

## FLOOD MODELLING ULAR WATERSHED IN NORTH SUMATRA

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#### ABSTRACT:

Floods are widespread and frequent large areas may be inundated when rivers overflows or coastal regions flooded following major storm. Flash flood occurs in small catchments basins, particularly in mountain region. Nutter and Mannan (1977), Safii (1985), and Sandy (1997) have been research, the floods an indicator of the environment quality degradation includes as vegetation, physical, and local community. The flood plains Ular Watershed are 44385 Hectare or 36.7 percent from total this area watershed, which distributions are at flat topography (e.g. swamp, peneplain) region. The rainfall will be making floods area upper 30 mm/day intentions in all the Ular watershed. And so at elevation upper 500 m datum with dominants slope more than 35 percent, plantation bad quality and high rainfall in a month or years. The objective is a know flood Modelling in land-use management. The problem is a how to correlation physical characteristic with flooding region? And how to make a flood Modelling Ular Watershed? The variable depends are physical characteristic, and land-use. The variable independent is a flood region. The overall methodology involved use of a flood Modelling, the universal flood (e.g. topography, land-use factor) in GIS and Dynamic analysis (e.g. Powersim or Stella) tools, with data obtained from weather stations (e.g. BMG Government institution), reconnaissance surveys, and topographic map with scale 1:50,000.

#### Introduction

The flood plains is the lowland that borders a river, usually dry but subject to flooding. It is built of alluvium, of sediments carried, deposited, and reworked by the river. When the river is low, it occupies only a part of its bed, leaving many bars and low islands exposed. The banks of the flood plain stand high above the river and there is sandy beach on side or the other as the stream swings across its bed in short meanders. During ordinary high water, the highest stage reached nearly every year, the river occupies all its bed, drowning out the short within-channel meanders, and the channel is said to be bank-full. This level is generally marked by the lower limits of the vegetation. Less frequently about once in two or three years, the river goes over its banks and invades low places on its flood plain, with a tendency to overflow across low meander necks of the main channel. Backwater from the tributaries may also inundate low places on the flood plain along the valley edges. This the lowest stage that deserves to be called a flood.

Higher stages, occurring with decreasing frequency, flood increasing areas of the flood plain, but only once in a century or longer is there a flood that submerges all the alluvial deposit on the valley bottom. These

frequencies are descriptive of graded river generally, where the banks represent the alluvial flood plain, but the frequency of flooding may be much greater in low swales in the alluvium, for example in an abandoned channel. On the other hand, the frequency of flooding may be much less where the stream impinges against the country rock of the valley wall, or against a terrace of old alluvium, usually representing a vestige of a flood plain formed during a higher stand of the river in the geologic past. Terrace lands have many of the advantages of the more modern flood plain, combined with advantages of relative freedom from flooding (Hoyt, 1955 : 15).

Land cover is determined by complex interactions between climate, topography, soils, and is modified by human and economic pressure. In recent decades changes in land-use patterns have been governed by accelerating requirements for food, fuel wood and land to build on. The data are based on BPN's one year (2000) in Ular watershed has of widely flood region. Reliable data on the areas effected by flood and land use productivity that occurs are scarce. To improve the situation FAO, UNEP and UNESCO have been collaboration since 1975 on the development of a world map of flood in catchment area or watershed, a

semi-quantitative assessment of actual and potential flood in terms of its physical characteristic and human pressure (Dudal, 1982). Flooding area/location has been known in Ular watershed dispersed at alluvial plains region with elevation as 0-25 m datum, and so land use or land cover is a plantation, settlement, and grassland regions. The flood plains in Ular watershed can as swamp or basin, lower plain, and peneplain region with area 44385 Ha.

### 1.1 Objectives

The purposes of this research are as follows:

To know the characteristic physical spatial pattern (e.g.: topographic), and flooding dispersion;

To know the land-use or land cover (e.g.: vegetation quality);

To know the floods are a Modelling in research area.

### 1.2 Hypothesis

The hypotheses are:

The dispersion of the land-use follows the spatial pattern;

There is a corellation between the vegetation and the physiographic with the flood in Ular watershed.

### 1.3 Problems

The problems of this research are:

- 1) How is a dispersion a physiographic and land use in Ular watershed?
- 2) Where is a location of the flood plain in Ular watershed?

How is to Modelling physical/topographic characteristic with flood the Ular watershed?

### 1.4 Methodology

The overall methodology involved use of a flood Modelling, the universal flood (e.g.: physiographic/topography and land-use or land cover factor) (Sandy, 1997) in GIS (Geographic Information System), with data obtained from weather stations, reconnaissance surveys, and topographic maps with scale 1:50.000.

The data are base to collected from as:

- a) Topography maps 1946 army TNI institution Topography AD scale 1:100,000 sheet 2751; 2752; 2753; and 2754;
- b) Topography maps, Bakosurtanal institution edition 1980 scale 1:50,000 sheet 0619-11; 0619-12; 0619-13; 0619-21; 0619-32; 0619-34; 0619-41;

and 0619-61;

- c) Land use BPN institution province North Sumatra scales 1: 25,000.

#### 1.4.1 The Modelling Tools

GIS tolls interoperability is the key concept for integrating the various of information stored in different and differing repositories. The data Modelling approach to information exchange focus's on the resolution of differences in the underlying data models, data structure, spatial primitives and relationships between different GIS.

GIS tools are using an Arc/info and Arcview (input, processing, and output) data Modelling Ular watershed in north Sumatra. Arc/Info use relational database management system data model to build and maintain data. We can use either tables or info for managing and viewing your attribute data. In arcedit, a number of facilities are provided for editing feature attribute as well as graphics/coordinates. Arcplot provides full cartographic output capabilities for arc/info, from simple screen displays to high quality cartographic plots for reports and presentation. Arcplot includes commands for scaling and positioning maps; specifying symbols; selecting; drawing and labeling coverage features; adding titles, legends, neatlines, scale bars, and north arrows; querying the database; and for composing plots interactively on monitor screen with base map and thematic maps scale 1:50,000 are an outputs.

Powersim tools used for analysis dyanamic has systems archetype basics (Daniel and Anderson, 1998) as follows causal loop diagrams (CLDs) are graphic representations of our understanding of systemic structures. They are valuable because they reveal our thinking about how the system is constructed and how it behaves. When we share our CLDs with others, these diagrams become especially useful because they help us understand one another's thinking about how the system in question works.

#### 1.4.2 Flood Modelling

Digital physiographic data for the Ular watershed were obtained by digitizing 24 sheets of topographic maps of scale 1:50.000. The contours and the drainage system were digitized separately and used to build up Digital Elevation Model (DEM) of the watersheds. The contour interval used was 200 m, taking into account available computer memory and technology at the time in North Sumatra. A gird cell of 100 m was used in building the DEM, as this was considered to be less than the maximum slope length, based on reconnaissance Survey. The resulting DEM was used to determine the

variable physiographic factor between as landscape or physiographic, slope and elevation plains.

Database type for flood modelling Ular watershed has a two category data, is numeric, and character.

1. The topographic factor includes as slope degree and elavation region, which in areas Ular watershed (North Sumatra)-Indonesia has effect as rainfall structure (intensity daily higher about 250-300 mm in month and more than 3000 mm per year);
2. The Ular watershed have land use factor between built up area (settlement, industry), and man made features (straits, parking and others) more than 20 percent from total areas land use on slope less than 10 percent and elavation less than 100 m means level sea;
3. Identity variable as flood region (y) and topographic factor (x1), rainfall structure (x2) and land use factor (x3). The all variable process have done in powersim software.

## RESULT AND DISCUSSION

### 1.5 Flooding in the Ular Watershed

If we look morphology map on Ular watershed, we know spatial information about:

- (< 100 M ) LOWER PLAIN 1580 HA (12.5%);
- ( 100-500 M) PENEPLAIN 28545 HA (24,2%);
- (500- 1000 M) HILLY MOUNTAIN 48305 HA (41%);
- (> 1000 M) MOUNTAIN BELT 25355 HA (21.5%).

If we look isohyet map on Ular watershed, we know spatial information about:

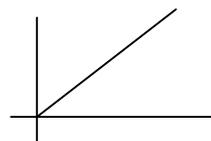
- MINIMUM RAINFALL 1500 MM/YEARS AT LOWER PLAIN;
- MAXIMUM RAINFALL 5500 MM/YEARS AT HILLY MOUNTAIN PLAIN;
- AVAREGE 3250 MM/YEARS;
- WET SEASON 8 MONTH, DRY SEASON 4 MONTH;
- SHADOW RAIN 2250 MM/YEARS

If we look flood area map on Ular watershed, we know spatial information about:

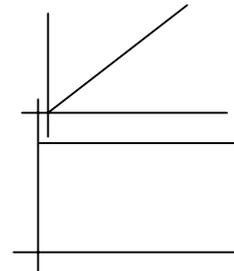
- ULAR WATERSHED 118045 HA;
- FLOODING AREA 44385 HA (37,6%)
- ACTUAL AND POTENTIAL AT ELEVATION 0-25 M DATUM

### 1.6 Flood Modelling in the Ular Watershed

#### Flooding

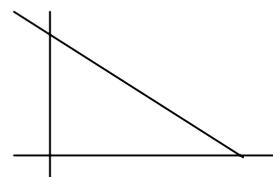


#### Flooding



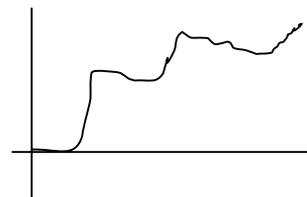
#### Topography factor

#### Flooding



#### Land use factor

#### Flooding



If we look figure kurve flood modeling in the Ular watershed have variations graph between linear and model j shapes.

#### Conclusion

- The Ular Watershed have different morphology, if looking factor slope and elevation region (upper, middle, and lower plain);

- Flooding area in the Ular watershed 44385 Ha at lower region includes peneplain and swamp area;
- Linear model and model J (rainfall structure, land use and morphology factor) for flooding area in the Ular watershed. The flood modeling have updating data on 5 years (siklus rainfall include el-nino and la-nina) or 1 year (rainfall intensity)

Database type flood modelling area in Ular watershed as:

NO	Field Names	Data type	Descriptions
1.	River_ID	Numeric	River code
2.	Watershed	Character	Watershed area
3.	Length	Numeric	River length
4.	Elevation	Character	Elevation region
5.	Slope	Character	Slope region

6.	Physiography	Character	Physiography region
7.	Rain structure	Numeric	Isohyet
8.	Land use/land cover	Character	Land use area
9.	Flood Plains	Character	Flood plains area

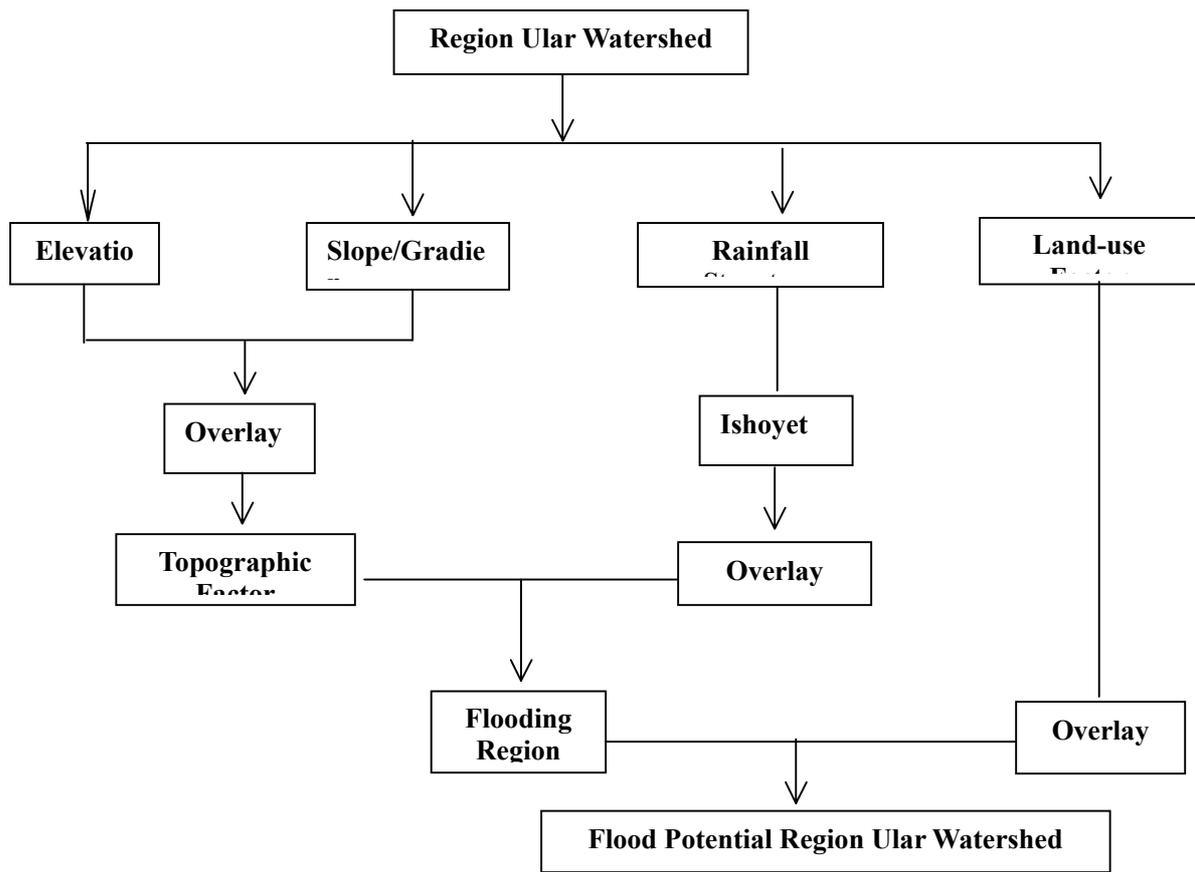
Spatial database flood modelling ular watersheds as:

NO	Feature/ Object	Type	No_ID
1.	River	-	-
	a. River net	Line	101
	b. River pattern	Polygon	102
	c. Watershed area bounded	Line	103
	d. Sub watershed region	Polygon	104
2.	Land use/ Land cover	-	-
	Forest	Polygon	10
	Plantation	Polygon	11
	Settlement		12
	Mix Garden		13
	Grass		14

The data analysis spatial for flood modelling area Ular watershed in north Sumatra have use buffer, overlay (union, intersection, and identity), and so arc view as query, script, hotlinks, shapefile, geoprocessing wizard, export, and database access.

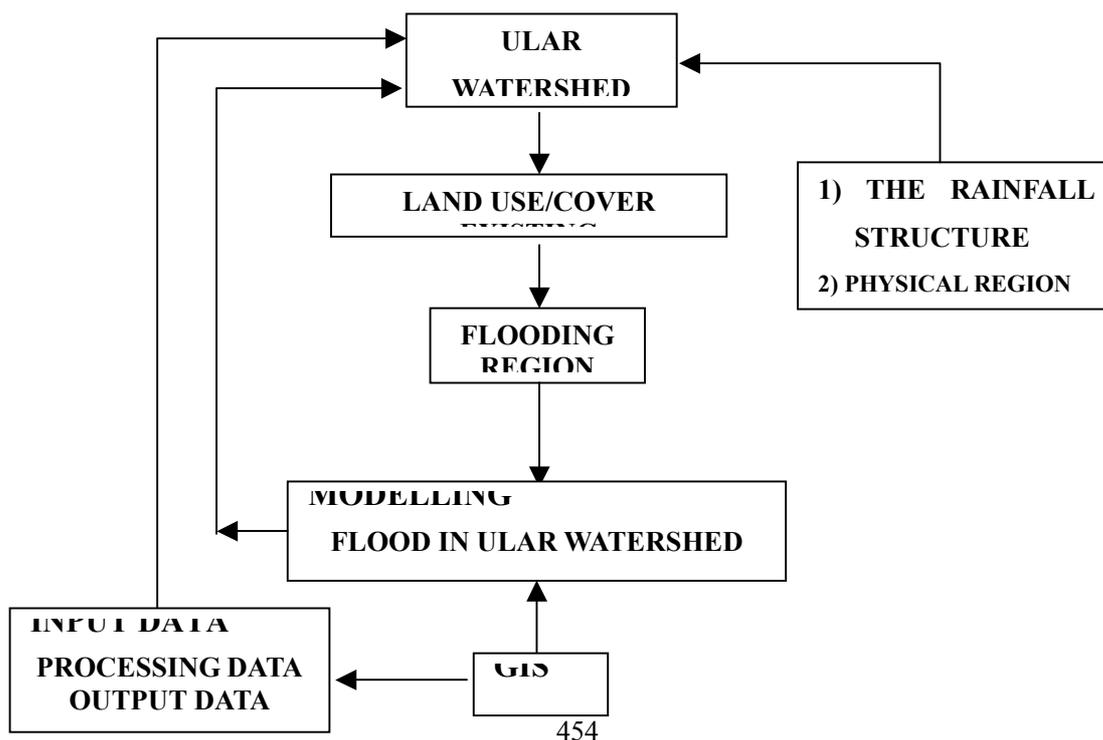
Input	Processing	Output	Description
Digitize maps slope and elevation.	Overlay (union)	Landscape or Physiography	Classification morphology
Digitize maps land use/land cover and morphology map.	Query	Land use region for sustainable physical region	Category sustainable (good- far, and worse)
Data tabular local community and rain structure.	Database access	Population density region and rain fall itensitas an hour.	Population regions and isohyet.
Citra flood plains	CCT (pixel to vector)	Flood plains region	Area flood in ular watershed.

### Dynamic Spatial Analysis tools used for the flood modelling

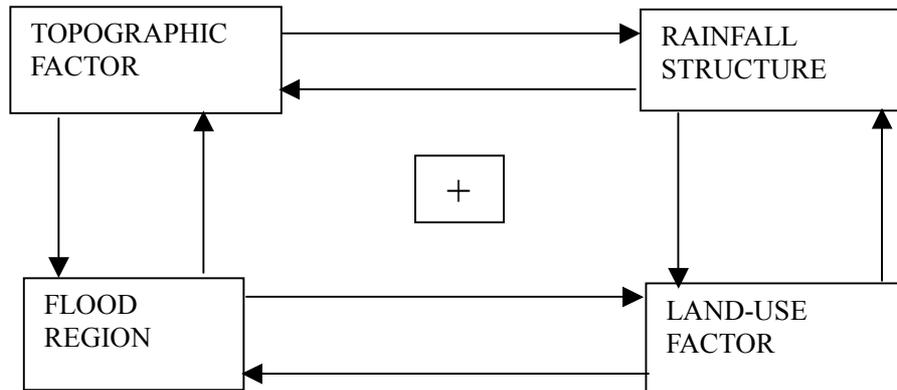


### An Outline of the Research Concept

An outline of the research is described in the flow chart below:



### Powersim tools for the flood modelling



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