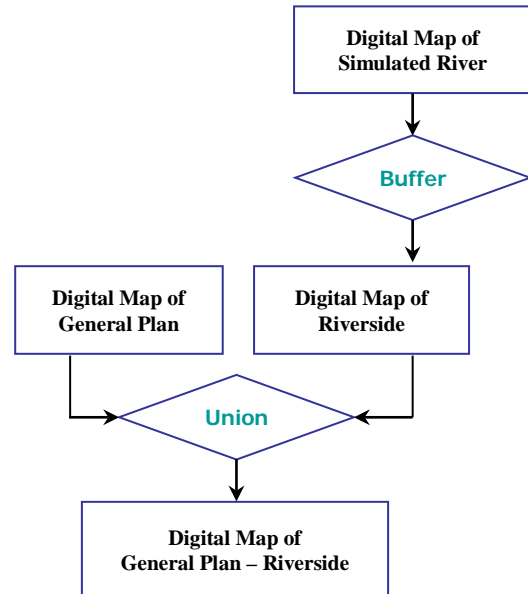


Fig.6 Analysis to Obtain Information of Riverside Areas

4.2 Classification of Landsat TM Satellite Image

In this research, remote sensing image used was Landsat TM satellite image with RoI (Region of Interest) was Ciliwung River downstream [10]. The classification process of Landsat TM satellite image (Fig.7) was by using maximum likelihood guidance method [11], in accordance with the diagram below (Fig.8).



Fig.7 Landsat TM 541 Geometric Correction Results

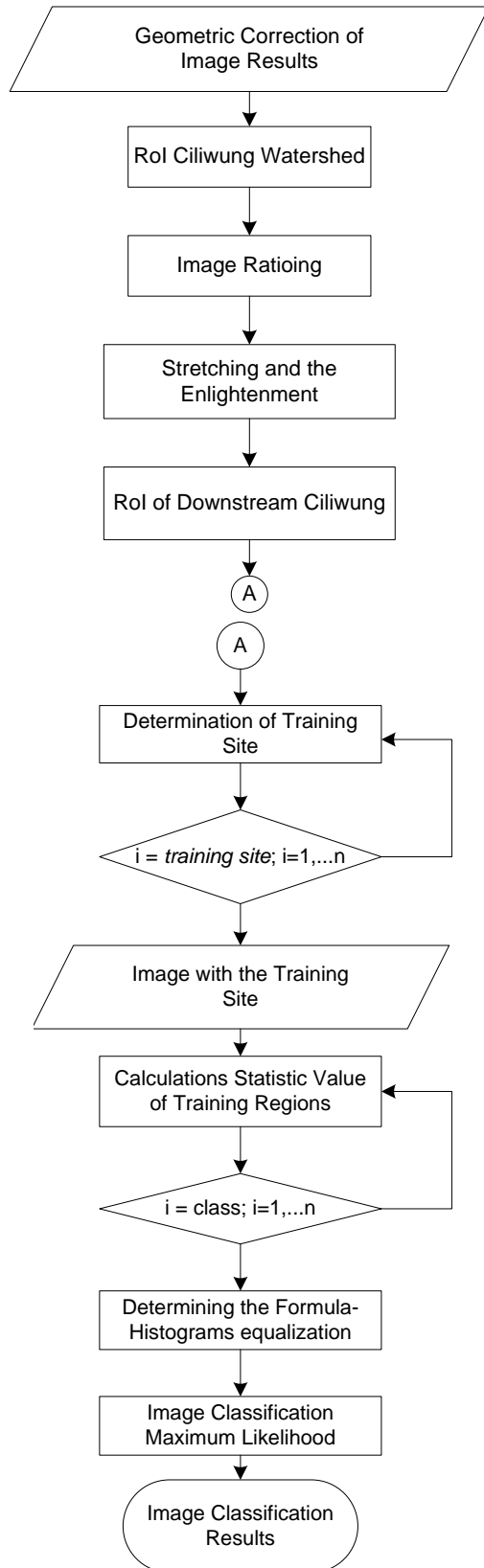


Fig.8 Classification of Landsat TM Process



Fig.9 The image with the Training Site

Figure 9 illustrates how the information from a different land-use to be utilized as a training site that is referred later for the same region type. The using maximum likelihood approach, the system will calculate the statistic value of the obtained information to judge the region function as an image classification results.

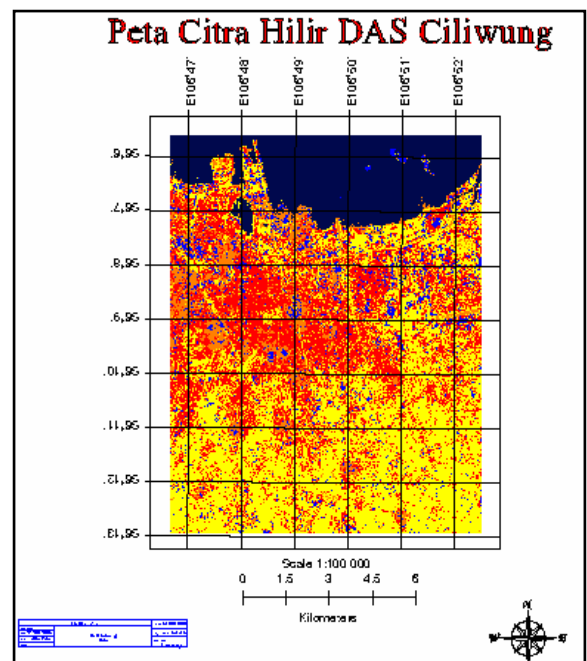


Fig.10 Image of Landsat TM of Downstream of Ciliwung Watershed Section Classification Results

The above figure (Fig.10) shows the result of the classification process. Different color arises as an answer to the statistical calculation of the training regions. The statistical result is used to determine the histogram equalization formula of the image to separate image with a different level of color. Fig. 11 shows the digital map of land use of Ciliwung watershed downstream section.

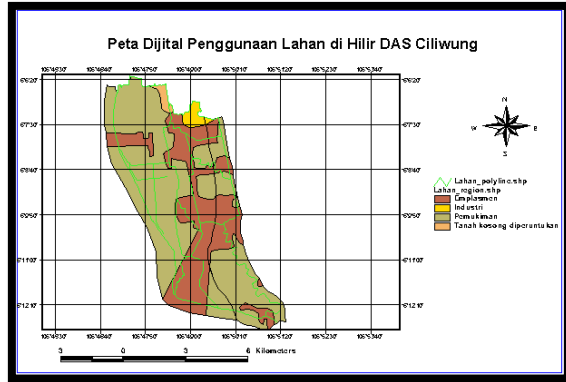


Fig.11 Digital Map of Land Use of Ciliwung Watershed Downstream Section

where the classification is as the following table:

Class	Name	Color
All		black
1	Greatwaters	0,8,77
2	Emplasmen	yellow
3	Tanahkosong	blue
4	Pemukiman	red
5	Industri	255,128,0

Fig.12 Land-use classification

5. CONCLUSION

In general, digital image process and image classification conducted in this research showed quite good results. But, in the classification process, the overlay process between digital map and image map had not done so yet known which of these techniques produce the best classification image. For further research, other techniques of classification are necessary to be done so that the results can be compared with the results of the previous techniques.

If we compare the digital maps of land use in watershed of Ciliwung downstream issued by Bakosurtanal (Coordinator for The National Survey and Mapping) and Geotek LIPI (Indonesian Institute of Sciences for Geological

Technology) at Sangkuriang, Bandung, using Landsat TM image with 30 m resolution taken in 1997 using RoI (region of Interest) in Ciliwung downstream watershed. The classification result in it is there were differences of class. These differences can be accepted because of several reasons: (a) Digital map obtain from the result of field review and from competent authorities (the local government of DKI Jakarta, Bogor regency, and the city of Bogor), while the images capture concrete information on the earth surface so that information for classification have different patterns, (b) For example for settlement classes, the information detected by the satellite is the appearance from above. This information can also be gotten from industrial class so that the image classifications were not obtained because it is considered as class settlements. In contrast to the information from the digital map because the information described by the related institutions is in a form of the area so that the classes of land use are shown.

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