Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666

Volume 6 Issue 24 (December 2021) PP. 174-185
DOI: 10.35631/JISTM.624018

JOURNAL OF INFORMATION SYSTEM AND TECHNOLOGY MANAGEMENT (JISTM)
www.jistm.com

GLOBAL ACADEMIC EXCELLENCE

GEOSPATIAL APPROACH FOR GEOLOGICAL INVESTIGATION AT DISTRICT OF MERSING

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Article Info:

Article history:
Received date: 01.10.2021
Revised date: 01.11.2021
Accepted date: 20.11.2021
Published date: 01.12.2021

To cite this document:

Zamari, M. A., Musa, T. A., Mohamad, E. T., Musliman, I. A., & Aris, W. A. W. (2021). Geospatial Approach for Geological Investigation at District of Mersing. *Journal of Information System and Technology Management, 6* (24), 174-185.

DOI: 10.35631/JISTM.624018

Abstract:

Effective geological information evaluation is essential for accurate site characterization. A major concern in geological mapping is to locate the accurate location of the geological information. The geoinformation approach such as precise GPS surveying and UAV mapping could be integrated with other geospatial information to augment the geological information. This research aims to integrate the geoinformation approach into geological structure mapping. To achieve the overall purpose of the study, the objective identified was the establishment of a high-precision control point by using Precise GPS measurement in the study area. Therefore, the establishment of GPS data observations involves the establishment of primary networks and several GPS controls points within the study area. Subsequently, the GPS positioning has been processed to produce a topographic information map and to support the collection of geological data in the study area. It is hoped that the integration of the geoinformation approach has been provided a significant increase in geological information at the district of Mersing.

Keywords:

Geological Information, Precise GPS Surveying, UAV Mapping

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Introduction

Understanding the Geological profile of our earth is important for many different applications within geosciences especially in geoengineering. The creation of three-dimensional models can assist with this understanding by providing us with a conceptual and quantitative model of the Geological profile. Detailed and reliable assessment of the ground condition is one critical aspect in order to do a proper ground evaluation. Geological profile conditions play an important role in the analysis and design of geology structures and facilities. Geological profile offers information about land profiling that can be used for exploration purposes. In the study, the Geology of the study area is underlain by unpredictable lithology of older alluvium as in Gobbett et al. (1973).

It is underlain by sandstone, siltstone, shale, clay, and tuff. The utmost common variation is coarse feldspathic sand with irregularly rounded phenocrysts, but gravelly clay, sandy gravel, sandy clay, silty clay, clayey sand, and clay are correspondingly presented. Therefore, in the case of the common feldspathic sand type its surface appearance is that of sandy clay or clayey sand where the Mersing formation are located with sedimentary rock associated volcanism. This research aims to integrate geoinformation approach into geological structure mapping at district of Mersing in Eastern Johor as shown in Figure 1.

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Figure.1.0: Location of The Study Area.

Methodology

The study area was conducted in the district of Mersing in Eastern Johor with a total land area of 838.6 km2, and a population of 69,028**.** The project was covered three locations of the geological site i.e.: Site A, Site B, and Site C within the district of Mersing as shown in Figure 1. There are two (2) types of data have utilized in this study which are primary and secondary data. Global Positioning System (GPS) measurements and digital aerial image as a primary while geological information as secondary data in the study area.

GPS Data Collection

There were two (2) GPS observation method were adopted which are GPS static and GPS fast-static method. The static observation was conducted for an hour for each control station while fast static observation was conducted from 30 to 45 minutes for each. The static method was utilized in order to establish the reference stations in the study area where this reference station was relatively connected with Malaysia Real-Time Kinematic GNSS Network (MyRTKnet)

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stations that are maintained by the Department of Surveying & Mapping Malaysia (DSMM). These primary reference stations were observed continuously by the static technique throughout the project.

Figure 2: GPS Observation Conducted in The Study

At the same time, the GPS observation on the GCP was carried out so that there is an overlap time between the BASE and GCP observation. It is intended to control the quality of GPS observations data for the purpose of processing and generating GCP coordinate. Meanwhile, the fast-static observation was adopted to establish the GCP stations in the study area. This to ensure a better quality of GPS observation data and the final coordinate of GCPs generated from the processing. Observation information such as start/end time of observation, device type, antenna height, and station ID for each GPS control point have been recorded in the Observation form.

The GPS data were processed by using Trimble Business Centre (TBC) software in post-processing mode i.e: network and single baseline processed for coordinate estimation. As the result, this process has provided final GCP coordinates in Geocentric Datum of Malaysia 2000 (GDM2000) and these 3D coordinates were projected onto 2D mapping coordinates system (RSO Geocentric).

The primary three (3) GPS reference stations (BASE) was relatively connected to three (3) stations of MyRTKnet station namely KROM, MRSG and LBIS stations to form a network as shown in Figure 3. Each GCPs has processed to form a single baseline connected to Base Station (BASE A, BASE B and BASE C). As a checking purpose, each GCPs also connected to KROM station. Therefore, there are two sets of coordinates for each GCPs referred to BASE and KROM station as shown in Figure 4.

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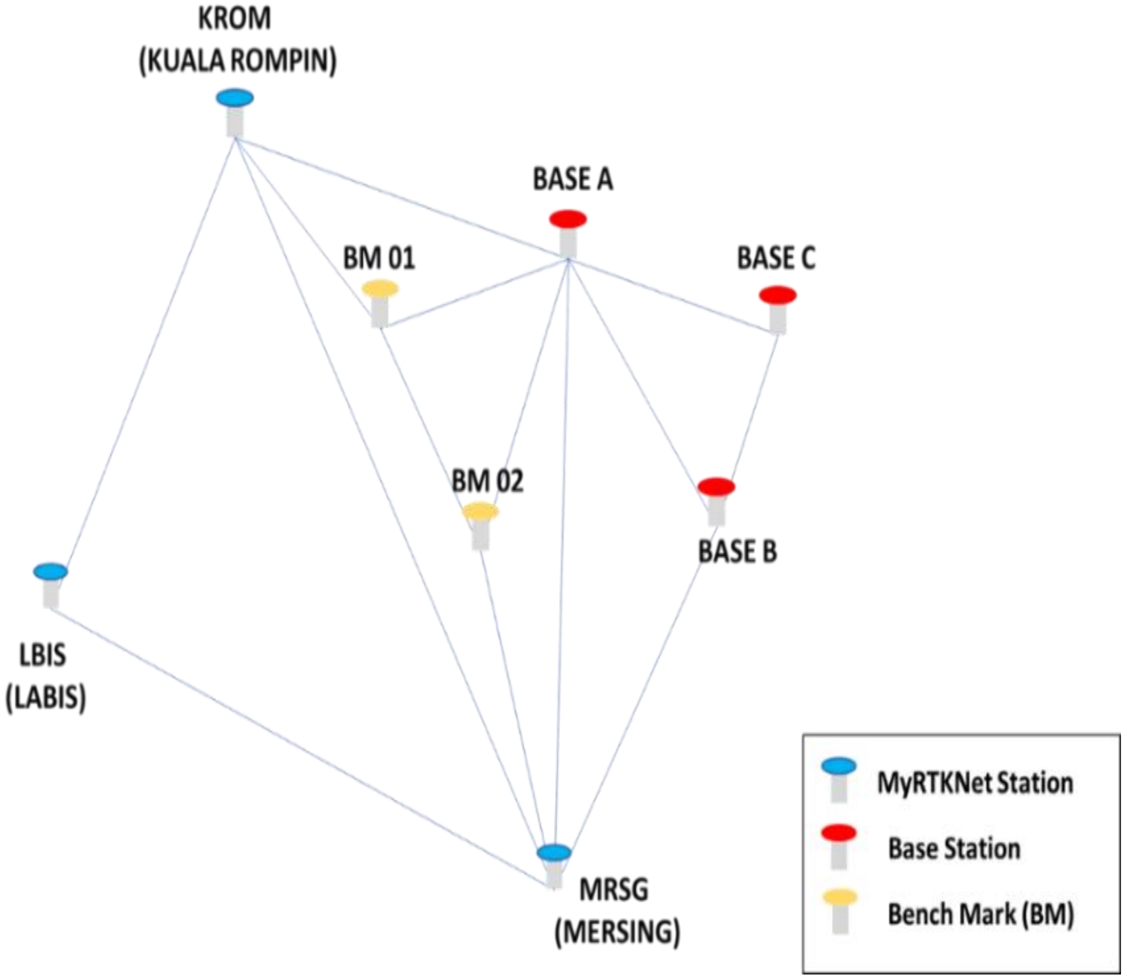

Figure 3: Design of the GPS Network Observation.

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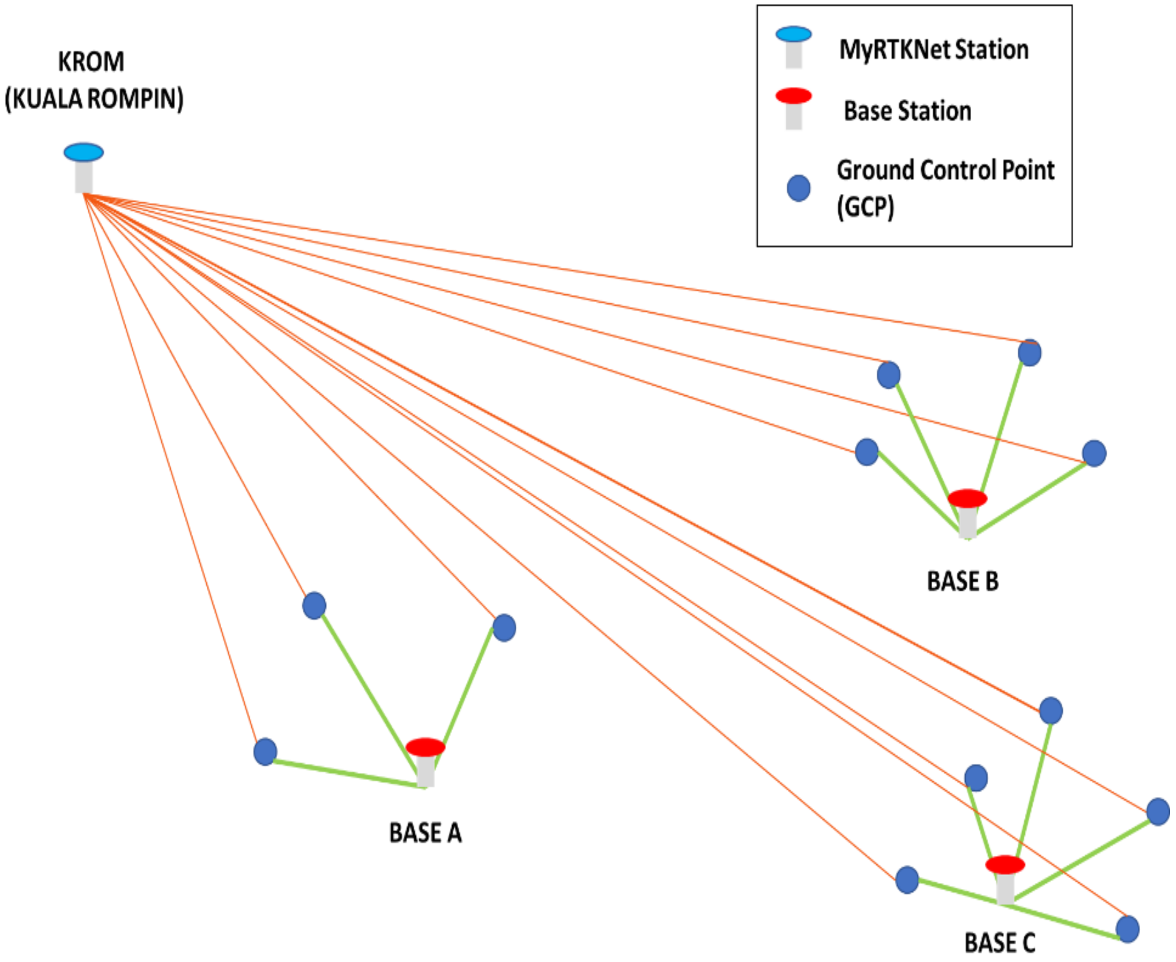

Figure 4: Each GCP is Connected to the BASE and Checked Using KROM Station for Quality Assurance.

UAV Data Collection

The purpose of Unmanned Aerial Vehicle (UAV) data collection is to generate the latest topographic map to support current of the study area (Zamari, 2017). The digital aerial images have collected by using multi rotor UAV. This data was post-processed by using Agisoft software in order to produce digital orthophoto and DEM. There are several parameters required in preparation of the flight planning which are overlapping of images, flight path determination and UAV altitude. In this study, the proposed flight altitude in this data collection was 150 meters with lapped of images was 70 % for the whole study area. The drone deploy application software will be used for preparing the flight planning as shown in Figure 6.

Table 1: Parameter for Preparation of The Flight Plan.

Parameter	Information of Flight Plan
Flight altitude	150 Meter
Overlapping of images	70 %
Speed of drone	15 m/s
Flight direction	0-180 degree

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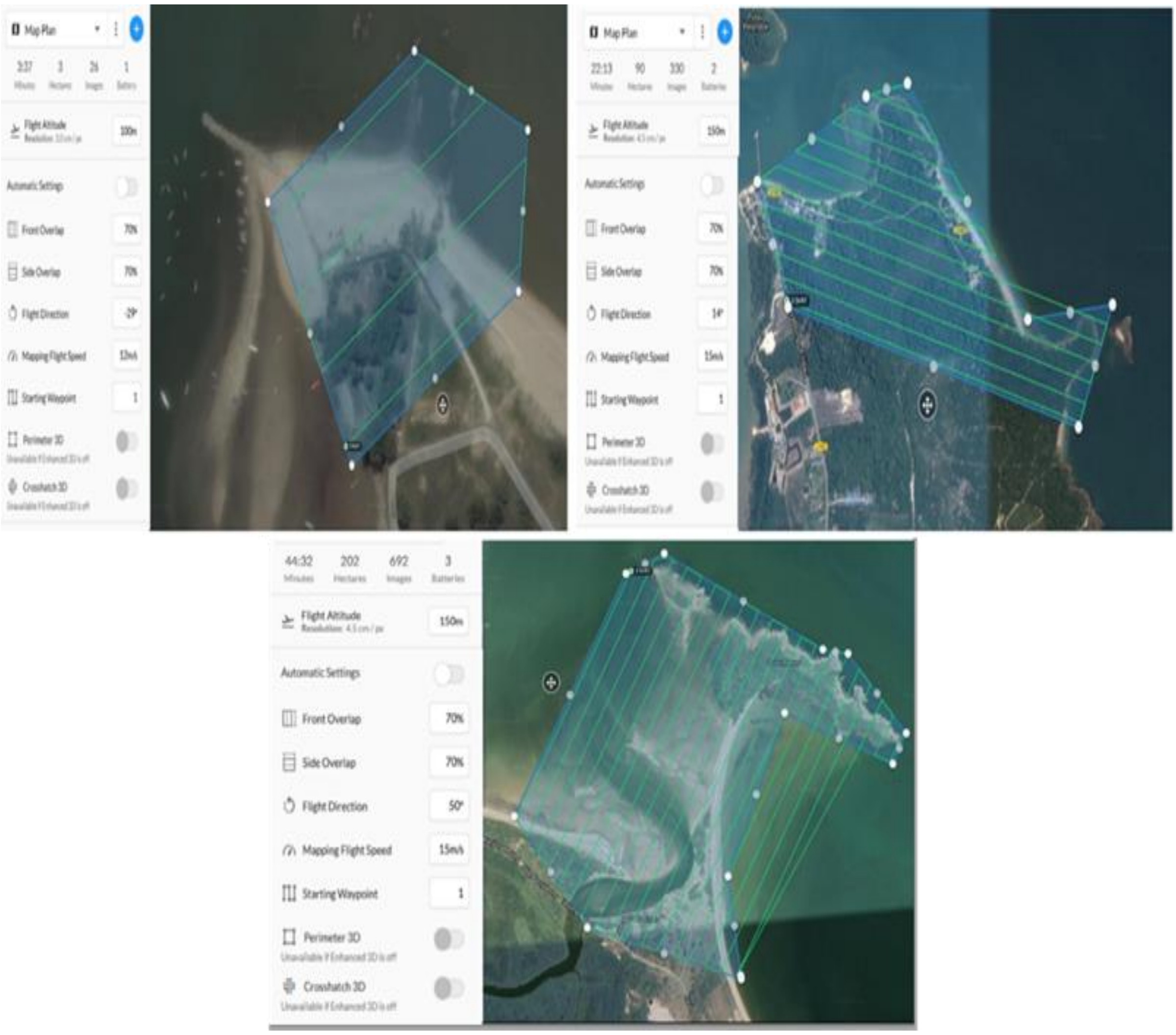

Figure 6: Design of Flight Plan for This Study.

Geological Field Investigation

Firstly, the existing geological map in hardcopy has been crop, digitized and georeferenced by using GIS approach. Then, Geology field investigation has been conducted to verify geological information in the study area as shown in Figure 7. During this field investigation, the GPS observation has utilized to validate location of the geological information in the geological map.

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Figure 7: Geological Field Investigation at The Study Area.

Result and Discussion

Accuracy Assessment

The GCPs final coordinates derived from GPS baseline post-processing represented in 2D RSO Geocentric (GDM 2000) in Table 2 until Table 4, respectively. Height components for each GCPs was also provided in Ellipsoidal height and Orthometric height. The accuracy coordinates in horizontal components for all GCPs meet the requirement of below 3 cm as coordinate checking was conducted by comparing set of coordinates derived from BASE and KROM stations within 3 location geological site. Meanwhile, the height component accuracy achieved below 6 cm except for point B01 (7.0 cm) and B08 (6.5 cm) and B02 (6.4 cm) at the site B. Overall, the results show that established GCPs have obtained high accuracy and suitable for geological mapping works of this project.

Table 2: RMSE of Horizontal and Height Component GCP On the Site A.

Name	1st set coordinates from BASE A(m)			2nd set coordinates from KROM (m)			Difference (1st – 2nd (m)	
Point	**Northing**	**Easting**	**Height**	**Northing**	**Easting**	**Height**	**Horizontal**	**Height**
A01	639355.544	292538.357	3.418	639355.532	292538.379	3.418	0.025	0.000
A02	639814.570	292788.443	6.671	639814.55	292788.47	6.652	0.030	0.019
A03	640026.020	292977.882	39.621	640026	292977.91	39.636	0.030	-0.015
A04	640180.540	292806.963	3.142	640180.52	292806.99	3.15	0.028	-0.008
A05	640087.130	292553.262	1.908	640087.12	292553.28	1.919	0.023	-0.011
A06	640314.4	292558.239	5.428	640314.39	292558.25	5.413	0.021	0.015
A07	640528.35	292443.411	1.703	640528.33	292443.42	1.668	0.021	0.035
A08	640816.12	292366.075	1.971	640816.11	292366.09	1.948	0.022	0.023
			RMSE				**0.025**	**0.007**

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Table 3: RMSE of Horizontal and Height Component GCP On the Site B.

Name	1st set coordinates from BASE B (m)			2nd set coordinates from KROM (m)			Difference (1st – 2nd) (m)	
Point	**Northing**	**Easting**	**Height**	**Northing**	**Easting**	**Height**	**Horizontal**	**Height**
B01	642502.357	289688.984	1.556	642502.349	289689.000	1.486	0.018	0.070
B02	642840.426	289535.750	1.266	642840.422	289535.762	1.202	0.013	0.064
B03	642750.312	289171.144	2.130	642750.310	289171.148	2.112	0.004	0.018
B04	642644.199	288815.311	2.065	642644.207	288815.305	2.049	0.010	0.016
B05	642587.157	288452.749	1.810	642587.159	288452.746	1.806	0.004	0.004
B06	641980.094	288632.746	1.783	641980.094	288632.748	1.779	0.002	0.004
B07	642609.083	288212.487	2.844	642609.085	288212.489	2.848	0.003	-0.004
B08	643373.716	289284.502	1.691	643373.708	289284.515	1.626	0.015	0.065
			RMSE				**0.009**	**0.030**

Table 4: RMSE of Horizontal and Height Component GCP On the Site C.

Name	1st set coordinates from BASE C (m)			2nd set coordinates from KROM (m)			Difference (1st – 2nd) (m)	
Point	**Northing**	**Easting**	**Height**	**Northing**	**Easting**	**Height**	**Horizontal**	**Height**
C01	629412.19	294872.741	2.828	629412.18	294872.73	2.785	0.010	0.043
C02	629485.64	294876.42	1.464	629485.64	294876.41	1.455	0.010	0.009
C03	629383.76	294818.547	1.352	629383.76	294818.53	1.32	0.016	0.032
C04	629416.16	294754.026	1.946	629416.15	294754.01	1.959	0.016	-0.013
			RMSE				**0.013**	**0.018**

Development of Geospatial Database

Geospatial database is a medium for storing and managing the spatial data. Three (3) components has utilized in development a geospatial database of the study area: (1) feature datasets, (2) raster dataset and (3) tables. The overall framework in developing a geospatial database for this study is illustrated in Figure 8. Based on this database, the information such as topography and profile information of the geological structure have been integrated in the GIS environment. Figure 9 shows geological properties at the study area. Figure 10 shows topographic information of the study area and is being used as the base map for the geospatial database of geological mapping information in this study.

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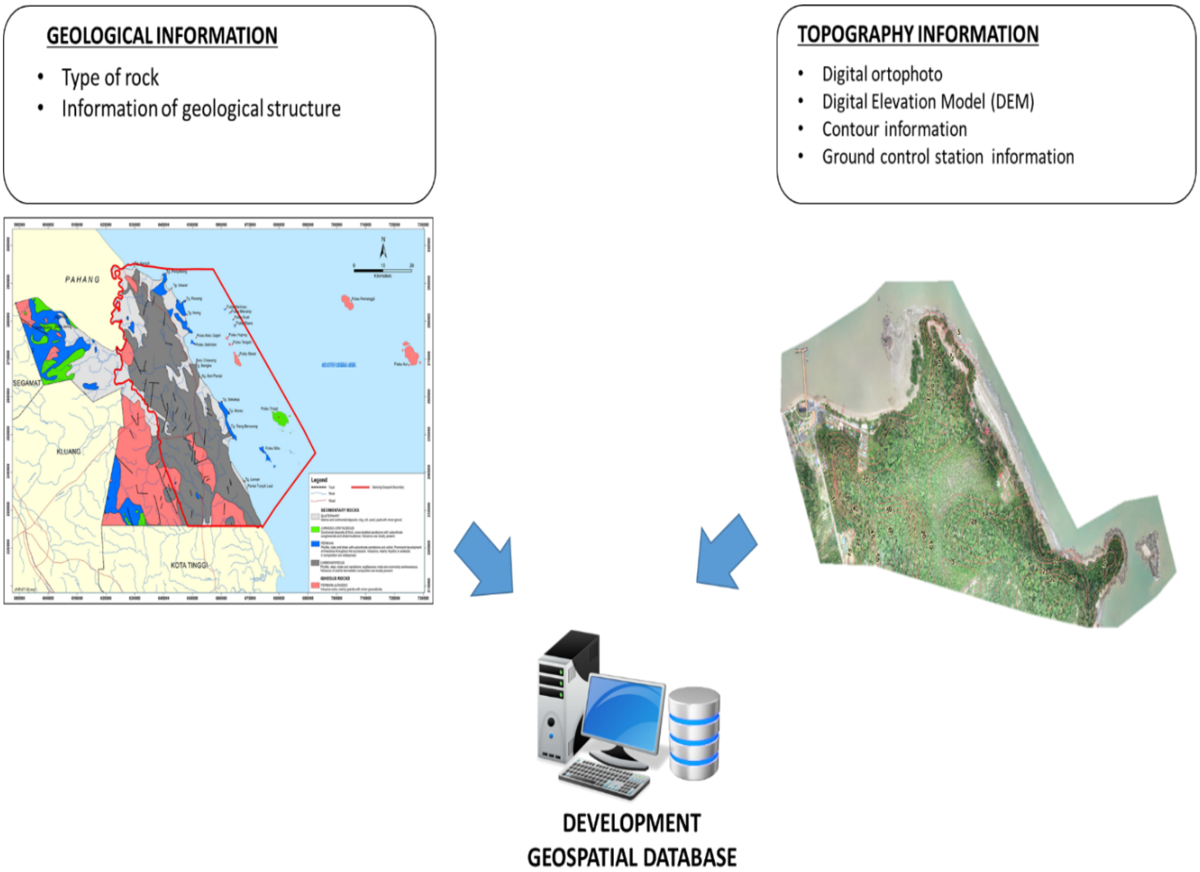

Figure 8: Framework in Development of Geospatial Database.

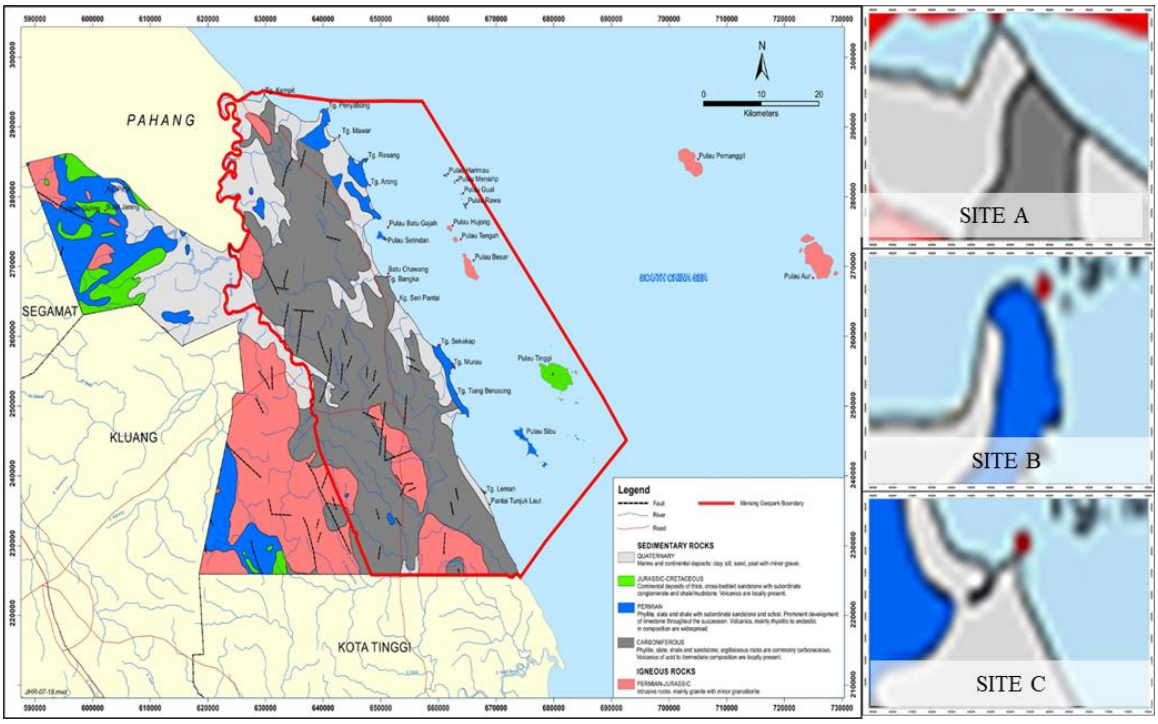

Figure 9: Geology Properties of The Study Area.

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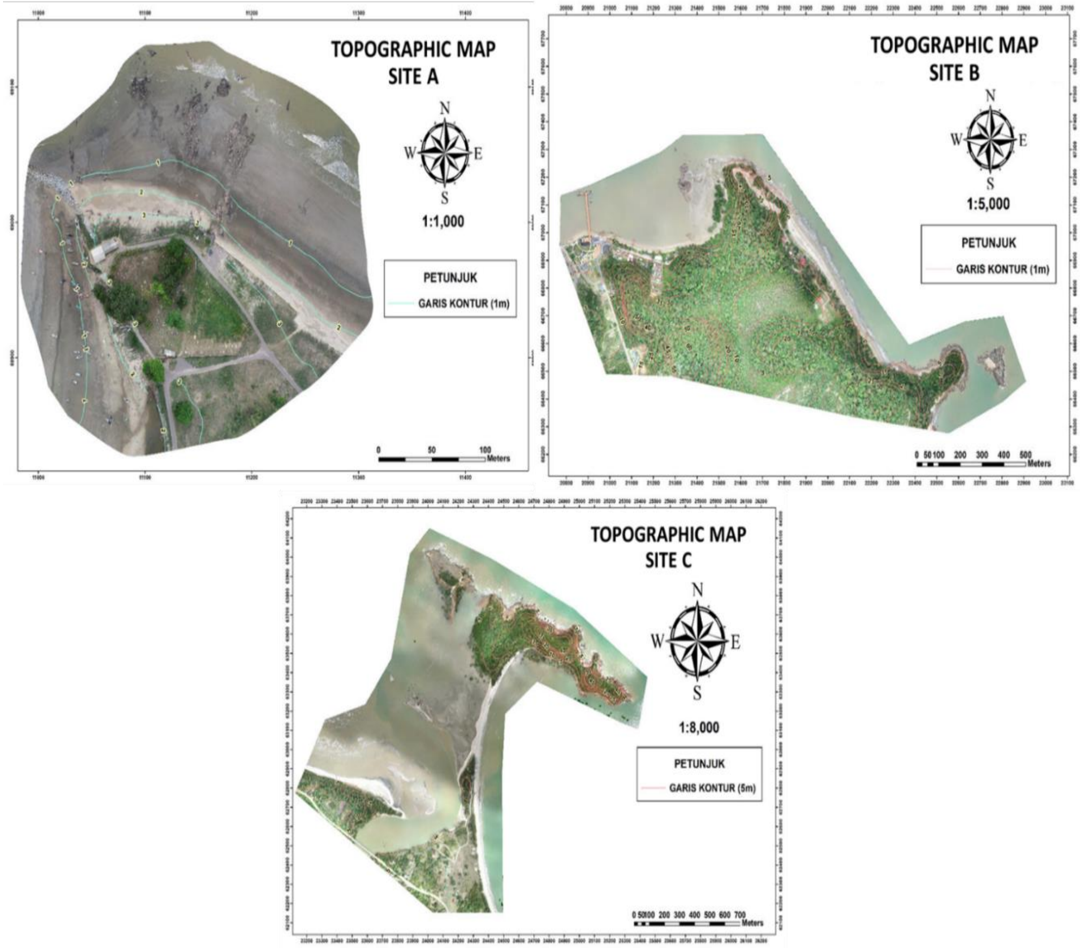

Figure 10: Digital Orthophoto for The Study Area.

Conclusion

The purpose of this research project is to support geological mapping with a geospatial approach. This mapping area has been focused on three mapping areas located in the district of Mersing, Johor. The main data consisted of GPS measurements and digital aerial photographs used for the creation of topographic maps of the study area. The results of this study successfully established twenty -three (23) GPS control points in the area. Based on the GCP accuracy results, it is found that the average RMSE for the horizontal and vertical components of GCP is less than 7cm. Then, digital aerial photo data was successfully observed and processed by combining together the established high - precision GPS control points. Meanwhile, secondary data consisting of existing geological maps were digitized and georeferenced using GIS techniques. All data sets have been integrated into a useful geospatial database to provide insight in decision making and future planning for geological mapping in the study area.

Acknowledgement

The authors would like to acknowledge the Research University Grant (RUG) vot number R.J130000.7352.4J341 for providing funds in this project. Special thanks also to the Centre of Tropical Geoengineering (GEOTROPIK) and Geomatic Innovation Research Group (GnG).

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