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Determination of Catchment Area Using DEM Delineation in Bakri Drainage Network

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Abstract: The flood disaster had been an issues for all country around the globe including Malaysia. This impact can be observed through the economic activities, social, environmental and psychology aspect. In this studies, the flood prone areas that had been investigate were at Bakri, Muar. For flash flood that have been prone to happen in Muar is because of the drainages system of construction is not fully maintenance and cause the traffic flow in Muar effected furthermore the safety of citizen unsecured. Thus, drainage system at Bakri, Muar had been observed and navigate by using the Unmanned Aerial Vehicle (UAV) for delineate the watershed. The result from the flight of the drone to construct the images from plotting Digital Elevation Model (DEM) data have been determined. The result of DEM with the aid of UAV have been accurately plotted for the area and the area of the flow drainage. The result of the DEM with the aid of the Google Earth was plotted randomly with the maps of site. Thus, the flood mapping for Bakri are plotted into the DEM with the aid of the UAV. Then, the uses of online tools had fully utilized and practice in order to obtain the final output which is watershed delineate. The online tools such as QGIS, Google Earth and GPS Visualizer had been adapt through the process of producing final output product. Thus, the QGIS plays an important role in in this studies to obtaining the accurate and reliable data for the watershed delineate.

Keywords: Flood Mapping, Watershed, QGIS, DEM

1. Introduction

Each country all around the globe will not be escape from the disaster. At the end of the year, Malaysia will be face the monsoon season. Excessive rainfall and the narrow size of catchment area will be the main factor of the flood phenomenon happened [7]. Thus, the impact of the disaster can bring harmful in all aspect which are in social, economic, environmental and psychology.

For generate the optimum drainage system to solving the problem of flood, the construction of watershed boundaries is important. The catchment can be act as the area for transferring overflow of

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water when the heavy rain happened. The increasing of rainfall due to heavy rain will automated transfer to the catchment. This could reduce the flood event happened in future thus the effect from the flood can be decreasing over the years. Throughout the years, the Muar River had experienced the consistent heavy rainfall in which resulted in the flooding at the lower area of Muar. This can be seen through the recorded data concluded that in total 29 flood event from the year of 1980 to 2010 [9]. The catchment can be act as the area for transferring overflow of water when the heavy rain happened. The increasing of rainfall due to heavy rain will automated transfer to the catchment. The shape of the catchment is differ path to stream line and flow down to the stream network [2].Thus, in order to clearly identify the location of the watershed for this area, so this study was perform to delineate watershed by using UAV. Then, this study of watershed delineation conducted will overcome the problem by using UAV to determine the best location to propose of catchment area. The objectives of this research is to determine the delineation of watershed by using Unmanned Aerial Vehicle (UAV), to produce the mapping of drainage for development of watershed Bakri and to analyze the process to produce the watershed by using QGIS

The Unmanned Aerial Vehicle (UAV) is deploy to give overall view on the structural and geographical areas. The advantages of using an UAV in capturing the images are can be shorten the time of operation and clearly images with the precise topography and geographical of the area. Thus, the system and database process of Digital Elevation Model (DEM) and process through the QGIS software. The DEM are obtain derived from the mapping and processing the data at QGIS software for standard operation for delineating watershed areas. The digitization methods are used for deriving the terrain elevation from standard topographic maps [10]. With undergo the research, the observation and data collection at location of flood disaster at Sungai Muar was implementing the knowledge and practical as a civil engineer. Thus, this information will be beneficial to the Department of Drainage of Muar for the estimating the flood disaster that will happened in future.

As concluded, this study will be explained in details for the delineation of watershed with the uses of online tools such as Google Earth, GPS Visualizer and QGIS. The objectives is projecting as the guideline for the studies achieve the data analysis align with the title.

2. Literature Review

In this literature review, the component Digital Elevation Model (DEM) for watershed delineation and the flood management in Malaysia is explained in detailed and practically. The definition of Digital Elevation Model (DEM) is the digital representation of the land surface elevation with respect to any reference datum [1]. The Digital Elevation Model (DEM) is compatible and practical to produce topography map. According to the article written by [1], the uses of DEM can be used in hydrologic and geologic analysis, hazard monitoring, natural resources exploration and the agricultural management. The causes of the flooding are happened due a few factors such as improper drainage system, pollution, management of urbanization, cracking of dam and lastly the environment factor which is weather [1].

There are different tools and function that can be used as watershed delineation which are Digital Elevation Model (DEM), Digital Terrain Model (DTM) and Digital Surface Model (DSM). For ground elevation data is the Digital Terrain Model (DTM) can be obtained through sources such as LIDAR, aerial photo, ground survey and satellite data. This DTM are functioning in the aerial photography for the purposes on analytical and digital photogrammetric techniques [4].

In determining the watershed and reservoir area, it can be determined by using manually via topography maps or simplified using Digital Elevation Model (DEM) data [2]. The purpose of building the catchment is to identify the areas within a development that are at risk flooding base [2]. Thus, DEM resolution play an important roles to the modelling resolution and accuracy for the flood inundation modeling. If the DEM is in low quality, DEM simulation can affect the flood propagation even though model simulation can be obtained [5]. Terrain elevations for ground location are derived from standard topographic maps through the use of digitization methods.

As conclusion, the Digital Elevation Model (DEM) is a crucial for producing topographic maps and needed for the flood mapping. Thus, the topographic data are crucial in determining water surface elevations, base flood elevation, extent of flooding, and the accuracy of flood maps at the prone area

3. Methodology

This methodology is creates based on the previous studies along the requirement from the objectives of study. In the Figure 1 shown the flowchart of this study.

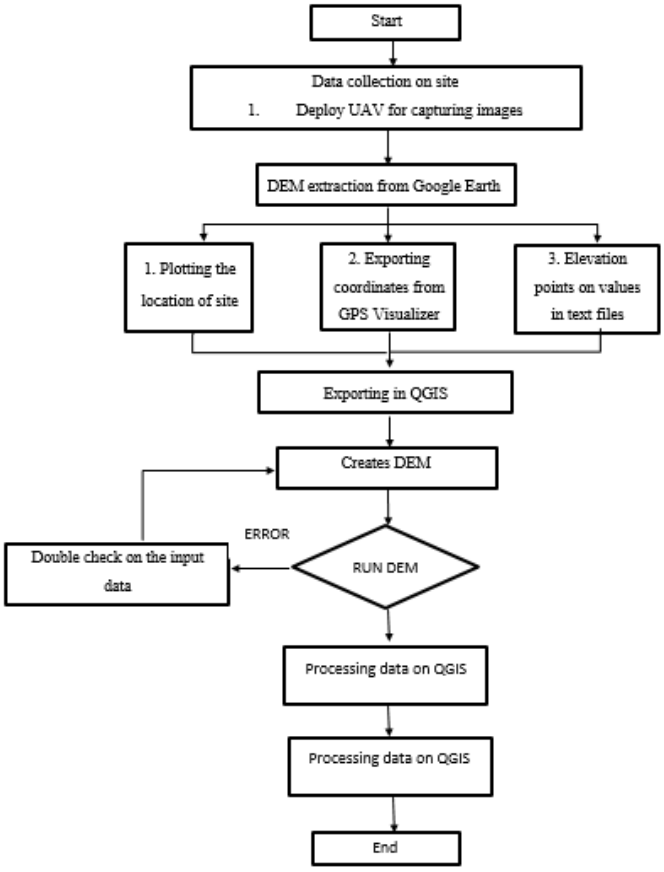

Figure 1: Flowchart of this study

3.1 Data collection on site

The collection of data that obtained from the site are collected with the aid of Unmanned Aerial Vehicle (UAV). With the aid of UAV, the boundaries and area of the site were accurately measured and observed. With surveillance from the lecturer, the UAV was proceed to fly along the drainage system of Bakri area. Before arriving at the location, data collection and analyzing of data have been discussed and practically shown by the lecturer for avoiding any miscommunication data or error happened.

3.2 Data extraction from Google Earth

In this stage, the Google Earth had played a big roles in obtaining the DEM data. Nowadays, the surveyor will be comparing the method on using online tools and traditional methods. Before the online tools is used, the government agency related which know as Department of Survey and Mapping (JUPEM) were gathered the topographic maps. Later on, the topographic maps was scanned, digitalling the contour lines for the obtained the evaluation values. This method was time consuming, less accurate and unpractical [9]. Next, in order to systematically arrange the values from Google Earth, moved

forward to the next online tools which is GPS Visualizer. With this online tools, the existing boundaries of river map that created from the Google Earth will be proceed to create watershed of Sungai Muar. This online tools is practically used to converting the format from Google Earth before successfully added into the QGIS. The GPS Visualizer is converted the data into the Keyhole Markup Language (KML) File formatted. After that, the data will be uploaded on the QGIS software for proceed the process of watershed delineate.

3.3 Processing on QGIS

The definition of the QGIS is the open source of desktop application that can be installed in the on various operating systems such as Windows, Mac OS X, Linux (Ubuntu), and Unix. For this online tools can be easier to be access with no subscriptions. For process creating DEM into the QGIS, the installing of QGIS is the primary step in getting the work done. For installing the QGIS, this online software available on the official website at the Google.

The steps that needs to be focusing more to avoid any mistakes and inaccuracy data recorded are by installing the plugins file name HCMGIS and coordinator. The properties of the DEM is observe to convert the data output before process of fill sink is proceed. This data is reprojected into the UTM zone 43N. After successfully creates the DEM, the contour can be creates by using the terrain analysis of hillshade. In this analysis the azimuth (horizontal angle) have been changed into 315.00 and the horizontal angle into the 45.00 for followed the geographical of location. By decreasing the transparency into 30% and changing the style into singlehand psuedocolor the contour of boundaries can be seen clearly. The process of fill sink will obtained the result of filled DEM. The fill sink process contains in three version which is fill sink xxl (Wang and Liu) that suitable for the degree of slope above the 1.0 and lastly fill sink. Thus, for our studies recommended for the fill sink xxl (Wang and Liu) in which the slope is below 1.0.This process is carried by save the file name Filled DEM.

Firstly, the process from the Strahler stream is for obtained the stream at the selected area and then will proceed into the raster calculator. Next, for producing channel network and drainage basin, click onto the processing toolbox from the work environment in QGIS. From this process, the flow direction can be determined. In the flow direction, the values on the each color range is different in the direction such as north, south, west, north east, south east, south west, north west. The output of this process will obtain the stream line with different range of color. Then, the boundaries of each watershed can be estimate.

The outlet point process must be starting with saving the new layer name shapefile layer. The outlet point is plotting by using the toggle editing and adding the point feature. The outlet point is chosen at the end of the point of stream in watershed. Then, the upslope area of the watershed can be proceed with the accurate of data longitude and latitude from the outlet point. The output of upslope area are the boundaries of the chosen watershed is visualize. After that, the upslope area output project in polygon shape and must be convert from raster to vector. Therefore, to produce the watershed chosen highlight the boundaries inside by clicking on the properties then deleting the file not meet requirement.

3.4 Watershed delineation

Before the final output is obtain, the channel and the upslope must be in clipped file. For carry this process, upslope clipping and the channel clipping can be find in the processing toolbox. The arrangement of the layer is crucial for the output result in watershed delineate. Lastly, the watershed is observed with the filled DEM underneath for the accurate boundaries watershed plotted. Before the final output is obtain, the channel and the upslope must be in clipped file. For carry this process, upslope clipping and the channel clipping can be find in the processing toolbox. The arrangement of the layer is crucial for the output result in watershed delineate. Lastly, the watershed is observed with the filled DEM underneath for the accurate boundaries watershed plotted.

4. Data Analysis and Discussion

For this part will be presented and discussed about the result and output obtained when the methodology that had been carried on. The result and output started with the DEM extraction from the Google Earth. In this stage, the location of the site have been plotted with the aid of the images from Unmanned Aerial Vehicle (UAV). After that, the coordinates have obtained from the Google Earth Then, the points elevation obtained from the GPS Visualizer website. Next stage, the data obtained had been exporting to QGIS to perform the DEM. By using the QGIS, data analysis is shown the DEM output, contour output, filled DEM output, strahler stream output, flow direction output, outlet point output, upslope area output and the watershed output. With this DEM, the data for proposing watershed delineate can be completed.

4.1 Analysis of DEM output from Google Earth and the aid of the UAV

In this section, relationship between DEM output from the Google Earth and the aid of UAV have been explained in details. The data output in both options have been portrayed to show the accuracy of the data output. Thus, the comparison of both options have been shown which options can be used in for flood mapping.

4.2.1 Analysis on the DEM extraction from Google Earth

In this studies, the area and boundaries of Sungai Muar drainage system had been determined during the site visit. With the technology of civil engineering improved along the years, the identifying and determining the boundaries and area of site can been easy to obtain. With the aid of Google Earth, the images of case study can be obtained in short of time. The visualizing of the location is crucial for the next stage process. The Google Earth software is compatible to be using as the mapping is updated with the time. The Google Earth also user friendly as the user can understand without complicated procedure.

4.2.2 Result in Google Earth

In Google Earth, the details information on the current location contained latitude, longitude, and altitude. The accuracy of flowpath boundaries can be determined by marking and traced inside the boundaries numerous path as the denser of the points plotted and the faster who leads to the accurate and output of DEM. The Figure 2 below will be shown on Bakri, Muar that have been plotted with the aid of Google Earth.

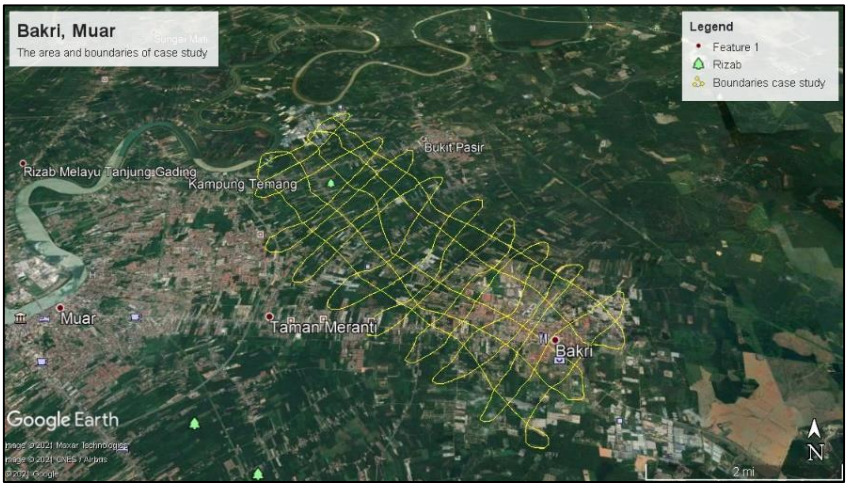

Figure 2: Figure shown on boundaries of case study

In Google Earth, the boundaries of the case study have been plotted and the data obtained are the longitude, latitude and altitude. The maximum value of accuracy flowpath boundaries can be determined by marking and traced inside the boundaries numerous path as the denser of the points plotted and the faster who leads to the accurate output of DEM. The data output obtained was in the

unsystematically order. The markings and pointing is based on the UTM zone 43N. Thus, the process on the collected and arranging the points of data have been proceed to the next online tools. The tools that had been used for this task is GPS Visualizer

4.3 Analysis of data from QGIS

In this analysis, the result of each steps in this stages have been shown. For this software which is QGIS, there are a few steps that helping in collecting the result and data analysis.

4.3.1 Result on DEM

Firstly, in producing DEM in the QGIS function of Inverse Distance Weighting (IDW) Interpolation have been used. The layers of interpolated will be shown in the layer column for ensure the boundaries had been plotted accurately. The DEM is used for the base for showing the streams of the boundaries area. This DEM file was added on work environment of QGIS as the raster layer. This output was reprojected in the format of UTM zone 43N. Figure below shown the output of DEM by using the QGIS software. The Figure 3 below show the DEM output from the QGIS plotted.

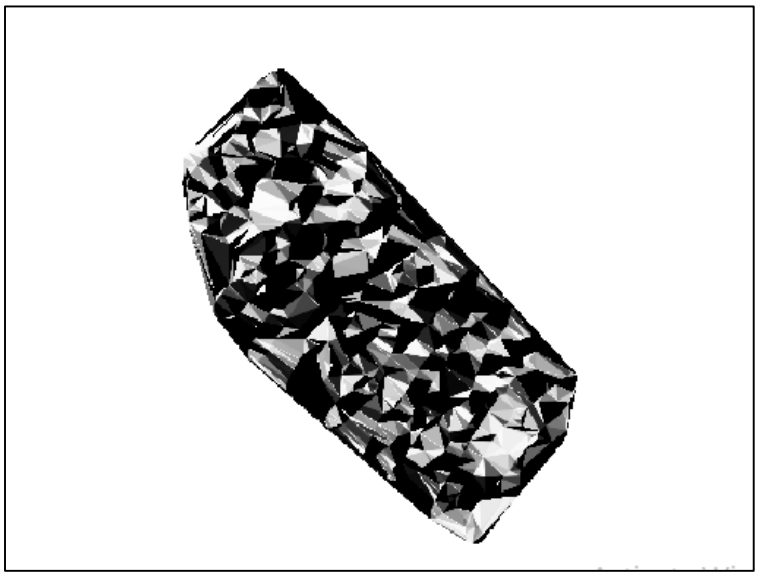

Figure 3: The DEM output from QGIS plotted

4.3.2 Result of the contour

In this analysis, the contour have been succeed produced the contour by using the terrain analysis of hillshade. The azimuth (horizontal angle) have been changed into 315.00 and the horizontal angle into the 45.00 in this analysis as followed the geographical area. In the interpolation natural neighbor, the data of cell size value of 0.0001 and attribute of elevation have been projected. The Figure 4 below shown the contour produced in the QGIS.

Figure 4: The contour by the terrain analysis of hillshade

4.3.3 Result of Fill Sink (Wang and Liu)

In this analysis, this study had chosen the Fill Sink (Wang and Liu) because of the most stable extension for slope angle because of lower than 1.0. For this location of case study, the slope angle is lower than 1.0 is because this boundaries is plotted on the flat road without hilly area nearby. This file had been save as filled DEM. The Figure 5 shown the filled DEM.

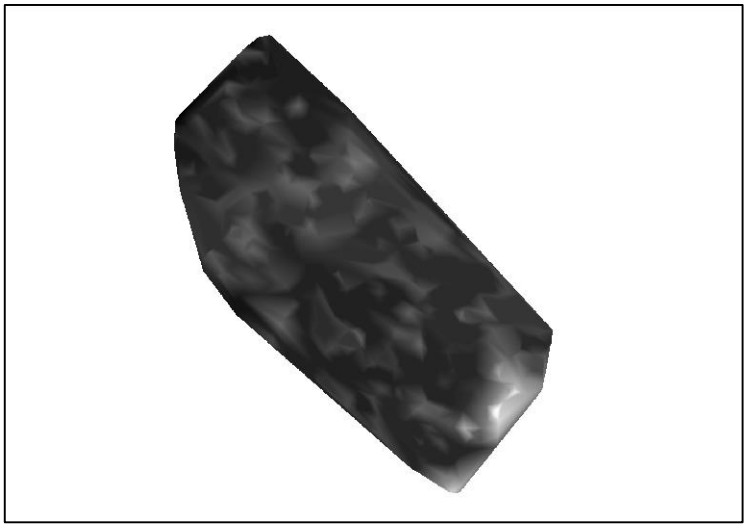

Figure 5: The filled DEM output from the Fill Sink method

4.3.5 Result on the Strahler stream order

For this stages, the Strahler stream order is easier to be obtained as the extension for plugins toolbox. The output of this steps had shown the stream available inside with the DEM filled. Figure 6 shown the output on the strahler stream order

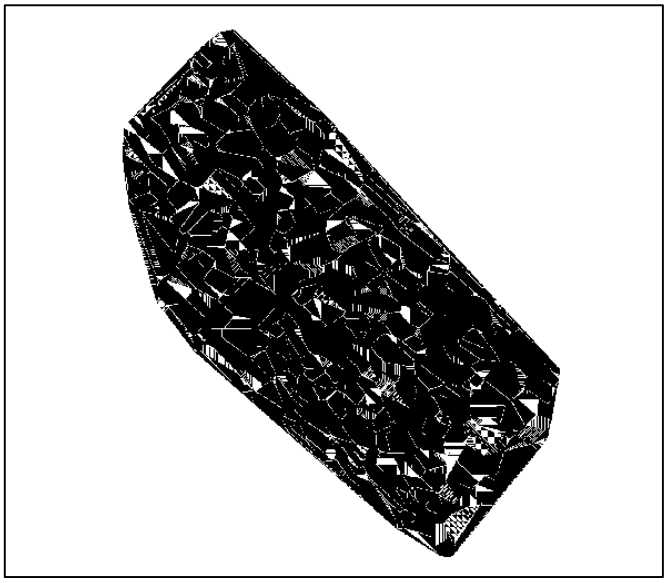

Figure 6: The output on the strahler stream order

4.3.4 Result of flow direction

The flow direction output had been obtained when the Strahler stream were proceed in to the raster calculation and then proceed with the channel and drainage basin. The channel and drainage basin was successfully created. Thus, the flow direction can be operated as well. The flow direction consists of 6 class of color in which with different direction to identify which are north, south, west, north east, south east, south west and north west. Thus the output have shown each of the watershed boundaries with different flow direction as in Figure 7.

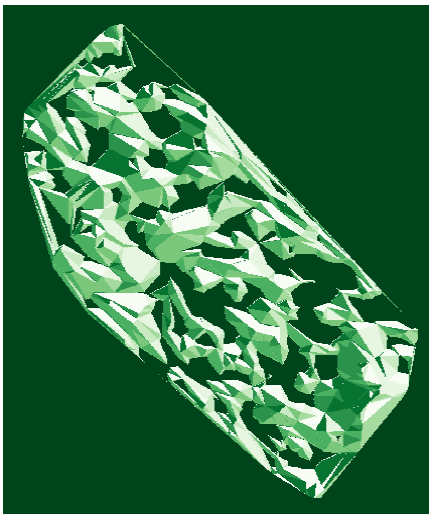

Figure 7: The output of flow direction

4.3.6 Result of the outlet point

The shapefile layer had been saved for carried out the outlet point. At the outlet point, the end of the watershed nears to the river taken. .From the outlet point, the latitude and longitude of the point chosen had been same input into the coordinator plugins from QGIS. This plugins have helped in finds the coordinate of outlet point. Figure 8 below shown the outlet point that have been chosen.

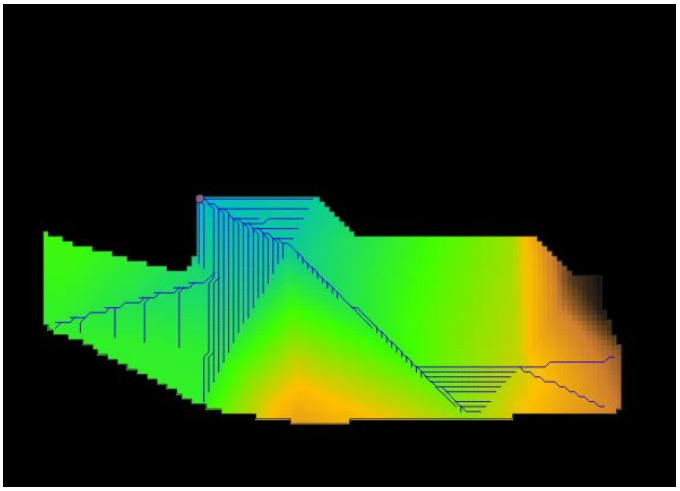

Figure 8: The output of outlet point

4.3.7 Result of the drainage basins

For the drainage basins, the output can be obtained when the upslope area determined. The upslope area obtained by compute the latitude and longitude values Figure 9 shown the output of upslope area.

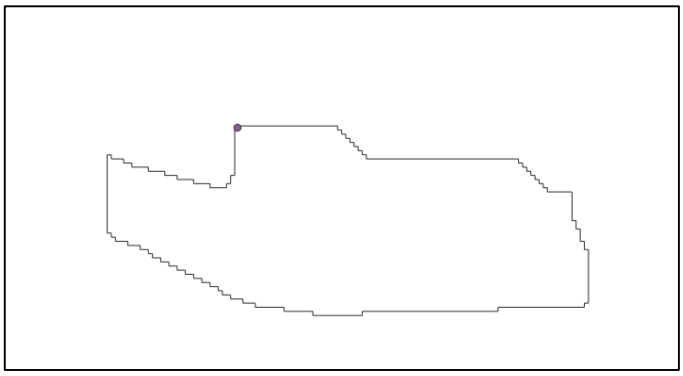

Figure 9: The output of upslope area

4.4 Analysis of watershed delineation

For the watershed delineate, there are steps that need to accomplish before getting the final output. The upslope area had been converted to upslope polygonised for created the line boundaries inside the upslope area. The layers had been rearrange to produce the watershed shape in the clear and accurate. At the toolbox, polygon clipping had been chosen for the shapefile outline. The final output had been compared with the DEM underneath the watershed in order to geotagged the boundaries from DEM. Figure 10 shown the output layer of the watershed delineate.

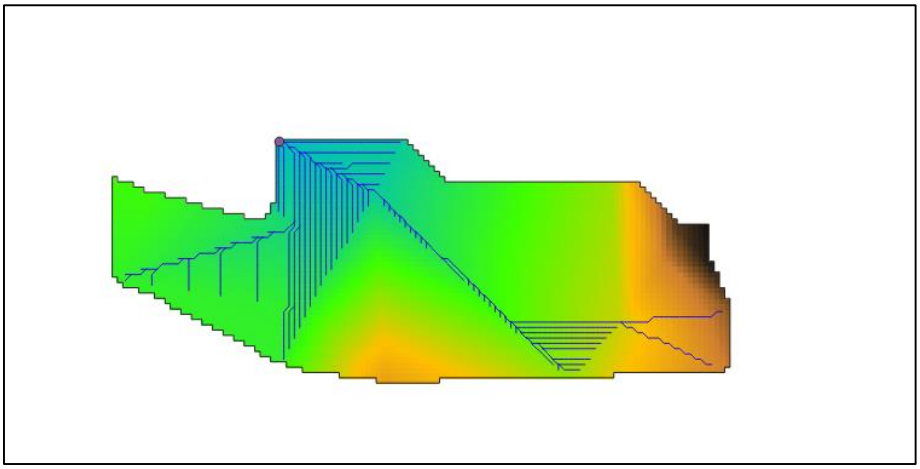

Figure 10: The final output of the watershed

4.5 The comparison data on the DEM extraction from the google Earth and the aid of UAV.

With this options by using the DEM extraction from the Google Earth and with the aid of the UAV, both of the method can produced the DEM. This DEM can be compare with the accuracy of the data obtained. This both method have obtained the data from aerial view. Figure 11, 12 and 13 shows the DEM obtained with the aid of drone and with the Google Earth.

Figure 11: The DEM from the Google Earth

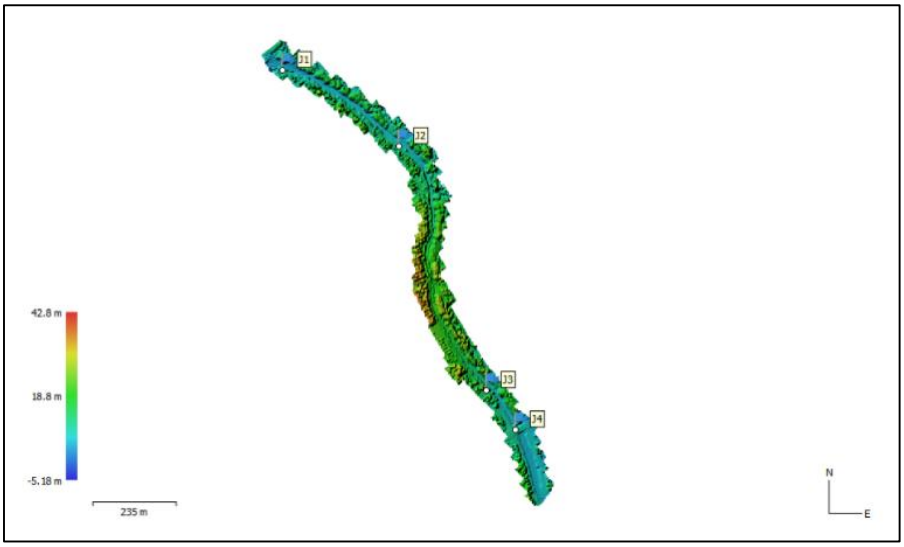

Figure 12: The DEM data with the aid of the UAV at the north view

Figure 13: The DEM data with the aid of the UAV at the south view

The DEM output has shown the stream of the Bakri drainage system in general. The output was not in details as the flow is determine by using the maps without consider the factor of the flow of the drainage and the area of the drainage. The DEM output from the aid of the UAV, shown in details and accurate of the Bakri drainage system. The drainage shown in the aerial view have been specified the area of the drainage and the flow of the drainage. Thus, the data output DEM with the aid of the UAV have been chosen and practically accurate as the drone was flight along the stream from the south to the north of the boundaries.

4.5.1 Relationship of output DEM with the aid of UAV and the Google Earth

In this studies, the DEM output was obtained with the aid of the UAV and with the aid of Google Earth. In the Google Earth, the plotting of the site was manually plotted by marking the boundaries with the references of the maps. The longitude and latitude of the boundaries area was generated into the Google Earth. The data obtained from the Google Earth are converted into the GPS Visualizer. Thus, the latitude, longitude and altitude data of the site able to be generate at the QGIS. Therefore, with the help of the QGIS the DEM can be generate with the data obtained from the Google Earth. The DEM output by using the UAV was obtained by flight the drone under the supervision of the lecturer at the location

of site. The data obtained from the drone have been generated through the software named Agisoft. With the generated, thus can be converted and used into the QGIS.

5. Conclusion

The following are the conclusions that were obtained from the outcomes of this study after conducting tests, data collecting and data collection to fulfill the objective. Firstly, the objective is to determine the delineation of watershed by using Unmanned Aerial Vehicle (UAV). The UAV have been successful been deploy at the site with the surveillance of the lecturer. The briefing for the flight of drone have been carried along the drainage system at Bakri, Muar. Thus the result in data analysis with the aid of UAV for the DEM delineation have been compared with the data analysis with from Google Earth for the DEM delineation Therefore, the data analysis DEM delineation from the Google Earth can be used for the flood mapping in Bakri.

Secondly, the objective of this study is to produce the mapping of drainage for development of watershed Bakri. In the data analysis, the mapping drainage and database for development of watershed Bakri have been successfully plotted with the online tools which is QGIS. This result have been visualize in data analysis of watershed delineation.

Lastly, the objectives of this study is to analyze the process to produce the watershed by using QGIS. The watershed for the Bakri successfully plotted with the lower slope angle as Bakri is known as the lowland area. In the data analysis of watershed delineation, the stream of the watershed has been projected. The shape of watershed also has been identified.

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