# FLOOD PLAIN SIMULATION MODEL BY INTEGRATION OF SURVEYING PACKAGES AND GIS

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**Abstract**

*Geographic Information Systems (GIS) are tools for managing, analyzing and displaying geographic data and data which can be related to geographic objects. The collaborating element of present day GIS and computers can benefit organizations using a GIS (combined with other data base systems) as the foundation of all its data operations. To produce an effective flood monitoring systems it is therefore highly beneficial to utilize both flood modeling and GIS technologies. This paper is focusing on development flood plain simulation model. An evaluation of this approach has been using the practical application of surveying packages and GIS software. The model includes GPS data of the flooded areas based on the spatial database created for the study area. In order to identify the potential flood risk zones, respective hydrographs have been drawn to show the occurrence for the particular area. For instance, it has been implemented for the river basin of the Gombak River in Kuala Lumpur. ArcView Software is chosen to implement the model for the reason that it's highly relevant towards the model development. The final section of this paper, we will concentrate on visualizing spatial data using a three dimensional in providing water volume on specific flood area and obtaining the analysis on the river. Triangulated Irregular Networks (TIN) is the methodology that was used in producing the flood plain model. TIN was our working map because it provided us with elevation, which is very important when looking at water levels and cross sectional river profiles.*

***Keywords:*** *GIS, GPS, spatial data, Triangulated Irregular Networks (TIN) and profiles.*

## 1.0 INTRODUCTION

The competence of very high performance GIS software packages such as ArcView and surveying packages such as AutoCad and Surfer offers new prospects for engineers to perform flood monitoring analysis with interactive visualization. Data processed by surveying packages is transported to produce a digital elevation model (DEM). When a DEM is available, a GIS system can be used to draw geometrical data for the surface of the area, the river branches and spills/overflows from the DEM. It can also be used to distinguish the potential flooding areas (areas to be modeled in two-dimensional) and to visualize the spatial extent of the modeled floods. In this way, the GIS system is applied both as pre-processing tool and a post-processing tool. The communication between the surveying packages and the GIS system acts in two directions. Development of this flood plain simulation model is projected to visualize flood prone area within the study area.

Hence, an evaluation of this approach of river flood plain simulation model has been made by the practical application of the surveying packages; AutoDesk Map 6 and Surfer 8.0 in combination with ArcView 3.2. It has been implemented for the Klang-Gombak River basin in Kuala Lumpur. The river network for this basin is shown in Figure 1.

## 2.0 THE STUDY AREA

The study reach covers Gombak River and Klang River at Kuala Lumpur. Area covered from Gombak River near Jalan Raja and Klang River near Jalan Melaka towards where the two rivers meet until Klang River close to Market Square. This covered river area crammed with commercial and historical buildings, compounds and structures. For instance, Klang and Gombak Rivers Confluence is located 0.1 km from Masjid Jamek, 0.1 km from Market Square and it is also located 0.1 km from Bangunan Sultan Abdul Samad. Estimation area covered is about 600m² x 800m².

Klang and Gombak Rivers Confluence and its adjacent rivers have a history of frequent flooding problems. Previously, Kuala Lumpur suffered serious damages during the flash flood in April 2001. Flash floods following over two hours of heavy rain caused thousands of vehicles and several main roads in the city to be submerged and lives lost. According to "The Klang River Basin Environmental Improvement and Flood Mitigation Project" study commissioned by the Government and funded by the Asian Development Bank in July 2003 clearly indicates that the confluence of Klang River, Gombak River and the Ampang River could not carry storm water during the heavy rains. This river was selected for this study because of availability of river survey data and concurrently, due to its flood prone area.

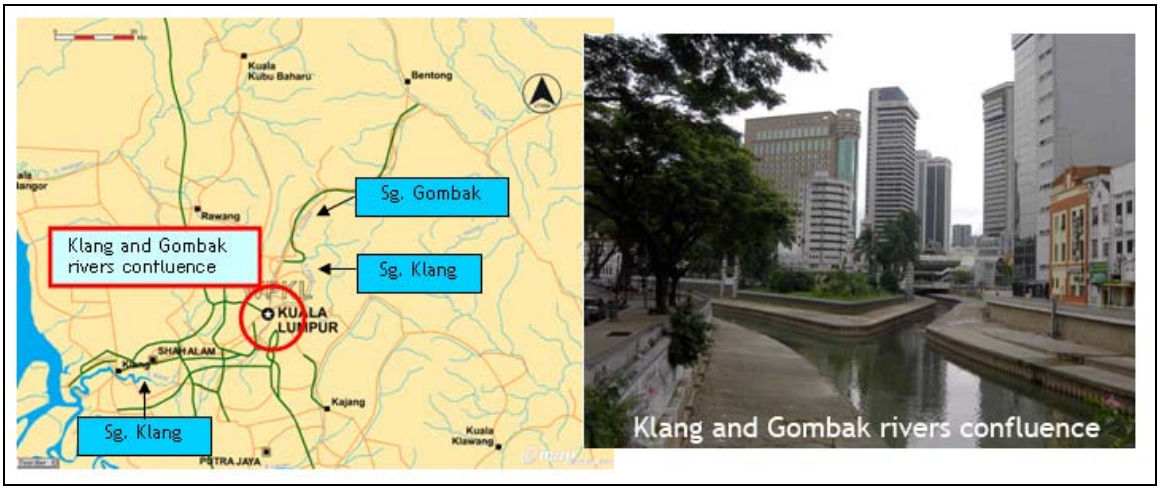



Figure 1: Klang and Gombak rivers confluence; flood prone area in Kuala Lumpur.

### 2.1 Objective of the study

The main purpose of the study is to develop flood plain simulation model by integrating surveying packages and GIS system.

The study will concentrate on visualizing spatial data using a third dimension in providing water volume on specific flood area and obtaining the analysis on the river. Triangulated Irregular Networks (TIN) is the methodology that been using in producing the flood plain model. TIN was our working map because it provided us with elevation, which is very important when looking at water levels and cross sectional river profiles.

## 3.0 USE OF A SURVEYING PACKAGES

Essentially, the use of surveying packages is integrated module packages that comprehensively resolve in every surveying operation, engineering and its design. Surveying packages capable in receiving data

input from electronic data collector, digitization and memory card. On the other hand, it able to process details observation data from a fieldwork.

Surveying packages used in this study are Civil Design and Survey (CDS), Surfer 8.0 and AutoDesk Map 6.0. CDS used for processing surveyed data for producing a plan. It competent in doing engineering analysis and CDS open for high capability with recent needs.

### 3.1 Data : Downloading, processing and editing

Data collected and downloaded from total station and is carried out information regarding water level and rainfall is obtained from Department of Irrigation and Drainage's (DID) official website.

With CDS, data is processed and calculated automatically in obtaining the height value, coordinates and its adjustment for every detail. After downloading, data exported into Autodesk Map for editing process before integrate it with ArcView software for modeling and analysis. The contour, lines, Triangulated Irregular Network (TIN) and Digital Terrain Model (DTM) are generated from previous calculations. These are the steps that required in producing the model. Data processed is forwarded to editing stage by Autodesk Map. A plan on study area is produced using Autodesk Map software shown in Figure 2.

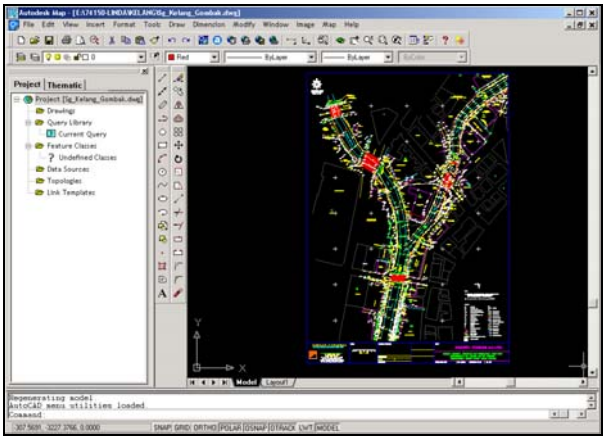


Figure 2: A plan on study area is produced using Autodesk Map software

## 4.0 USE OF A GEOGRAPHICAL INFORMATION SYSTEM

The growth of GIS technology recently has brought the GIS software into various analyses, not only on spatial information in fact on its attributes information too. ArcView is chosen for completing the study in modeling the flood plain simulation of area covered around 600m² x 800m² and the base height of the model is depends on z value (elevation) obtained from the generate contour taken at 22m. The water level is simulated by few times that each is represented for different height of water level. The normal water level height at Gombak River is at 26m and it simulated at increment of 1m water level until the maximum height of the water level is at 32m. When water level reach maximum level at 32m, flood will occur and drench homes and business surrounding.

### 4.1 Visualization of Flood Plain

Figure 3 given away the visualizations of increment water level from 26m until 32m.


Figure 3: Visualizations of increment water level from normal height;
26m until the maximum height of 32m.

From Figure 3, it shown clearly the risky flood prone area with different depth value. The height values on the top bank of river is at 30m. Both 3D and 2D display are created from ArcView software. From

the interpolation raw data and detail survey using ArcView able to illustrate its water volume as shown in Table 1 and in Figure 4.

Table 1: Flood area and its volume.

| Water Level (m) | Water Volume ($m^3$) | Flood Area ($m^2$) | Percentage of Flood Area (%) | Area flood unaffected ($m^2$) |
|---|---|---|---|---|
| 26 | 2171570.617 | 16438.445 | 3.674 | 431028.835 |
| 27 | 2593125.289 | 22834.777 | 5.103 | 424632.503 |
| 28 | 3008650.328 | 30230.484 | 6.756 | 417236.706 |
| 29 | 3416976.451 | 49992.149 | 11.172 | 397475.131 |
| 30 | 3793798.225 | 146730.442 | 32.791 | 300736.796 |
| 31 | 4105644.776 | 255949.238 | 57.299 | 191518.042 |
| 32 | 4266926.467 | 285282.902 | 63.755 | 162184.378 |

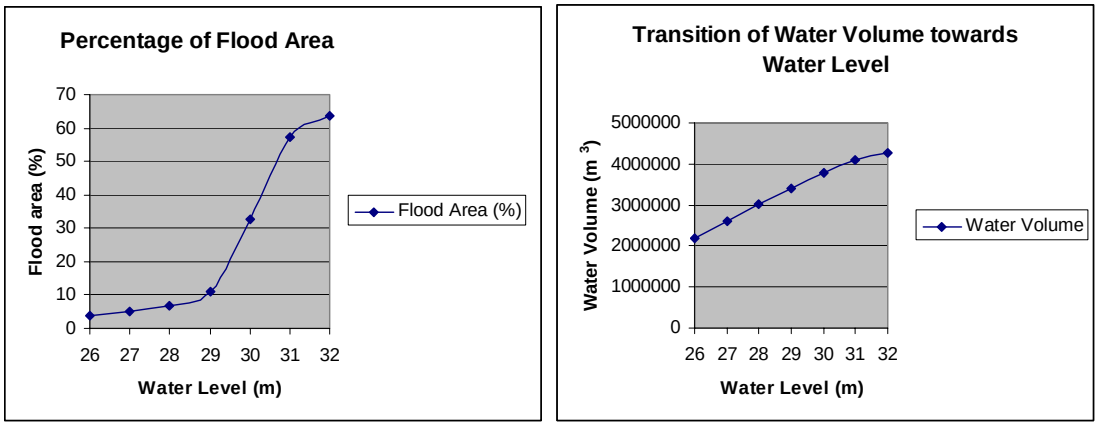



Figure 4: Percentage of Flood Area and the Water Volume Towards Each Water Level

From the Figure 4, it shown 26m is normal water level in the river. Increment of 1m water level will increase the flood prone area. For instance, at 28m the increment of water volume is about 3008650.328m3. And at 32m it will increase to 4266926.467m3. This will cause the water spills from the river bank and cause overflow to the area involve.

### 4.2 Analysis on cross-sections graphs

The cross sections graph of Gombak River in Figure 5 shows that the maximum water level is at 32m. From the cross sections line between A and A' is about 400m. For clear analysis on each water level, Figure 6 is shown clearly relation between cross sections and water depth for each water level.

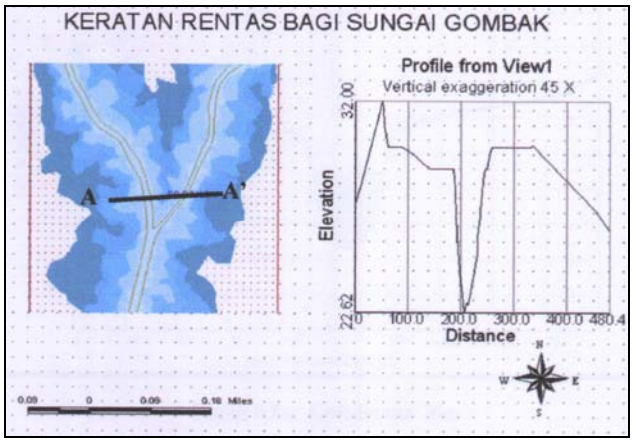
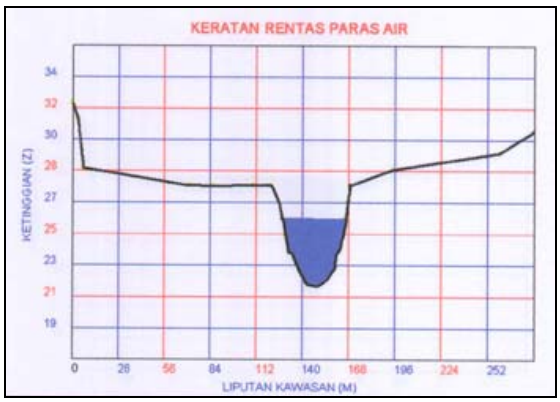
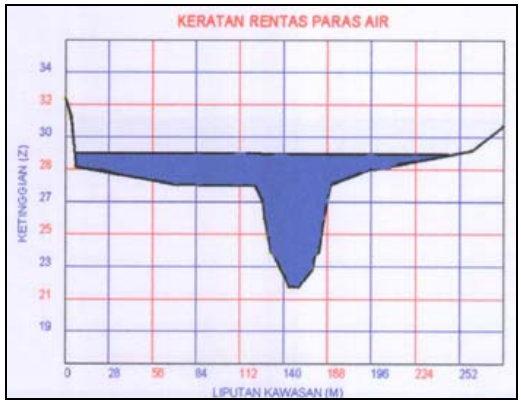


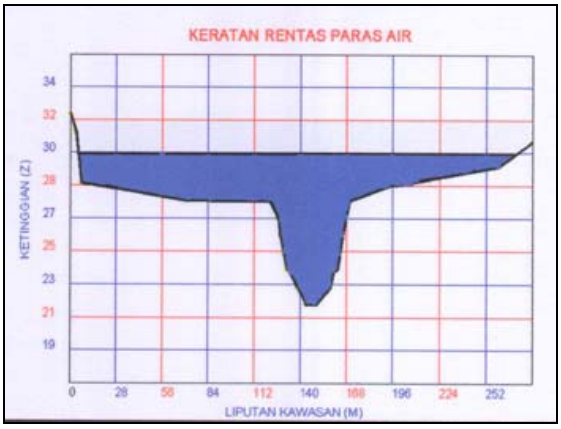

Figure 5: Cross Sections Graphs



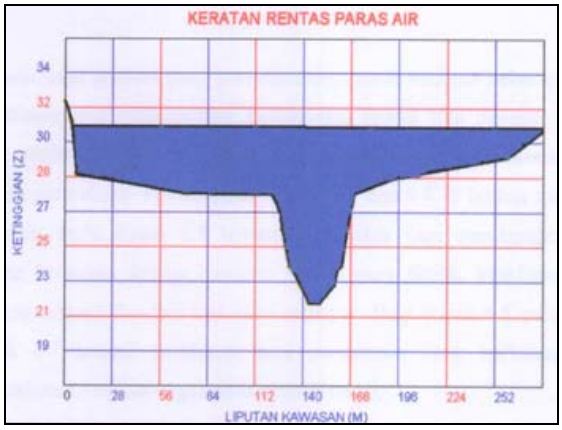

Water Level 26m




Water Level 28m




Water Level 29m




Water Level 31m

Figure 6: Relation between cross sections and water dept for each water level.

## 5.0 CONCLUSION

Flood plain simulation model can be created and further studies from it can be carried out.. The integration between survey interpolated data and ArcView give a result as we expected. Creating flood plain simulation using ArcView and few surveying packages managed to generate desire flood plain model can provide information regarding the extend of area covered under water at different water level. It can gives information for flood management work. In fact, ArcView application is easy to use in updating data and flood plain simulation can produced in interactive visual.

## ACKNOWLEDGEMENT

Our gratitude goes to Department of Irrigation and Drainage (DID) for providing the required rainfall data on Gombak River. This research was made possible by support from Ministry of Science, Technology and Industry (MOSTI) that has granted Intensified Research in Prioritized Area Grant (IRPA).

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