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Geospatial Analysis of Road Networks in Determining Land Fire Evacuation Routes in Banjar Regency, South Kalimantan

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Abstract

The land fires that occurred in 2019 in Banjar Regency, South Kalimantan disrupted economic, educational and public health activities. A total of 269,777 ha is flammable peatland. Banjar Regency experienced land fires of 22,943 ha. The number of hotspots in Banjar Regency was detected as many as 2000 points. Using analysisNetwork Analysis which is one of the analysis Geographic Information System (GIS) used to analyze the movement.The route will be built with the assumption that the route will be optimal for the distance traveled against the time it takes. Thus, this analysis will produce the fastest route (based on time) and the shortest route (based on distance).. The results indicate that from 8 sample points of API hotspots on peatlands, there are 8 evacuation buildings for evacuation routes with the fastest route and time in Road Class I, road width, road conditions and vehicle category.

Keywords: Disaster Mitigation, Network Analysis, Travel Distance, Travel Time, Banjar Regency.

1 Introduction

Based on BNPB head regulation no 2 of 2012 Disaster is an event that threatens and can disrupt people's lives and livelihoods caused by natural or non-natural factors and also human factors so that it can result in human casualties, damage to the environment. [1]

The land fires that occurred in 2019 in Banjar Regency, South Kalimantan disrupted economic, educational and public health activities. Several incidents of fire spread to residential areas[2]. This happens because the distance between hotspots and settlements is very close. Available data shows that a total of 942,484 ha of land experienced fires in Indonesia[2]. A total of 269,777 ha is flammable peatland[2]. Banjar Regency experienced land fires of 22,943 ha. The number of hotspots in Banjar Regency was detected as many as 2000 points[2].

The field of Geomatics, especially Geographic Information System (GIS) technology, makes a strategic contribution to providing basic information in disaster risk assessment, and one of these contributions is by making maps of disaster evacuation routes.[3]

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Appropriate mitigation measures are needed in Banjar Regency. The number of hotspot points with distribution near settlements threatens the lives of residents. In general, the mitigation steps that can be taken are as follows[4]: Spatial planning, Development arrangements, infrastructure development, building planning, Implementation of education, counseling and training in conventional and modern ways.

These three steps are carried out in a comprehensive and interrelated manner. One of the approaches used in the community is by providing evacuation routes. The purpose of this study is to determine the evacuation route. Mapping evacuation routes is part of the mitigation of peatland fires by utilizing data and information in the form of distribution of hotspots, road networks, data on the distribution of buildings used as temporary evacuation sites, and data on peatland cover.

The evacuation route is determined from the distribution of hotspots in 2019 in Banjar Regency by analyzing and calculating the nearest evacuation route using a spatial approach (GIS) using the Network Analysis method to analyze evacuation routes, as well as determine the feasibility of temporary evacuation buildings and the accessibility of evacuation vehicles based on BNPB regulations and the Department of Transportation.

2 Metodology

GIS can provide information to users regarding transportation about the roads that can be traversed. It can affect the analysis decision-making. Users can make decisions about a problem. The problems found in the field of transportation include: the problem of determining the shortest path so that users can make transportation effectively and efficiently [5]. The method used in this study is a quantitative research method with network analysis and overlay interpretation techniques [6]. Interpretation technique is a special method used to carry out remote sensing methods. There are two types of interpretation techniques, namely manual interpretation and digital interpretation[6]. This study uses manual interpretation techniques with network spatial analysis. Network analyst method (Route Analysis) namely determining the path from settlements close to the hotspots to temporary shelters by calculating the travel time from the resulting distance. Method used can be useful in facilitating path determination evacuation from residential areas close to the fire point to the place evacuation or temporary shelter. Meanwhile, the overlapping technique in this research is used to show the degree of correspondence between the data and the position or position of the coordinates according to the projection system. [6]

2.1 Temporary Evacuation Site And Fire Protection Management

Temporary shelter is a place to live temporarily while disaster victims are displaced, either in the form of mass shelters or families, or individually [7]. Temporary evacuation sites can be provided in the form of tents, barracks or public or social facility buildings in this study referring to school buildings that are spread not far from hotspots and road accessibility. Based on the Regulation of the Head of BNPB Number 7 of 2008 concerning guidelines on procedures for providing assistance to meet basic needs, it states that the criteria for a temporary evacuation site are 3 square meters in size for each person, have safety and health requirements, have accessibility to public facilities, and guarantee privacy be-

tween types. gender and various age groups. Fire protection management in urban areas is all efforts related to organizational systems, personnel, facilities and infrastructure, as well as procedures to prevent, eliminate and minimize the impact of fires on buildings, the environment and cities [8]. Based on the Regulation of the Minister of Public Works Number 20/PRT/M/2009 concerning technical guidelines for urban fire protection management in the annex, it states that the fire response time to notification is not more than 15 minutes and the factors that affect response time are the type of disaster management service, the size of the area served. served by firefighters, and the ability of local communities to provide infrastructure[8].

2.2 Locations of Hotspot and Evacuation Baracks

Locations of hotspots on peat soil in Figure 1 are identified locations near residential areas. Based on Figure 1, temporary shelters that meet the following requirements are determined[4], as shown in Table 1.

Table 1: Requirements of Temporary Shelters or Barracks

No	Requirements
1	Size 3 (three) m2 each person
2	Has safety and Health requirements
3	Easy access to public facilities
4	Guarantee the privacy of different genders and age groups

The results of identifying evacuation barracks locations that comply with these requirements are shown in Figure 1.

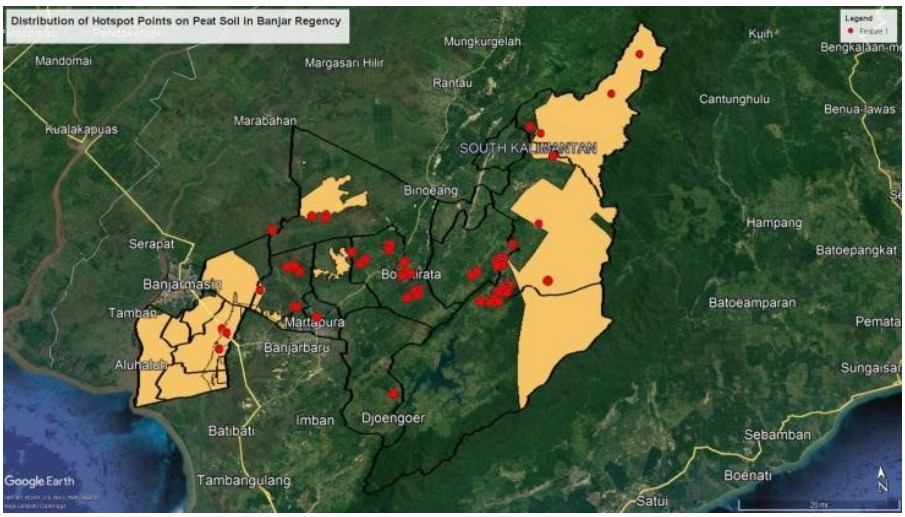

Figure 1: Distribution of Hotspot Points on Peat soil in Banjar Regency

The location of the evacuation barracks identified in Figure 2 is the school building. The school building was identified as meeting the requirements as an evacuation barracks.

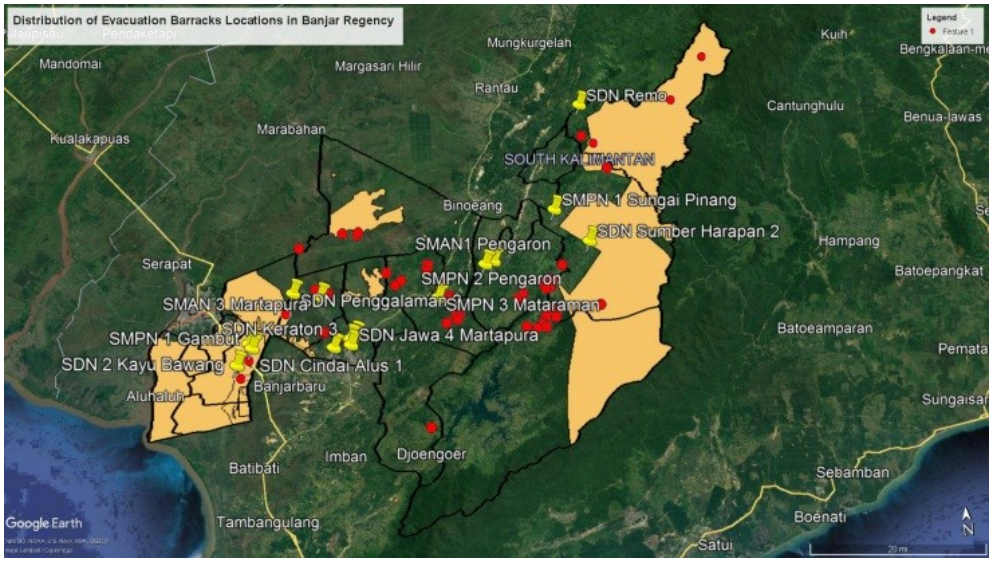

Figure 2: Distribution of Evacuation Barracks Locations in Banjar Regency

3 Evacuation Route Plan

Evacuation routes are determined by looking for the shortest route to predetermined public facilities, namely in the form of school buildings which of course also have sufficient room size and other facilities.

3.1 Hotspot A

The evacuation route plan to avoid hotspot A is shown in Figure 3.

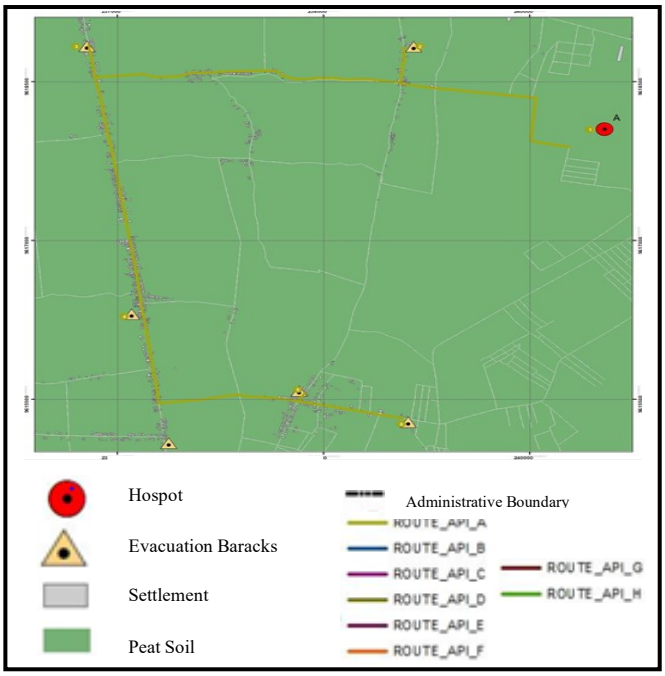

Figure 3: Evacuation Route Plan to Evacuation Barracks from Hotspot A

The evacuation route plan uses road class I. This class of road can be passed by motorized vehicles with a maximum width of 2.5 m, a maximum height of 4.2 m and a maximum payload of 10 tons[9]. The categories of vehicles that can go through the evacuation route are categories M1 and N1. Vehicles in the M1 category have a maximum of 8 seats. The vehicle weight is not more than 3,500 kg[10]. Vehicle category N1 is a four-wheeled vehicle. The maximum weight of vehicles in this category is 3,500 kg. The results of the analysis of hotspot A are shown in Table 2.

Table 2: Information On The Distance And Travel Time From Hotspot A To The Evacuation Barracks

Name	Road Width (m) and Class	Condition and Mileage (Km)	Travel Time (minutes)	Vehicle Category	Information
Kayubawang Public elementary School 2	2.47 (I)	Gravel (2.2)	4.41	M1 and N1	Access nearest evacuation barracks
Madrasah Ibtidaiyah Bustanus – Saniyah Malintang	5.05 (-)	Asphalt (4.24)	8.49	-	
Guntung Papuyu Public Elementary School	5.05 (-)	Asphalt (6.20)	12.41		
Guntung Ujung Elementary School 1	3.02 (-)	Cast Cement (8.14)	16,29		
Gambut State Junior High School 2	3.02 (-)	Cast Cement (8,8)	17,71		

Based on Table 2, Kayubawang Public elementary School 2 is the closest to fire point A. Residents can evacuate to Kayubawang Public elementary School 2 quickly with gravel road conditions. Other school buildings are alternatives 2 to 5 that can be accessed by residents

3.2 Hotspot B

Gambut State Junior High School 2 is the closest to hotspot B with road width 2.74 m, have mileage 0.569 km, asphalt pavement conditions, and travel time 1.14 minute. Residents can evacuate quickly to Gambut State Junior High School 2 with paved roads. Other school build-

ings are alternatives 2 to 3 which can be accessed by residents. Figure 4 shows the distance between the close evacuation barracks. Fire-affected residents have alternatives to seek refuge in any evacuation barracks. The evacuation route plan to avoid hotspot B is shown in Figure 4.

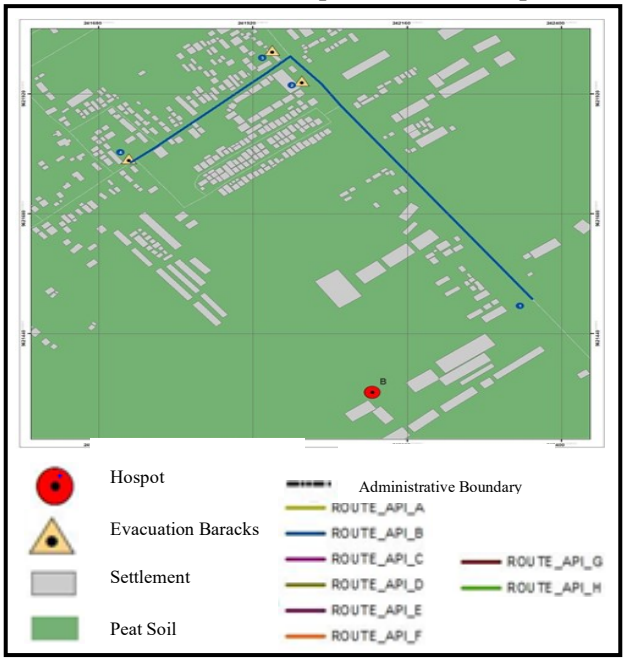

Figure 4: Evacuation Route Plan to Evacuation Barracks from Hotspot B

3.3 Hotspot C

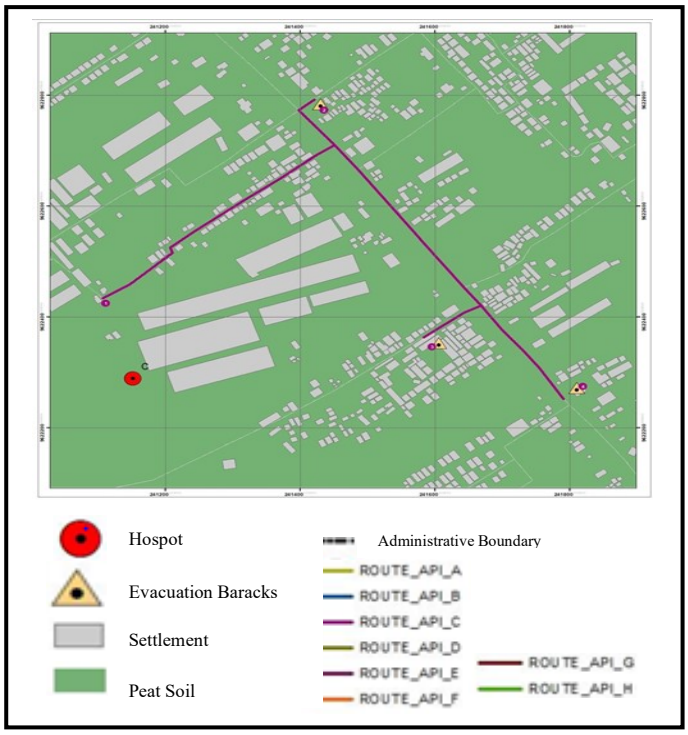

Figure 5: Evacuation Route Plan to Evacuation Barracks from Hotspot C

Based on the results of the analysis of the road network in Figure 5, it shows that Mawar Gambut Kindergarten is the closest evacuation site when compared to the other two schools (Madrasah Aliyah Negeri 1 Martapura and Madrasah Ibtidaiyah Negeri Gambut) with road specifications in the form of paving, travel time and distance required of 1.12 minutes and 0.56 km

3.4 Hotspot D and E

Based on table 3 which shows the evacuation route for hotspot D shows that, Penggalaman Public Elementary School 2 is the closest to hotspot D. Residents can quickly evacuate to Pejambuan Public Elementary School 2 with paved roads. Other school buildings (Mawar Kindergarten and Pejamuan Public Elementary School 2) are alternatives 2 to 3 which can be accessed by residents.

Table 3: Information On The Distance And Travel Time From Hotspot D To The Evacuation Barracks

Name	Road Width (m) and Class	Condition and Mileage (Km)	Travel Time (minutes)	Vehicle Category	Information
Pejamuan Public Elementary School 2	3.92 (I)	Asphalt and Soil (3.1)	6.20	-	
Mawar Kindergarten	3.92 (-)	Asphalt and Soil (3.17)	6.35	-	
Penggalaman Public Elementary School 2	5.04 (-)	Asphalt (2.96)	5.85	M1 and N1	Access nearest evacuation barracks

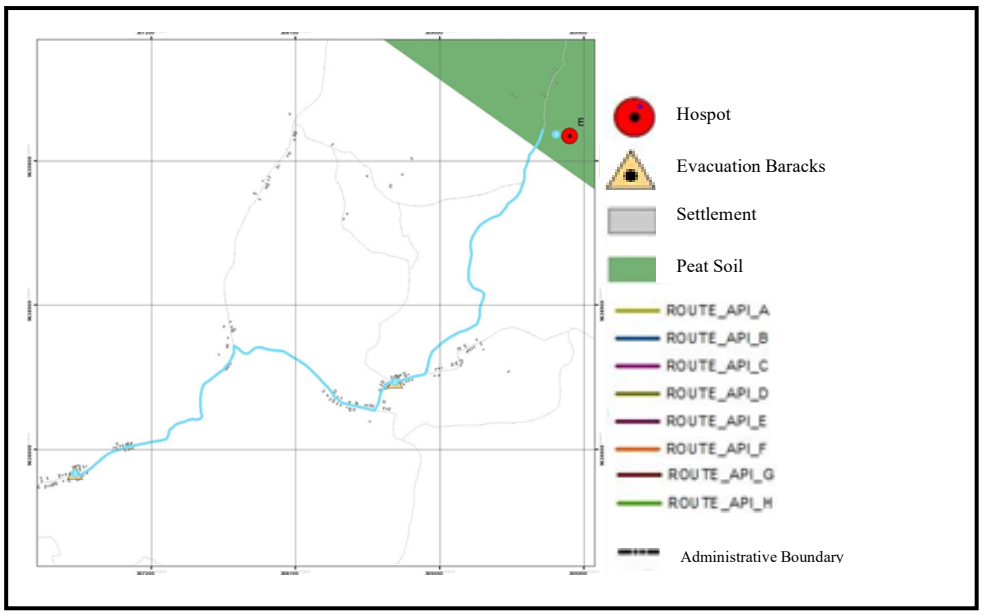

Figure 6: Evacuation Route Plan to Evacuation Barracks from Hotspot E

While in Figure 6 shows that Sumberharapan Public Elementary School 2 is the closest evacuation site when compared with Sumberharapan Public Elementary School 1. The road specifications clay, travel time and distance required of 4.23 minutes and 2.11 km.

3.5 Hotspot F and G

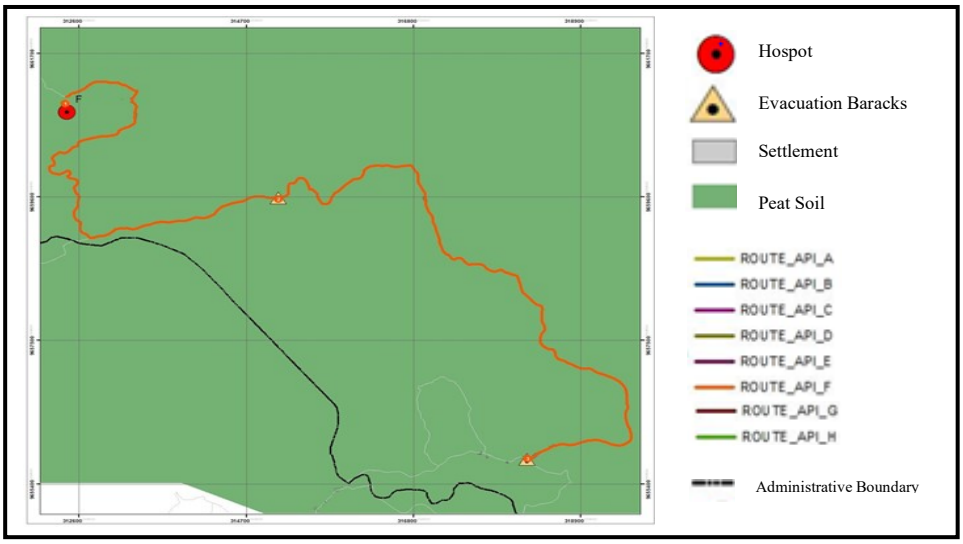

Figure 7: Evacuation Route Plan to Evacuation Barracks from Hotspot F

From the results of Figure 7 it shows that the evacuation access for Pamangkih Public Elementary School is farther (16 km) when compared to Remo Public Elementary School which only has a distance to a hotspot of 6.97 km, this is also supported by the not too long travel time of 14 minutes and the road conditions are dirt clay.

Table 4: Information On The Distance And Travel Time From Hotspot G To The Evacuation Barracks

Name	Road Width (m) and Class	Condition and Mileage (Km)	Travel Time (minutes)	Vehicle Category	Information
Pejamuan Public Elementary School 2	4.07 (I)	Clay (0.80)	1.61	M1 and N1	Access nearest evacuation barracks
Paramasan Bawah Public Elementary School 1	4.07 (-)	Clay (0.96)	1.93	-	
Paramasan Bawah Public Elementary School 2	4.01 (-)	Asphalt (5.48)	10.97	-	

Based on Table 4, PAUD Al Ikhlas is the closest to hotspot G and the closest to the evacuation building access in Pejamuan Public Elementary School 2. Residents can evacuate to PAUD Al Ikhlas and Pejamuan Public Elementary School 2 quickly with the condition of a dirt road. Other school buildings are alternatives 2 to 3 which can be accessed by residents.

3.6 Hotspot H

Paramarasan Atas Public Elementary School being the only evacuation barracks that is closest to the hotspot with a distance and travel time of 8.11 km and 16.24 minutes, has a clay road condition.

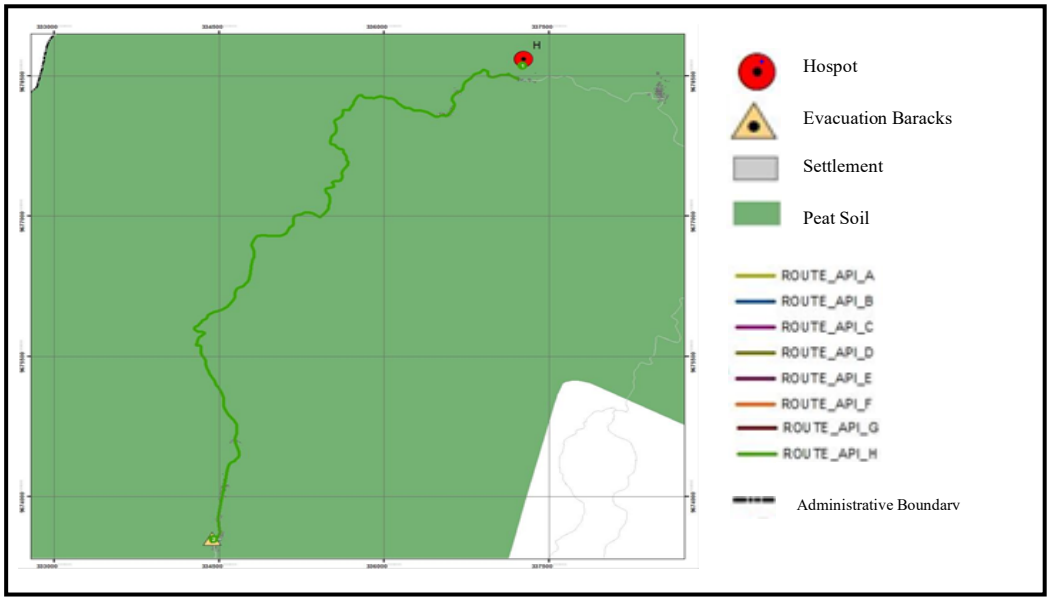

Figure 7: Evacuation Route Plan to Evacuation Barracks from Hotspot H

Paramarasan Atas Public Elementary School being the only evacuation barracks that is closest to the hotspot with a distance and travel time of 8.11 km and 16.24 minutes, has a clay road condition.

4 Conclusion and Discussion

The distribution of hotspots in Banjar Regency has 8 points located on peat soil. For the location of the evacuation barracks, use a school building that meets the requirements as an evacuation barracks by taking into account and using the Class I route, road conditions, road width, and vehicle category. The evacuation route plan to avoid hotspots AH is as follows: Avoiding hotspots A through Kayubawang Public Elementary School 2 with a distance of 2.207 km and the fastest travel time of 4.41 minutes, avoiding hotspots B passing Gambut State Junior High School 1 with a distance of 0.569 km and a time the fastest 1.14 minutes, avoiding hotspot C passing through Mawar Kindergarten with a distance of 0.560 KM and the fastest travel time of 1.12 minutes, avoiding hotspot D by passing Penggalaman Public Elementary School 2 with a distance of 2.96 km and a travel time of 5.85 minutes.

The results of the analysis show that the peat area hotspots are close to residential locations.

Using network analyst tools, information is obtained on the nearest evacuation route to the evacuation barracks. Class I roads are used with the assumption that residential routes are not routinely passed by heavy vehicles. Taking into account the various road conditions, the estimated travel time can be longer or vice versa. In general, all locations have alternative evacuation barracks locations that residents can use. At hotspot H, no other alternative locations were found. However, the distance from the fire point to the location of the evacuation barracks is quite far.

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