34-42-4710-Sarino-July-2019-59

by Dinar Putranto

Submission date: 12-Mar-2019 12:44PM (UTC+0700)
Submission ID: 1091899019
File name: 34-42-4710-Sarino-July-2019-59.pdf (782.39K)
Word count: 4929
Character count: 25515

5
International Journal of GEOMATE, July 2019, Vol.17, Issue 59, pp.34 -42
Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/2019.59.4710
ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan

DATABASE STRUCTURE OF LAND ALLOCATION MANAGEMENT INFORMATION SYSTEM FOR ESTIMATING RUN-OFF IN WATERSHEDS

*Sarino[1], *Dinar Dwi Anugerah Putranto[2], *Agus Lestari Yuono[3] and Imroatul Cholimah Juliana[4]

[1,2,3,4]Faculty of Engineering, University of Sriwijaya, Indonesia

*Corresponding Author: Received: 19 Dec. 2018, Revised: 09 Jan. 2019, Accepted: 27 Jan. 2019,

ABSTRACT: Changes in land use are so fast, has changed the pattern of surface drainage (run-off) in the river sub-system area in urban areas. The problem of stormwater is influenced by several factors, such as occupational problems of riverbanks, improper swamps, river tidal influences, which affect the capacity of river sub-systems in the region[1]. This study will discuss the spatial issues in surface water flow systems in urban spatial planning by emphasizing the integration of run-off and land allocation management. The method used in this study is to conduct spatial analysis using all Run-off parameters in the database structure by utilizing the Land Allocation Management Information System (SIMAL) interface built to test the magnitude of flood peaks using the Nakayasu HSS method, with a case study of the Jakabaring river sub-system , in the city of Palembang. The results obtained were able to see the conversion of swampland, which was utilized for the Palembang Sports City Region in the face of the 2018 Asian Games in Palembang City, has caused flooding in the Kedukan river region, part of the Jakabaring watershed, Seberang Ulu area, Palembang City, Indonesia. Based on the analysis using the Nakayasu unit hydrograph model, the occurrence of peak flooding will occur when rainfall reaches more than 120 mm / hour which causes the low river discharge to reach up to 400m3/sec. Making artificial lakes as a retention pool and at the same time as a sports venue has not been able to reduce the height of the inundation that occurs around 0.6 - 1.2 m above sea level.

Keywords: Run-off, SIMAL, Peak flood, Retention pond

1. INTRODUCTION

The Jakabaring watershed is one of the sub-watersheds in the Seberang Ulu area or across from the upstream of Palembang City which was originally a flood plain, and some of its territories is a swamp and not widely used for activities until 1995. To develop the Seberang Ulu area, the government of South Sumatra Province together with the government the city of Palembang has reclaimed the swamp area and utilized for the implementation of Sports activities such as the Asian Games 2018 in Indonesia, with all facilities including residential areas, trade, offices, and other supporting facilities. The process of development of the area of Seberang Ulu is done by hoarding the swamp area using the soil material derived from the dredging of the Musi River and the soil material taken from other areas.

The process of accumulating floodplains and swamps, of course, requires a water system in accordance with the conditions of the subwatershed Jakabaring that form the initial ecology of the Seberang Ulu area. In its development, some areas in the area after the land conversion occurred, floods that flooded some areas such as residential areas, even runoff flooded the surrounding residential areas. This is one of the mistakes caused by the mismatch between land use allocation in spatial arrangement and the management surface flow in a watershed. Understanding surface flow management with changes in urban and regional land use will help urban planners and hydrologists in spatial planning.

The Land Allocation Management System [1] is a watershed analysis system (DAS) that will be developed by utilizing GIS techniques using land use change parameters, morphometric and hydrometric watersheds. By using hydrodynamic analysis and spatial analysis (1D / 2D) [2]-[9], the water level in river and drainage channel, so it can get information about the change of water level distribution in subwatershed, due to land use change is done when a determination of land allocation. Puddle management involves the diagnosis of problems within the watershed with emphasis on the causes of rainwater runoff and tidal rivers causing flooding and puddles and optimizing land allocation to increase water absorption into the soil to reduce surface or puddle flow.

2. METHOD

2.1. MCA and GIS

Land allocation management to reduce flood risk can be divided into two parts: Flood risk analysis and the assessment on the one hand and risk mitigation on the other. Broadly speaking, the purpose of land allocation management is the assessment of flood risk to establish where the risk is very high, where mitigation measures will be required. Risk mitigation means proposing, evaluating, and providing alternative solutions to mitigate risks in the area. To map the risks and effects of flood risk reduction due to land allocation, the utilization of Geographic Information System (GIS) with its ability to present spatial data is an appropriate tool for processing spatial data in surface runoff analysis [2]. The approach presented in this paper is combining MCAs with GIS.

The amount of runoff surface in a watershed is the relationship between the topographic condition of the area, land use, soil type, drainage channel condition and the amount of rainfall. The smaller the area of infiltration, the greater runoff occurs, if rainfall and channel capacity are reduced [3]-[10]. On that basis, it can be used to translate the level of detail in the decomposition of the object class into a derived class (specialization) of the required database.

The Land Allocation Management System as defined by Sharifi [4]-[12] is a Geospatial Information. System classification, consisting of data/ information (spatial and nonspatial), models, and visualization tools, especially developed to support planning and decision-making processes. In connection with the understanding as mentioned above, the method that will be developed in the manufacture of Spatial Allocation Management Information System will be focused on the planning phase, namely the preparation of database structure related to Basic Geospatial Information (BGI), such as topographic area, channel profile (river and drainage), the width and shape of the watershed, land use, and rainfall distribution. The overall architecture of the planning support system to be constructed is presented in Figure 1.

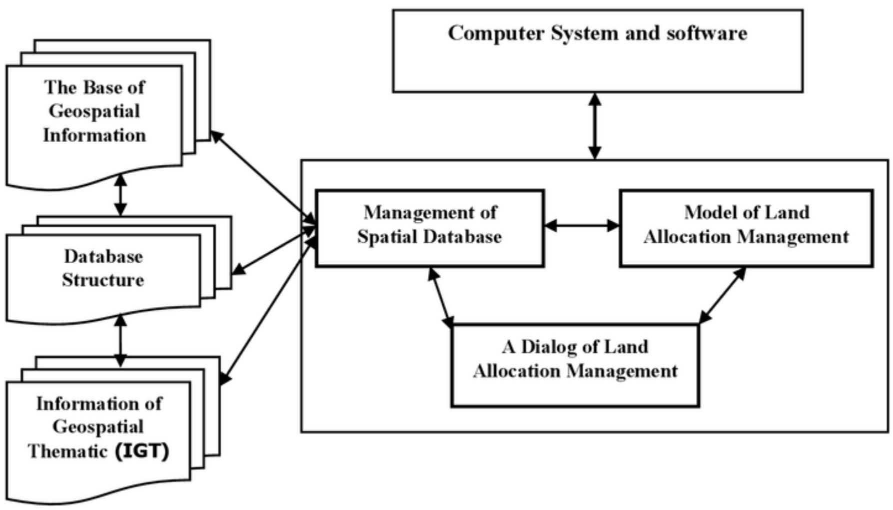

Fig. 1 Architecture Planning Dessicition Support System (DSS) in Land Allocation Management

The main components to be built in the Planning Support System are as follows:

(1) A database management system. This system includes the preparation of database structure which includes the design of conceptual data model, identification of physical data collection, Meta Data, E-R Diagram designed to accommodate and organize spatial database and Geospatial Thematic information, and able to provide facilities to analyze and manipulate data

(2) A Database Management System Model. The system includes both quantitative and qualitative models that support surface flow analysis, namely the assessment of potential surface flows and spatial capacity at different levels of land allocation management

The hydrological response of the watershed leads to the formation of surface runoff governed by interactions with topology, land use, and soil physical properties. Therefore, the use of Geographic Information Systems (GIS) will be better than traditional techniques in the quantification of appropriate surface runoff by storing and analyzing the underlying factors affecting runoff [13]. The estimation process becomes more efficient, interactive and less complicated when Geographic Information System (GIS) is used to store, interpret and display the data required in surface runoff overlay techniques.

2.2 Development of Interfaces in Arc-GIS

One method to analyze the peak of flooding due to changes in land use in a watershed is to analyze the amount of runoff. One of the empirical formulas for determining the peak runoff rate is the Hydrograph Formula Nakayasu Synthetic Unit. Unit hydrographs are typical hydrographs for a particular watershed. According to [10], the advantages of this method can not only provide the maximum flood discharge but can also provide the duration of rain. Another advantage is its ability to analyze rivers that have reservoirs because analysis can be done on routing floods to the downstream of the river.

$$Q_P = \frac{C.A.R_O}{3{,}6\left(0{,}3T_P + T_{0,3}\right)} \quad (1)$$

where,

Q_P = peak flood discharge, in m3 / sec
C = flowing coefficient
Ro = unit rain, in mm
A = watershed area, in km2
T_p = grace period from the start of the rain to the peak of the flood, in hours
$T_{0.3}$ = time taken by decreasing debt, from peak discharge to 30% from peak discharge, in hours

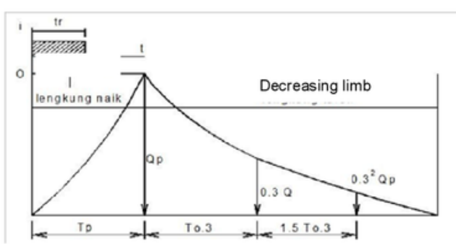

Fig. 2 The flood hydrograph of the Nakayasu method design

a. Calculates the rising limb of a unit hydrograph

$$Qa = Qp\left(\frac{t}{T_p}\right)^{2,4} \quad (2)$$

Where,
Qa = run-off before reaching peak discharge (m^3/s)
T = Time (hour)

b. Calculates decreasing limb

If Qd > 0,3 Qp: → $Qd = Qp * 0.3^{\frac{t - T_p}{T_{0,3}}}$ (3)

If 0,3 Qp > Qd >0,32 Qp : →

$$Qd = Qp * 0{,}3^{\frac{t - T_p + 0{,}5T_{0,3}}{1{,}5T_{0,3}}} \quad (4)$$

If 0,32 Qp > Qd : $Qd = Qp * 0.3^{\frac{t - T_p + 1{,}5T_{0,3}}{2T_{0,3}}}$ (5)

c. Counting the time to the peak of a flood (Tp)

$$Tp = tg + 0{,}8\ tr \quad (6)$$

L < 15 km → tg = 0,21 L0,7
L > 15 km → tg = 0,4 + 0,058 L

where,

L = river channel length (km)
Tg = time consentration (hour)
Tr = 0,5 tg until tg (hour)

The magnitude of α, the usual drainage area α = 2; the part goes up the slow hydrograph and the rapidly decreasing part α = 15; fast hydrograph section increases and slow decreases α = 3. The hydrographic parameters used in this calculation are (a) river length; (b) Area of catchment area; (c) flowing coefficient (C).

Based on the hydrographic parameters of each sub-watershed obtained from thematic maps, such as river length (L), watershed area (A), watershed perimeter, slope of the river, the next concentration time can be calculated by combining the calculated rainfall intensity for the time period as needed (can return period 2, 5,10 years), value C on thematic maps of land use, and map of soil types, the analysis can be done using Eq (1) approach to obtain unit hydrographs in the relevant watershed area. Thus, the parameter variable in each watershed is the value of C from changes in land use and the amount of rainfall intensity.

3. RESULTS AND DISCUSSION

3.1. Database Design

Database design in the Geographic Information System (GIS) always starts from the analysis of the appearance of geographical objects from the source of data input (real replication) or "real world" that is tailored to the needs of the utilization that will be carried out [2]

3.1.1 Study Area and Data Acquisition

The Jakabaring watershed with a geographical position of 104° 44 '56 "- 104° 47' 45" BT and 02° 07 '10 "- 02° 03' 50" is one of 19 sub-watersheds that make up the Palembang City watershed, a part of the Musi River Region, in the administrative territory of the Southern Sumatera Island, Indonesia.

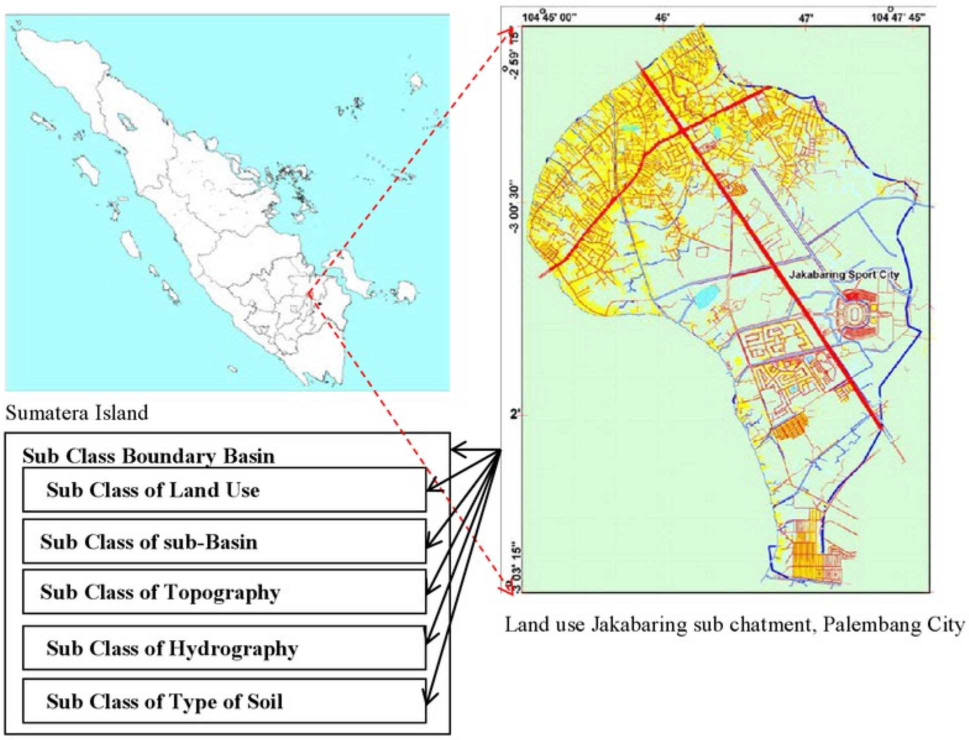

Fig. 3 Research Sites of Jakabaring Sub-watershed, and Specialization of Basin class, Land Use sub-class and enchantment sub-classes

3.1.2 Object Description

The introduction of objects based on the appearance of land use objects is classified according to the materials needed in river basin management. Understanding land use here is an object that uses or requires space or land. To that end, the objects of roads, rivers, and waterways (swamps, lakes, canals) are also objects that use space. Thus the subclass of a road and river objects can be incorporated into one class, called sub-class of space utilization or land use. Each space utilization will be within the watershed area. For that object, space utilization can be incorporated in a sub-class of objects called sub-class space utilization and watershed boundaries.

A set of methods for calculating objects having similar characteristics and shapes can be incorporated together with their attributes and called class definitions. The class hierarchy used is, the first class is called the base class, while the second class or sub-class, commonly called the derived class. {BOUNDARY OF WATERSHED; BOUNDARY OF SUB-WATERSHED; BOUNDARY OF SUB RIVER SYSTEM}, is a member of the watershed sub-class. A space utilization sub class is a form of "generalization" of the subclass {L_USE; WATER_BODY}. Sub-Class L_USE, is a generalization of sub Class{SETTLEMENT;OFFICE; INDUSTRY; EDUCATION; PUBLIC FACILITIES; TRADING; SOCIAL FACILITIES; HEALTH}. Sub-class of OPEN SPACE is a generalization of the subclass of {SPECIAL FORESTS; GREEN OPEN SPACE; BARRIER OF WALKING ROAD; BARRIER OF RIVER}. The HYDRO Sub-class is a generalization of the sub-class {RIVER; SWAMP; CHANNEL}. The sub-class of roads is DAMIJA objects (Road Owned Areas) having spatial structures of areas (polygons) can be incorporated with L_USE sub-classes, into BUILD AREA Subclasses. The merger (association) is because between the sub-class of watershed boundaries and the space utilization sub-class has many similarities in attributes and methods, such as names, spatial and non-spatial relationships, widespread calculations and so on.

Figure 3 above shows a nail diagram illustrating the hierarchy between the subspace class sub-district visibility, for the watershed boundary subclass.

Identification of the data unit of the object that composed the structure of the DAS Territorial Layout for each subclass can be fully detailed as follows:

(1) watershed area units used as observation limits for flood or puddle analysis are used within watershed boundaries. To that end, the subclasses of the watershed area contain the sub-watersheds including the sub-sub-basins with the object identification (primary key) in this class is the OID.

(2) spatial use specified by location and area of land for each watershed boundary, identified as land utilization subclass. The relationship (subdivision) between the land utilization class and the level of detail will be indicated by the level of numbering in the OID. Geometric shape and geometric spatial structure is represented by the geometric shape of polygon (area), consisting of geometric shape of boundary of utilization (ring) and the area of exposure (closure) and point coordinates that indicate location and relationship between geometric object based on topology (face) written in the form of non-geometric attributes

3.1.3 Attribute Data

Each object must have an attribute that describes the property (property) of the object. Determination/selection of relevant attributes for an object is important in making the data model. Attribute data is compiled based on the need for GIS utilization object for watershed management. The attribute will describe the contents of the geometric object numerically (numbers) as well as spatially related to other geometric objects, which will produce the derived attributes. The subclass will inherit attributes that are similar in character to the superclass attribute. Thus, there is no need to attribute that has been defined in the "base class", redefined in the subclass because it will only cause a waste of storage in the computer.

3.1.4 Connectivity among Object Class

Based on the relationship between spatial objects that have been discussed earlier, then finally can be arranged a relationship diagram that explains interconnection (relation) between subclass of spatial objects that make up the Spatial chatment Area. Using the logic of relationships, such as specialization, aggregation, generalization, and association, each class is linked by describing it in a spatial object linkage model diagram. Seen in Figure 4, the logic of the relationship as illustrated in the diagram of Figure 3, is arranged in the form of a spatially connected object diagram generalized by the subclass, with the following explanation: soil, topography, and hydrographic elements are unplanned Spatial Planning and is a watershed area planning area. The watershed area, divided into observation boundaries, is called the sub-basin boundary. Within the watershed area boundary which is an observation area, based on the planned land allocation within each watershed boundary, it is known that the run-off will occur in each watershed. Thus, within each watershed boundary, there is space utilization necessary to carry out activities that are applied in space utilization zones, such as settlement, education, trade, and so forth.

Any change of land use allocated within the watershed limits will determine the value of C (catchment coefficient) for each subclass of land use object in the area, but will also determine the amount of runoff to be produced by each subclass of land use object, which will determine needs of drainage systems and retention ponds. The allocation of existing land use distribution to each sub-watershed will ultimately determine the need of drainage network system in the area. Thus there is a spatial relationship between the variables of land use change within the watershed area with the amount of runoff to be generated. The amount of land use allocation to be able to serve the population allocated to each sub-basin will determine the number of distribution needs of network system Drainage (subclass utility object). Thus there is a relationship between the variables of land needs in each sub-basin with the needs of the distribution of the drainage system.

The attributes for each of these spatial use objects are stored in tabular data, broken down by land use type, sub-class of land use, within each sub-watershed. To obtain the amount of land utilization in each sub-basin, simply add up the utilization of land for each sub-basin boundary, and the utilization of each sub-basin is summed up to obtain land use throughout the basin. Connection diagram (E-R Diagram) for data storage, can be seen in Figure 4.

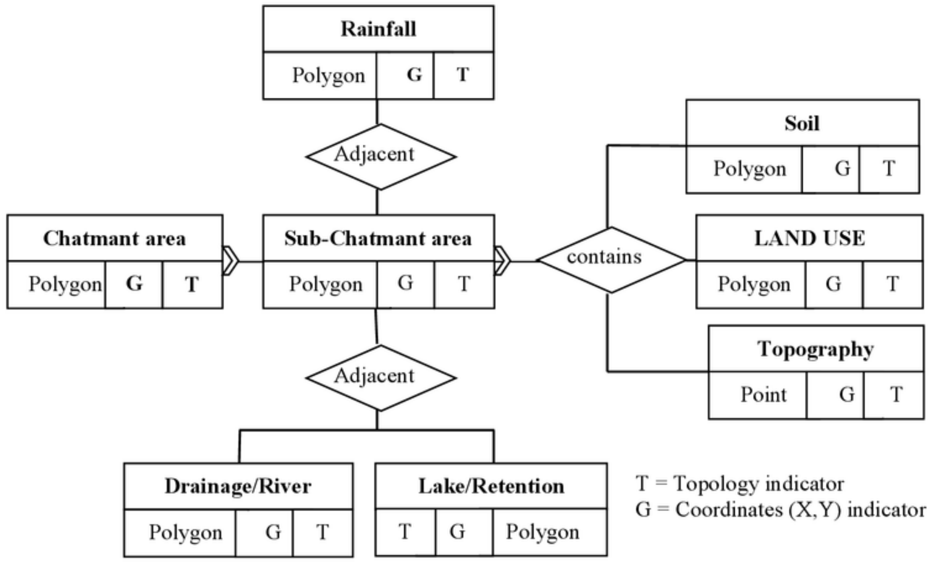

Fig. 4 Entity-Relationship Diagram for Run-off management at Chatmant Area

3.2. Data Structure

Each object will have at least one data attribute, which must be defined by the type of identifier (OID), the constructor type of each data column (integer, decimal, character, etc) and the value of each data column contained in the data attribute, - the column that will be used to load the attribute value.

The object set as the base class will be specified as the key identifier, which will be represented as the primary key. From the primary key, then each object that belongs to the class will have an OID that follows the hierarchy of the primary key of the class above it.

The method or commonly called function is used to write commands to perform mathematical calculations based on the analysis model used. In determining the allocation of any required land use and placed within each sub-basin boundary, a run-off model is used. The mathematical function used to calculate the probability of land use is directly defined in the sub-class definition of sub-basin boundaries. Thus, to know the value of the total infiltration coefficient that exists within the sub-subclass of sub-watershed or sub-basin it is the sum of the infiltration coefficient values present in each sub-watersheds. The principle is commonly referred to as inheritance, polymorphism, and encapsulation. The design of the data structures for each object classification used in the management of the Spatial Planning can be seen in Table 1 below.

Table 1 Structure Database at Chatmant Area

Object :	***Chatmant Area***	
Attribute	**Data Type**	**Wide**
Q code	Integer	(10)
N_CA	Character	(25)
NS_CA	Character	(25)
Area_Ha	Decimal	(15,3)
Perimeter	Decimal	(15,3)
Center_L	Decimal	(10,3)

Object :	***Land Use***	
Atribute	**Data Type**	**Wide**
OID	Integer	(10)
L_Use	Character	(30)
Class	Character	(30)
Area_Ha	Decimal	(15,3)
N_C	Decimal	(5,3)
RD	Decimal	(5,3)
ET_ETO	Decimal	(5,3)
A%	Decimal	(5,3)
P	Decimal	(5,3)

Object :	***Topography***	
Atribute	**Data Type**	**Wide**
OID	Integer	(10)
S_Height	Character	(10)
Z (m)	Decimal	(10,3)

Object :	***Hydrometry***	
Attribute	**Data Type**	**Wide**
OID	Integer	(10)
I_Countur	Character	(10)

O_Name	Character	(15)
Z	Decimal	(10,3)

Object :	***Soil***	
Attribute	**Data Type**	**Wide**
OID	Integer	(10)
Type_Soil	Character	(25)
Area (Ha)	Decimal	(10,2)
Z_Organic	Decimal	(5,2)
OM_Value	Decimal	(5,2)
Moisture_Sc	Decimal	(5,2)
BD	Decimal	(5,2)
pH	Decimal	(5,2)
K_Value	Decimal	(5,2)

The watershed class sub-class and space utilization shall consist of sub-basin boundary tables, which contain sub-basin objects and their attributes containing {OID; N_CA; Area_Ha; Perimeter; L_CA}, and chatment object with the same attribute, but the attribute value is the sum of all attribute values of the sub-watershed that are its members.

Land utilization subclass will contain Tables with attribute {OID; L_USE; Area_Ha; Coeff_C; Root_Depht}, which is connected to the sub-basin boundary based on the typical identifier number (OID), thus forming the sub-basin table relation {OID; L_USE}.

4. DISCUSSION

By utilizing the distribution of average C values from the thematic maps of land use for each sub-watershed, soil type, and the amount of rainfall intensity for each return period, an analysis can be carried out to calculate the run-off for each river system as part of the Jakabaring sub-watershed. The first step is the addition of GIS coverage (weighted coefficient infiltration value (C) on land use and land, river length in river subsystem, area and slope of river sub-system), edited to ArcMap TOC, in ArcGIS Visual Basic Editor module which is activated and interface code developed. This interface is named the Interface for Estimated Surface Runoff using a hydrograph. The codification of this section uses the concept of pointing variables and simple mathematical formulas to estimate the weighted hydrograph of the value of the condition of the river sub-system with different characteristics.

The following is the calculation of rainfall intensity using the Mononobe Method for a 10-year return period with a duration of 5 minutes using maximum daily rainfall of 150.59 mm, using TOC ArcMap facilities, in the Visual Basic Editor module that is activated and interface code developed using simple mathematical formulas to calculate rainfall intensity.

Table 2 Rainfall Intensity and rain of duration

t	t	Return period (*Year*)		
minute	hours	R2	R5	R10
5	0.083	212.68	249.36	273.65
10	0.167	133.98	157.09	172.39
15	0.25	102.24	119.88	131.56
30	0.50	64.41	75.52	82.88
45	0.75	49.15	57.63	63.25
60	1	40.58	47.57	52.21
120	2	25.56	29.97	32.89
180	3	19.51	22.87	25.10
240	4	16.10	18.88	20.72
300	5	13.88	16.27	17.85
360	6	12.29	14.41	15.81
720	12	7.74	9.08	9.96

Table 3 Resume runoff coefficient (*C*) Jakabaring river sub-system based on Figure 5

Chatmant	**Land use**	**A (Ha)**	**C x A**	**Σ CA**	**Cw**
Kedukan	Build up area	3.098	1.859	12.888	0.221
	Open space	55.148	11.03		
Jakabaring 3	Build up area	2.44	1.464	5.565	0.243
	Open space	20.507	4.101		
Ogan 2	Build up area	3.845	2.307	4.186	0.316
	Open space	9.393	1.879		

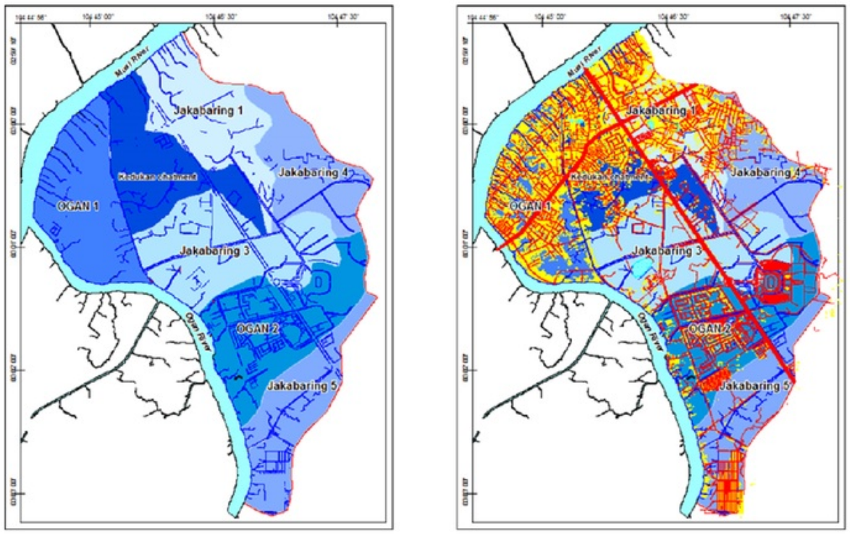

Fig. 5 River sub system in the Jakabaring watershed and Resume runoff coefficient

If seen in the Kedukan sub-watershed, to get runoff prices that occur every hour with variations in the return period of 2, 5 and 10 years. Calculation of the amount of runoff due to rain in minutes within 24 hours can be seen in Figure 6, for Tr 10 years, peak discharge (Qp) is obtained at 0.03 m3 / sec, while Base flow (Qb) is obtained at 0.02 m3 / sec.

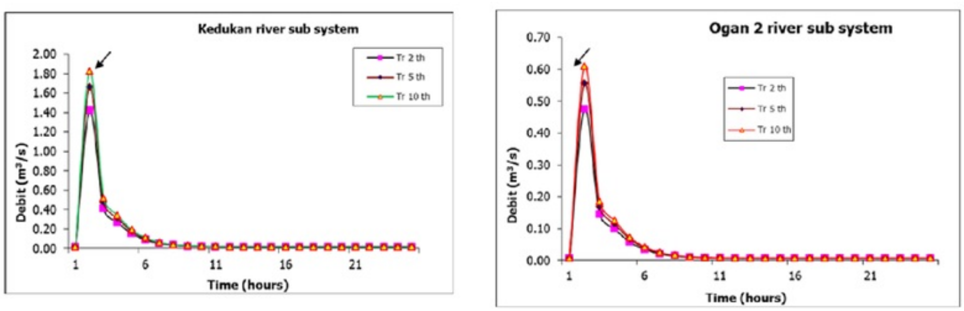

Fig. 6 Synthetic hydrograph of Nakayasu at Kedukan and Ogan 2 river sub-system

In this study, an interface for surface runoff estimation using the hydrograph technique Nakayasu synthetic unit was developed using the built-in macro programming language in Visual Basic Application (VBA). This research is carried out in conjunction with two other components, namely the prediction of surface runoff from the Kedukan river sub-system and the Ogan river sub-system by using interface development capabilities in GIS. The interface developed uses a series of activities ranging from creating a database structure to store all spatial databases in the form of a relational object database in the GIS feature to estimate surface runoff depth using Nakayatsu synthetic unit hydrograph.

5. CONCLUSION

(1) There are 8 data objects that can be identified with 7 relationships in the database structure
(2) The relationship between data objects is formulated by utilizing the SQL Select model by connecting tables and columns based on the formula of synthetic unit hydrograph Nakayasu
(3) From the design flood hydrograph shows that the flood reaches its maximum after the peak time reaches 1 hour and the maximum planned flood discharge based on the Nakayasu HSS method for the 10-year return period is 1.82 m^3/s.

(4) In the river system sub-system, the capacity of the pond is 11,116.25 m^3 with a pool area of 4446.5 m^2 and a depth of 2.5 m. While on the Ogan 2 river subsystem, the capacity of the pool is equal to 4,017.62 m^3 with a pool area of 1607.05 m^2 and a depth of 2.5 m.

(5) When simulating the existing conditions on the channel using the Tidal Forecasting program, the maximum flood water level elevation value is 2.15 m from the riverbed.

6. SUGGESTION

(1) This system requires further modification of the synthetic unit Hydrograph based method to include more scenarios or realistic indices to account for the previous conditions that apply in watersheds during and before rainfall occurs.

(2) This study developed a GIS-based Interface using the default macro programming language to estimate surface runoff using a curve count estimation technique. In addition, the developed interface needs to be operated in different watershed conditions to ensure the predictability of the modification of the hydrograph technique of the synthetic unit for estimation of runoff from unfilled watersheds

7. ACKNOWLEDGMENTS

Acknowledgments are submitted to the Research Institute of the University of Sriwijaya, which has provided a Competitive research fund for this activity.

8. REFERENCES

[1] Dinar DA Putranto, Heni Fitriani, Sarino, Agus Lestari Yuono, Land Allocation Management System in Watershed for Controlling Surface Flow and Inundation in Urban Areas, Research Reports, LPPM of University of Sriwijaya, 2016.

[2] Portugués-Mollá, X. Bonache-Felici, J.F. Mateu-Bellés, J.B. Marco-Segura, A GIS-Based Model for the analysis of an urban flash flood and its hydro-geomorphic response. The Valencia event of 1957, Journal of Hydrology, Elsevier, Volume 541, 2016, Pages 582-596.

[3] Sarino, Agus Lestari Yuono, Dinar DA Putranto, IC. Juliana, Flood Modeling for Mitigation and Drainage System Management Palembang City, Research Report, LPPM University of Sriwijaya, 20015

[4] Dinar DA Putranto, Sarino, Yuono, AL., Land Allocation Management System (SIMAL) as a basis for space allocation, Conference Proceedings, in 3rd CGISE and FIT-ISI, 2015, pp 573-579

[5] Getachew Tegegne and Young-Oh Kim, Modelling ungauged catchments using the catchment runoff response similarity, Journal of Hydrology, Elsevier, Volume 564, 2018, Pages 452-466.

[6] Yongyong Zhang, Jun Xia, Jingjie Yu, Mark Randall, Yichi Zhang, Tongtiegang Zhao, Xingyao Pan, Xiaoyan Zha, Quanxi Shao, Simulation and assessment of urbanization impacts on runoff metrics: insights from land use changes, Journal of Hydrology, Elsevier, Volume 564, 2018, pages 247-258.

[7] Zeynab Karimzadeh Motlagh, Mohammad Husein Sayadi. Siting MSW landfills using MCE methodology in a GIS environment (Case study: Birjand plain, Iran). Journal Waste Management, Elsevier. Volume 46, 2016, pages 322-377.

[8] Dinar DA Putranto, Sarino, Yuono, AL, Digital Field Model for the Rainfall-Runoff Analysis of the Musi Sub-watershed Upstream and Downstream of the Musi River Basin, Research Report, National Strategic Grants, 2015.

[9] Dinar DA Putranto, Sarino, Yuono, AL, 1D / 2D Model in Palembang City Flood Modeling Analysis, Research Report, National Strategic Grant, 2013.

[10] A. Wörman G. Lindström J. Riml (2017) The power of runoff, Journal of Hydrology. Elsevier, Volume 548 Pages 784-793.

[11] Emad Hasan, Aondover Tarhule, Piere Emanuel Kirstetter, Raceclark, Yang Hong, 2016, Runoff sensitivity to climate change in the Nile River Basin, Journal of Hydrology, Vol 561, pages 312-321.

[12] Hyun-Joo Oh, Yong-Sung Kim, Jong-Kuk Choi, Eungyu Park, Saro Lee, (2011). GIS mapping of regional probabilistic groundwater potential in the area of Pohang City, Korea, Journal of Hydrology, Elsevier, Volume 399, Pages 158-172.

[13] Malczewski J, Chapman T, Flegel C, Walters D, Shrubsole D, Healy MA (2013) GIS multicriteria evaluation with ordered weight averaging (OWA): case study of developing watershed management strategies. Environ Plan A 35 (10): 1769–1784

34-42-4710-Sarino-July-2019-59

ORIGINALITY REPORT

5%	4%	%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to School of Business and Management ITB Student Paper	1%
2	www.floodcba.eu Internet Source	1%
3	Submitted to Yüzüncü Yıl Üniversitesi Student Paper	1%
4	gmsarnjournal.com Internet Source	1%
5	Submitted to Universitas Diponegoro Student Paper	1%

Exclude quotes On

Exclude bibliography On

Exclude matches < 1%