Drone Radiation Detection System Information Mapping Design Using Quantum Geographic Information System

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Abstract - *Scan systems using unmanned aircraft or drone are designed to be able predicted when there is radiation exposure from radioactive sources. The drone is equipped with a Geiger Muller detector type J305 tube and a GPS (Global Positioning System) Tracker and other communication tools. Testing of this system was carried out in the field of B.J. Habibie Serpong, National Research and Innovation Agency using a radioactive source of Cs-137. The drone's flight direction has been designed at the Red Waypoint and has a height of 2 meters. Radiation detection mapping was carried out using Quantum GIS (Geographic Information System) software. The classification parameter in Quantum GIS is divided into 3 parts, namely the first class value is 0.00 to 0.10, the second class is 0.11 to 0.20, and the third class is 0.21 to 0.40. In this study, there are 5 coordinates of the highest radiation value with a red round symbol. These points indicate radiation levels of 0.24, 0.24, 0.24, 0.36, and 0.28. Using identification feature, the mapping results can help the user in analyzing and enable quickly find areas with high radiation. Thus, the decontamination or transfer of radioactive sources can be used as a quick and appropriate follow-up.*

Keywords: *mapping; drone; geiger muller; Quantum GIS*

I. Introduction

Radiation detection using drones can contribute significantly, especially to environmental radiation monitoring for safety and security and can display infographics of radiation monitoring results. Today's use of drone technology is developing very rapidly, drones equipped with cameras can be used for mapping, or even reconnaissance. Drones equipped with radiation detection and measurement equipment can be used to scan and map areas and locations suspected of having radioactive sources, or being contaminated with radioactive substances. Therefore, radiation detection systems using drones continue to be innovated in processing and delivering the results. [1]

The development of knowledge about Geographic Information Systems began in 1967 by Roger Tomlinson as CGIS (Canadian GIS - GIS Canada) at that time. Early in its development it was implemented in Ottawa Ontario by the Department of Energy, Mines, and Resources. Its use at that time was to store, identify, and process data collected for the Canadian Land Inventory (CLI). CGIS is the first system in the world and the result of improved mapping applications that have the ability to overlay, calculate, digitize/scanning, support a national coordinate system that spans the American continent, insert lines as arcs that have a topology and store attributes and locational information in separate files. Therefore, Roger Tomlinson is called the "Father of GIS". [2]

Analysis of geographic information system data which previously could analyze classification, overlay analysis, networking analysis, buffering analysis, three-dimensional

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analysis, then in this research innovation is carried out as radiation point analysis. It is known that the function of the geographic information system in previous studies was used as an inventory of natural resources, development planning, spatial planning, transportation planning, and disaster mitigation. Currently, the geographic information system also serves as an identification of the value of the radiation level. In its application, the geographic information system also supports disaster mitigation that has the potential to occur when exposure to radioactive sources occurs, thereby contaminating the environment. Mapping using Quantum GIS is known to be the area of the contaminated area so that it can quickly identify priority areas or points for handling high radiation hazards. [3] The level of public health is also taken into account as a cause and effect caused by the high radiation hazard in the environment.

Geographic information system components are hardware, software, data, user or brainware, and methods. [2] The hardware used in the radiation detection mapping system uses a drone or unmanned aircraft equipped with a GPS (Global Positioning System) sensor and a Geiger Muller radiation detector type J305 tube. The software used is Quantum GIS (Geographic Information System) software. Brainware or users are operators who are in charge of radiation monitoring using drones to carry out the mapping stages on the software. And the method used is by testing the operation of the radiation monitoring system using drones, starting with the design of the monitoring path, sending data, receiving data, processing data, to identifying radiation value points that are classified as high or dangerous. In this study, it is hoped that the mapping of radiation detection system information using Quantum GIS can build a system that is able to store data, manage, and display the results of radiation level monitoring in the form of a visual display.

II. Research Method

Monitoring the level of radiation that moves within a certain area by utilizing drone technology. The drone used is the DJI Inspire 2 with the ability to fly at 50 mph or as far as 80 kph in 5 seconds and with a maximum speed of 58 mph or 94 kph. Equipped with two batteries, this drone can operate for 27 minutes. As well as having the ability to avoid obstacles in two directions and sensor redundancy. [4] Figure 2. shows the drone device used in the radiation level monitoring system.

(a) (b)

Fig 1. DJI Inspire 2 (a) Remote Control Drone (b)

The isotope used in this research is Cs-137 with 100mCi activity on 01-01-1992. The isotope Cs-137 has a long half-life of 30.13 years. On the other hand, in the field of construction of petroleum industrial installations, the isotope Cs-137 is used in testing the quality of welds during the installation of oil/gas pipelines and oil refinery installations. Radiographic techniques are often used in the construction stages and this technique is also used in testing the weld quality of high pressure steam boilers as well as testing for hardness and cracks in concrete construction. [5] This isotope is placed in the field for the drone to cross directly above it at a certain height and speed.

Geographic Information System is an information system that is used to input, store, process, analyze, and produce referenced or geospatial data to support decision making. [6] Digitization in Quantum GIS that can be done is the technique of digitizing maps or mapping. In principle, map creation is processed and the mapping results file is stored using a computer. Mapping results are grouped according to layers according to their respective types. In the mapping process, 3 types of layers are used, namely, polygon types, point types, and line types. In each process, add attributes as needed that will be displayed as information. [7]

Quantum GIS is the Open Source tool chosen to be used in this test. Quantum GIS or Quantum Geographic Information System which was formed in 2002 was built using the QT toolkit and C++. Quantum GIS is capable of displaying a GUI or Graphical User Interface. Quantum GIS is easy to operate and comes with various functions and features. Quantum GIS can also be used as data visualization, data analysis, presentation of fund maps or atlases. [8] Quantum GIS software functions as a geographic information system that contains supporting programs such as data input, data processing, and data output. [3]

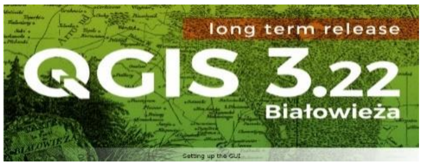


Fig 2. Quantum GIS Software 3.22

Research on drone radiation detection systems goes through several stages as follows:

1. Determine the location that is suspected to be contaminated or there is a radioactive source.
   a. In this study, the source is placed in the middle of the field in the science and technology area of B.J. Habibie Serpong, National Research and Innovation Agency.
   b. In future research, drones can be flown in affected areas.
2. Prepare a drone test equipment that is equipped with a detector.
   a. Checking the battery availability on the drone and connectivity to the software used for operation.
   b. Make sure the software is pre-installed. The software used is Red Waypoint.

Fig 3. Red Waypoint Software

3. Prepare the data receiving device operated by the monitoring operator.
4. Designing the radiation detection path to be traversed by the drone.
   a. Determine the speed of the drone.
   b. Drones with a speed of more than 5 Km/h will be difficult to do data sampling. The information obtained is not optimal.
   c. Set the drone's flying height limit of 2 meters.
5. Adjusting to the geographical conditions of the environment at the time of testing.

The flow diagram of the radiation monitoring process using drones is as follows:

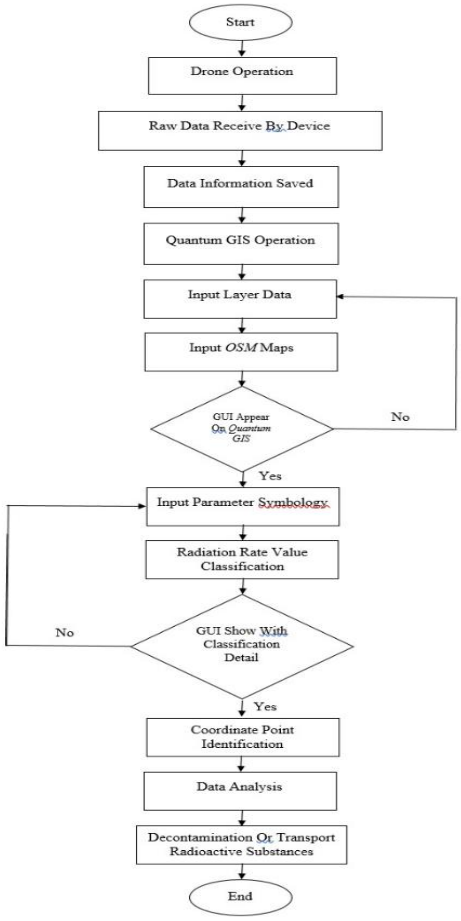


Fig 4. Drone Detection System Mapping Flowchart Using Quantum GIS

Quantum GIS can display radiation level points in the test area. The radiation monitoring test results processed using Quantum GIS can be identified in detail with radiation parameters adjusted to several classifications so that it is easy to find low radiation levels to the highest radiation levels in one test data. Classification can be adjusted to the data that will be used from field test results. The range of classification values can be adjusted according to the needs of the display output results. This range of values can be divided into two or more classifications of radiation levels. This is expected to make it easier for operators to read radiation monitoring data based on the classifications that have been made.

III. Result and Discussion

Quantum GIS operation is carried out in the following steps:

1. Install the latest version of Quantum GIS or Quantum GIS 3.22 on the laptop.
2. Operation begins by opening the Quantum GIS software.

Fig 5. Quantum GIS Has Been Installed On The Device

3. Choose Menu Option: Layer > Add Layer > Add Delimited Text Layer.

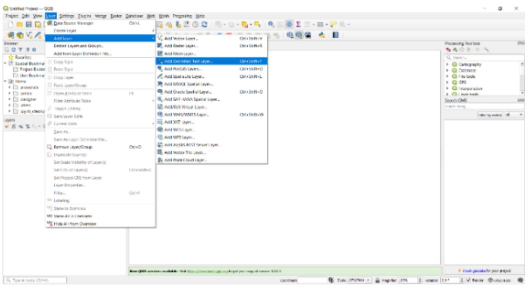


Fig 6. Adding Layers to Quantum GIS

4. Fill in the Data Source Manager on Delimited Text. Select the delimited text and continue by filling in the information on the required parameters.

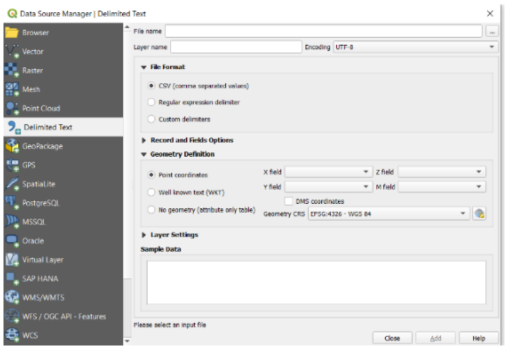


Fig 7. Data Source Manager in Quantum GIS

5. Select a file containing test result data in .CSV or Comma Separated Value file format.

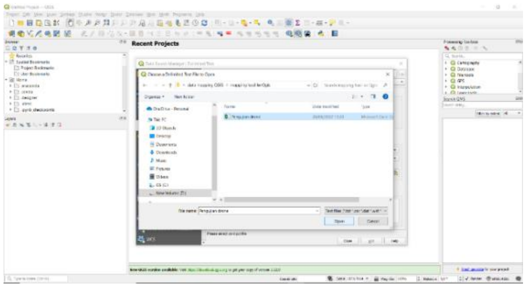


Fig 8. Select the Test Result File in Quantum GIS

6. Adjust the file format with the selected file format. And fill Geometry Definition as follows:

Table 1. Geometry parameter

Geometry Definition	Parameters
Point coordinates	Selected
X field	longitude
Y field	latitude
Geometry CRS	EPSG:4326 – WGS 84

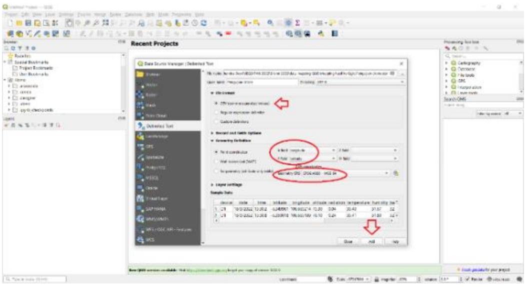


Fig 9. File Format and Geometry Definition in Quantum GIS

7. Choose Menu Option: Web > QuickMapServices > OSM > OSM Standart.

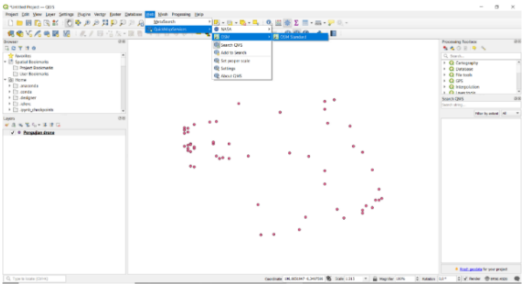


Fig 10. Displaying Standard OSM in Quantum GIS

8. Quantum GIS displays the coordinates of the radiation monitoring results in the previous test.

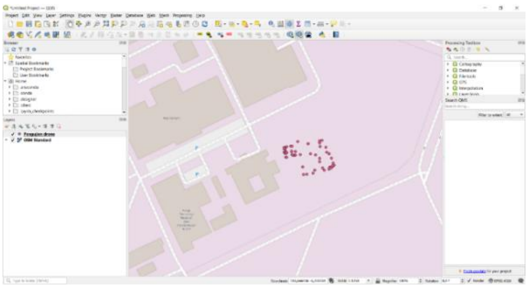


Fig 11. Displaying Radiation Detection Coordinates in Quantum GIS

9. Select Properties on the layer that has been successfully displayed.

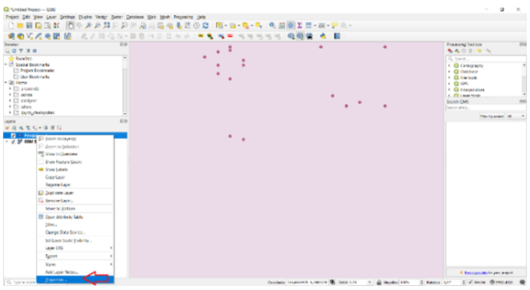


Fig 12. Properties Settings

10. Change the Symbology parameter on the layer file.

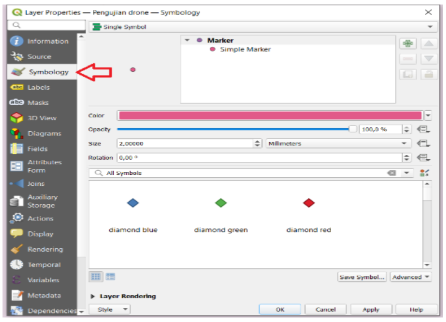


Fig 13. Symbology Parameter Settings

11. Fill in the Symbology parameters as follows:

Value selected 1.2 radiation and  clicked three times as a range or class of radiation levels.

Each class adjusts the filling of the symbol selector:

Table 2. First symbol selector parameter

Symbol Selector	Parameters
Class	First Class
Color	Green
Symbol	round
Opacity	100%
Size	2 Milimeters
Rotation	0

Table 3. Second symbol selector parameter

Symbol Selector	Parameters
Class	Second Class
Color	Yellow
Symbol	round
Opacity	100%
Size	2 Milimeters
Rotation	0

Table 4. Third symbol selector parameter

Symbol Selector	Parameters
Class	Third Class
Color	Red
Symbol	round
Opacity	100%
Size	2 Milimeters
Rotation	0

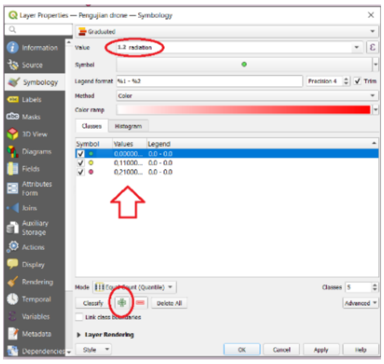


Fig 14. Symbology Parameter Settings

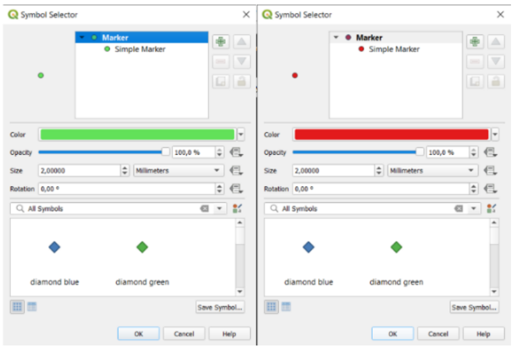


Fig 15. Radiation Level Classification Setting

12. Enter the value of each class using the parameters shown by table 5,6, and 7.

Table 5. First class bounds parameter

Class Bounds	Parameters
Class	First Class
Lower value	0.00
Upper value	0.10

Table 6. Second class bounds parameter

Class Bounds	Parameters
Class	Second Class
Lower value	0.11
Upper value	0.20

Table 7. Third class bounds parameter

Class Bounds	Parameters
Class	Third Class
Lower value	0.21
Upper value	0.4

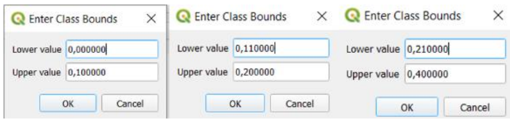


Fig 16. Radiation Level Classification Setting

13. After the class has been created, continue by clicking Apply to display the results of parameter settings in properties.

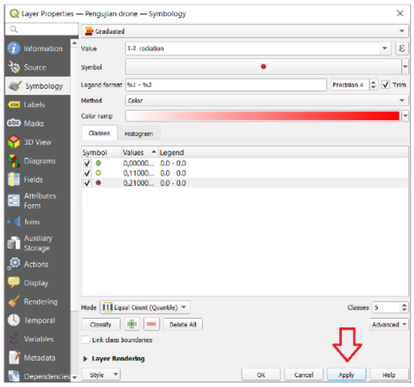


Fig 17. Saving Symbology Parameter Settings

14. Quantum GIS displays the results of the coordinates according to the radiation level class that has been determined in the previous step.

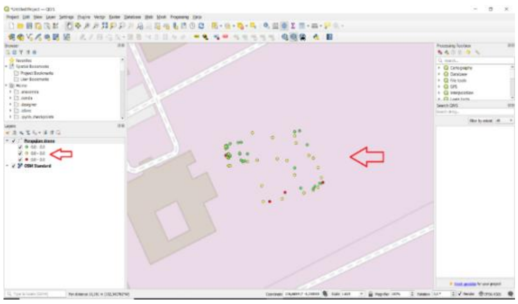


Fig 18. Mapping Results

15. Choose Menu Option: View > Identify Features.

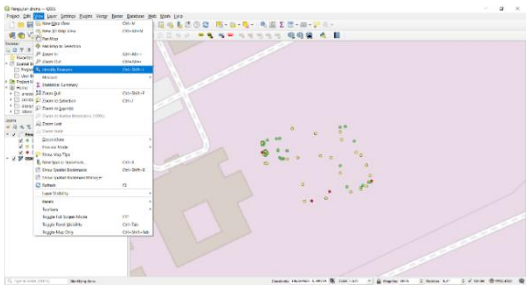


Fig 19. Identifying Mapping Results

16. Radiation point identification information with red class is shown on the right side of the screen.

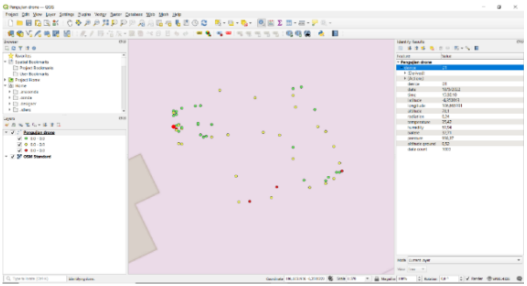
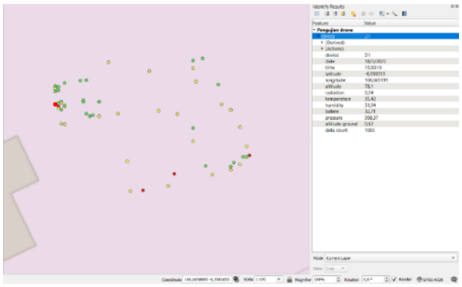
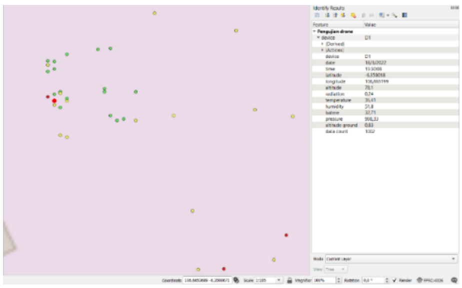


Fig 20. Display of the Mapping Result Identification Feature

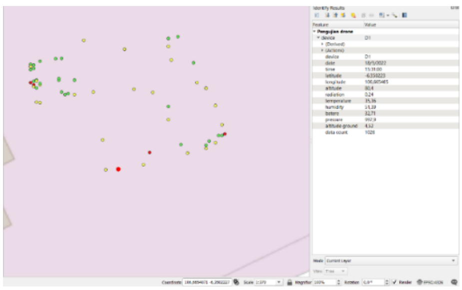
From reading the GUI display and supported by identify features, the results of the red class radiation level or the highest radiation class at the time of testing are as follows:



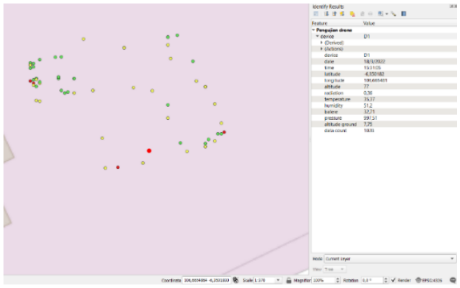
(a)



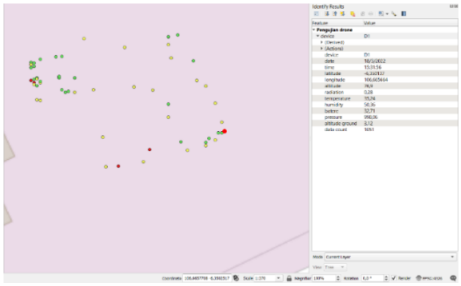
(b)



(c)



(d)



(e)

Fig 21. Radiation level with a value of 0.24(a), Radiation level with a value of 0.24(b), Radiation level with a value of 0.24(c), Radiation level with a value of 0.36(d), Radiation level with a value of 0, 28(e)

The results of the 5 coordinate points in Figure 21 can be seen in the table 8:

Table 8. Radiation monitoring results with red classification

Figure	Latitude	Longitude	Radiation
(a)	-6,350013	106,665191	0,24
(b)	-6,350018	106,665199	0,24
(c)	-6,350223	106,665405	0,24
(d)	-6,350182	106,665481	0,36
(e)	-6,350137	106,665664	0,28

In table 1 it is explained that there are 5 coordinate points that can be seen in the visualization of the radiation level detection mapping using drones. The first point (a) with coordinates latitude -6.350013 and longitude 106.665191 radiation level 0.24. The second point (b) with coordinates latitude -6.350018 longitude 106.665199 radiation level 0.24. The third point (c) with coordinates latitude -6.350223 longitude 106.665405 radiation level 0.24. The fourth point (d) with coordinates latitude -6.350182 longitude 106.665481 radiation level 0.36. And lastly, the fifth point

(e) with coordinates latitude -6.350137 longitude 106.665664 radiation level 0.28. The data shows that the five coordinate points are in the class with a red round symbol.

IV. Conclusion

Quantum GIS supports the implementation of visual radiation monitoring results. The operating method and class determination can be adjusted to the subsequent test results data when filling in the symbology parameters in classes parameters. The results of this research show the identification of radiation value points that are classified as high or dangerous using Quantum GIS software. This research data uses three ranges of classification of radiation values based on needs. To show that Quantum GIS can display the desired results, a lower value range of 0.21 and an upper value of 0.4 are created so that Quantum GIS is able to display radiation data in this classification as many as 5 identified data. The radiation level does not show high numbers but is included in the red classification that has been made. These data are radiation levels of 0.24, 0.28, and 0.36 as pilot data for high radiation levels in the tests carried out in this research. This is to prove and facilitate data analysis of the results of radiation monitoring tests using drones that have been carried out.

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