LAND SUITABILITY ASSESSMENT FOR POULTRY FARMS IN DAVAO CITY USING GEOGRAPHIC INFORMATION SYSTEM (GIS) AND FUZZY ANALYTIC HIERARCHY PROCESS (FAHP)

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ABSTRACT: The study was conducted to map out the suitable location for poultry farming in Davao City. Fuzzy Analytic Hierarchy Process (AHP) and Geographic Information System (GIS) were used to generate the suitability map. Triangular fuzzy number (TFN) was used in calculation of weight values which addressed the uncertainty of the experts' opinion. Experts participated were from Davao City Agriculturist department and Veterinarians office, NGO, and poultry farm industry. There were six factors considered namely elevation, land cover, landslide prone, river and road network, and soil type with weight values of 11%, 41%, 7%, 20%, 14% and 7%, respectively. The maps were reclassified into four classifications (high, moderate, marginal and not suitable). The classifications were represented by numerical values 1 to 4 with 1 as the highly suitable and 4 as not suitable classification. There were 28 highly suitable barangays in Davao City, Southern Philippines for poultry farming. Some recommendations for future research were to consider more factors, and replicate the methods using a different study area.

1. MANUSCRIPT

Chicken is one of the main consumed meats in the Philippines. As reported by the Philippine Statistics Authority (PSA) in January 1, 2017 the chicken production has reached approximately 175.32 million birds and per capita chicken meat consumption reached 11.60 kg. Philippine poultry industry prospects for continued growth to meet the market demands in the future (Cabanilla et al., 2013). Davao City is one of the fastest growing cities in the Philippines; however this rapid growing affects the agricultural area especially for the poultry farms. Davao City is one of the major contributors of chicken in the whole Davao region according to the Philippine Statistics Authority report in 2016. On 2017, several areas of Davao City faced chicken supply shortage this was due to closure of some poultry farms.

Expansion of the poultry farms has many factors to be considered to avoid negative effects to the environment. Poultry farms contributed to air pollution by releasing a large amount of dust particles coming from manure, feathers and other wastes. Respiratory problems such as chronic bronchitis and asthma resulted from too much exposure to dust from poultry farms (Omland, 2002). These dust contains microorganisms and allergens that causes allergic reactions to human body (Hamscher et al., 2003).

Land suitability decision making for poultry production is becoming more difficult because of the increasing human population. Increasing population increases the demand for a new land and the growing consciousness for sustainability and resource use (Amiri et al., 2012). Finding a suitable location must match the zone of the area and its assigned land use (Carsjens and Van Der Knaap, 2002).

Moreover, the research study could be helpful in the decision making of the officials for the benefit of the public health. The obtain map can be used as a basis for the future poultry farm owners in choosing a suitable location. The poultry farms were closed due to the land developers that were planning to construct building nearby. As much as the poultry farmers wanted to continue the operation, owners struggled about the expansion problem due to zoning.

The main objective of the study is to determine suitable areas for poultry production in Davao City using fuzzy Analytic Hierarchy Process (Fuzzy AHP) and Geographic Information System (GIS).

2. MATERIALS AND METHODS

2.1 Study Area

The study area is located in Davao City (Figure 2) on the southern part of the Philippines. The area under has an area of 244,000 hectares, of which is composed of sandy beaches and outlying islands, agricultural plains and valleys, rainforests and mountains including the Mt. Apo. The climate is mild tropical all year round. The city is divided into three political districts, such as District 1 is Poblacion and Talomo, District 2 is Agdao, Buhangin,

Bunawan and Paquibato, and District 3 is Toril, Tugbok, Calinan, Baguio and Marilog (Davao City - Profile). Davao City is a good location for farming because it's topographical location and weather, and has abundant water source and market accessibility.

The list of the poultry farms was obtained from the City Veterinarian's Office of Davao City, and there were 61 registered poultry farms as of January 2018. There were 57 poultry farms located in District 3, three in District 2, and one in District 1. There were 20 poultry farms location that were plotted in the map for the evaluation.

2.2 Software Used

Geographic Information System (GIS) which provides a spatial analysis was used. GIS is a computer-based information technology (Huisman and de By, 2009). The ArcGIS desktop was GIS software developed by ESRI. ArcMap is an integrated application of ArcGIS desktop. ArcMap application was used in analysing the datasets and maps.

2.3 Methods

Figure 1 summarizes the process undergone of the study.

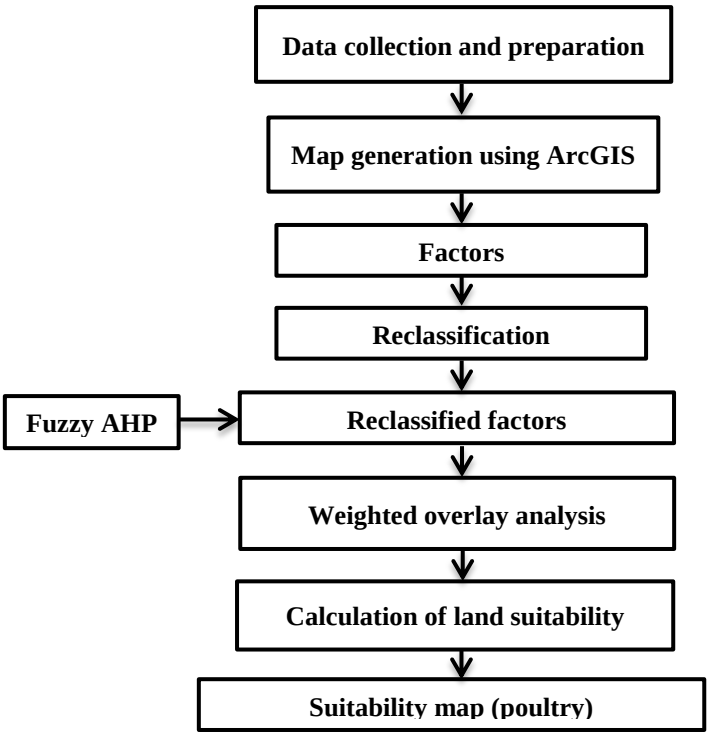

Fig. 1. Flowchart of the methods of the study (Lifted from Jamil et al. 2017).

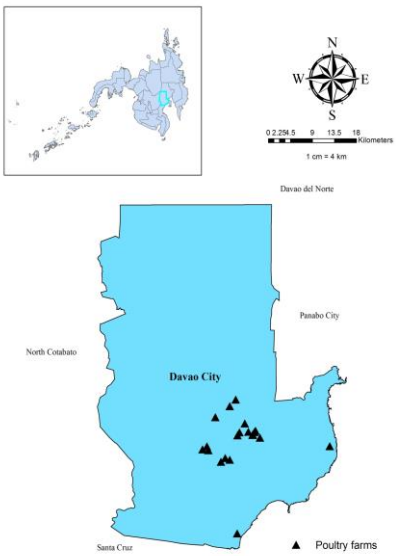

Fig. 2. Political boundary map of Davao City.

2.3 Dataset Collection and Preparation

The maps used in the study such as Davao City political boundary, soil type and SAR derived DEM (digital elevation model) were acquired from Geo-Safer project in UP Mindanao under the project head Engr. Joseph Acosta. Land cover, and road network were obtained from PhilGIS website. PhilGIS is an open source, free data – data portal of the Philippine geospatial datasets. Landslide dataset was acquired from NOAH (Nationwide Operational Assessment of Hazards) website. NOAH is a government funded by Department of Science and Technology (DOST) from July 2012 – February 2017, and was a Philippine disaster risk reduction management program. The datasets from NOAH are open data licensed under the Open Data Commons Database License (ODC – OdbL). River network was acquired from HDX (The Humanitarian Data Exchange) website and it is an open data sharing managed by United Nations (UN) for Coordination of Humanitarian Affairs.

The dataset of the six factors acquired have different cell size. The researcher resampled to 200 m by 200 m resolution for the uniformity of the maps using the ArcMap application.

Table 1. Data used.

	Format	Data Source	Description
Elevation	Raster	SAR – DEM	Height above or below reference point
Land cover	Shapefile	Phil – GIS	The physical material at the surface of the earth.
Landslide	Raster	NOAH	The sliding down of a mass of the earth rock from a mountain or cliff.
River	Shapefile	UN - HDX	A large natural stream of water flowing in a channel to the sea, a lake, or another such stream.
Road Network	Shapefile	Phil – GIS	A wide way leading from one place to another, especially one with a specially prepared surface which vehicles can use.
Soil Type	Shapefile	Geo – Safer	Type of soil in the study area.
River	Shapefile	UN - HDX	A large natural stream of water flowing in a channel to the sea, a lake, or another such stream.
Road Network	Shapefile	Phil – GIS	A wide way leading from one place to another, especially one with a specially prepared surface which vehicles can use.

2.4 Creating factor maps

There are six (6) factors in this study considered namely, elevation, land cover, landslide, river and road network, and soil type. The weights were obtained by creating a pairwise comparison matrix for the fuzzy AHP. The raster format maps of the factors were stored with the weight value of each factor.

DEM dataset from SAR was used in the elevation factor for the topographic features. Elevation has a value of -2.18289 m to 2,932.8118 m above the sea level. Land cover have 10 classifications namely, brushland, built – up, closed canopy, cultivated area, fishpond, grassland, inland water, open areas, open canopy forest, and tree plantation and perennial. Landslide prone map has four hazard categories namely, low risk, moderate risk, high risk and very high risk. Waterways have different types such as canal, ditch, river, stream and drain, and all of the types were considered as the river network factor. Road network has four types namely, barangay road, city road, national road and trail. Soil type was classified to five types, clay loam, sandy clay loam, clay, silty clay loam, and mountain soil.

2.5 Poultry farm factors

In evaluating criteria, objective and factors were identified with respect to the main goal of the study (Prakash, 2003). The factors used were acquired through survey – interview process and literature review. There are 61 poultry farms that were registered in the city veterinarian's office (CVO) as of January 2018 in Davao City. Fifteen poultry farms participated in the survey - interview. The following were the factors that have a highest number of votes in choosing the location of the poultry farms namely, elevation, and river and road networks. Factors from literature were the land cover, landslide, and soil type. A total of six determined factors were selected.

2.6 Reclassification of Factor Maps

There were six factors that undergone reclassification method in ArcMap. The factors were reclassified into four categories (1 as most suitable and 4 as not suitable). After reclassification the suitable elevation for poultry farming is 15% slopy and classifying it to [1-15%] as S1, (15% - 45%) as S2, (45% - 75%) as S3 and [75% - 100%] as not suitable (Chapman, 1995). Brush land and grassland were the most suitable classes for poultry farming and built – up areas, fishponds, and inland water were the not suitable classes (City Government of Davao, 2012). Landslide hazard map were already categorized to four classification where 1 as the low risk, 2 as the moderate risk, 3 as high risk and 4 as very high risk of landslide. Poultry farms must be outside the 25 m radius of any form of waterways, classifying the distance of the rivers to [1 m – 3000 m) was the most suitable location for poultry farm and more than 12000 m were classified as the not suitable (Housing and Land Use Regulatory Board, 2000). Accessibility of the poultry farm was considered as factors since it should be passable to any form of vehicles. As a requirement poultry farms must be outside the 1000 m radius of the road (national and city highway) (Housing and Land Use Regulatory Board, 2000). Reclassifying the distance of the road map resulted that the most suitable location was 1m to 2000 m and not suitable was more than 10000 m distance (Pourebrahim et al., 2011). Soil type suitable for poultry farm was sandy loam soil because it has a higher absorbability and heavy clay soil was classified as not suitable due to its absorbability of water (Gerber et al., 2008). There were eight soil classifications present in Davao City. The Camasan sandy clay loam and

San Manuel silty clay loam were the suitable soil type for poultry farming, and clay and mountain soil were the not suitable for poultry farming (City Government of Davao, 2012).

2.7 Fuzzy AHP

The importance rating given by the experts were based on the rating used by Prakash (2003) in his study. The scale showed how much important one element compared to the other element. The next step was to create a pairwise comparison matrix of the factors used in the study the table below shows the matrix. After that was converting the crisp value to triangular fuzzy numbers (TFN) .

Table 2. Pairwise comparison matrix of the criteria used in the study.

	Elevation	Land cover	Landslide Prone	River Network	Road Network	Soil Type
Elevation	1	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}
Land cover	$\frac{1}{a_{12}}$	1	a_{23}	a_{24}	a_{25}	a_{26}
Landslide Prone	$\frac{1}{a_{13}}$	$\frac{1}{a_{23}}$	1	a_{34}	a_{35}	a_{36}
River Network	$\frac{1}{a_{14}}$	$\frac{1}{a_{24}}$	$\frac{1}{a_{34}}$	1	a_{45}	a_{46}
Road Network	$\frac{1}{a_{15}}$	$\frac{1}{a_{25}}$	$\frac{1}{a_{35}}$	$\frac{1}{a_{45}}$	1	a_{56}
Soil Type	$\frac{1}{a_{16}}$	$\frac{1}{a_{26}}$	$\frac{1}{a_{36}}$	$\frac{1}{a_{46}}$	$\frac{1}{a_{56}}$	1

Table 3. Converted matrix in Fuzzy Triangular Number (TFN).

	Elevation	Land cover	Landslide Prone	River Network	Road Network	Soil Type
Elevation	(1,1,1)	(l_{12}, m_{12}, u_{12})	(l_{13}, m_{13}, u_{13})	(l_{14}, m_{14}, u_{14})	(l_{15}, m_{15}, u_{15})	(l_{16}, m_{16}, u_{16})
Land cover	$\left(\frac{1}{u_{12}}, \frac{1}{m_{12}}, \frac{1}{l_{12}}\right)$	(1,1,1)	(l_{23}, m_{23}, u_{23})	(l_{24}, m_{24}, u_{24})	(l_{25}, m_{25}, u_{25})	(l_{26}, m_{26}, u_{26})
Landslide Prone	$\left(\frac{1}{u_{13}}, \frac{1}{m_{13}}, \frac{1}{l_{13}}\right)$	$\frac{1}{(l_{23}, m_{23}, u_{23})}$	(1,1,1)	(l_{34}, m_{34}, u_{34})	(l_{35}, m_{35}, u_{35})	(l_{36}, m_{36}, u_{36})
River Network	$\left(\frac{1}{u_{14}}, \frac{1}{m_{14}}, \frac{1}{l_{14}}\right)$	$\frac{1}{(l_{24}, m_{24}, u_{24})}$	$\frac{1}{(l_{34}, m_{34}, u_{34})}$	(1,1,1)	(l_{45}, m_{45}, u_{45})	(l_{46}, m_{46}, u_{46})
Road Network	$\left(\frac{1}{u_{15}}, \frac{1}{m_{15}}, \frac{1}{l_{15}}\right)$	$\frac{1}{(l_{25}, m_{25}, u_{25})}$	$\frac{1}{(l_{35}, m_{35}, u_{35})}$	$\frac{1}{(l_{47}, m_{47}, u_{47})}$	(1,1,1)	(l_{56}, m_{56}, u_{56})
Soil Type	$\left(\frac{1}{u_{16}}, \frac{1}{m_{16}}, \frac{1}{l_{16}}\right)$	$\frac{1}{(l_{26}, m_{26}, u_{26})}$	$\frac{1}{(l_{36}, m_{36}, u_{36})}$	$\frac{1}{(l_{46}, m_{46}, u_{46})}$	$\frac{1}{(l_{56}, m_{56}, u_{56})}$	(1,1,1)

The value of each criterion was in fuzzy numbers and then solving the fuzzy geometric mean value ($\tilde{r}_i$). To solve $\tilde{r}_i$, multiplying all the lower (*l*), middle (*m*), and upper (*u*) value in each row, and was calculated using. After solving for the fuzzy geometric mean, the weights (w_i) for each criterion were calculated. The resulting value for the w_i was in TFN, converting it to crisp value.

If w_i>1, the weights should be normalized. After generating the weights of criterion for each expert, next was solving for the arithmetic mean of the weights.

2.8 Calculating of weights using fuzzy AHP

There were six (6) experts that rated the factors determined in the study. Table 4 shows the average weight of each factors.

Table 4. Weights of each factor used in the study.

Expert / Factor	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Row Average
Elevation	w_{11}	w_{21}	w_{31}	w_{41}	w_{51}	w_{61}	$\frac{\sum_1^6 w_{i1}}{6}$
Land cover	w_{12}	w_{22}	w_{32}	w_{42}	w_{52}	w_{62}	$\frac{\sum_1^6 w_{i2}}{6}$
Landslide Prone	w_{13}	w_{23}	w_{33}	w_{43}	w_{53}	w_{63}	$\frac{\sum_1^6 w_{i3}}{6}$
River Network	w_{14}	w_{24}	w_{34}	w_{44}	w_{54}	w_{64}	$\frac{\sum_1^6 w_{i4}}{6}$
Road Network	w_{15}	w_{25}	w_{35}	w_{45}	w_{55}	w_{65}	$\frac{\sum_1^6 w_{i5}}{6}$
Soil Type	w_{16}	w_{26}	w_{36}	w_{46}	w_{56}	w_{66}	$\frac{\sum_1^6 w_{i6}}{6}$

2.9 Overlaying Maps

The process followed in overlaying the maps is summarized in Figure 4. The maps of each factors was converted to raster format and then reclassified to four categories. After that is assigning the weights to each map factors.

The next step is the calculation of the suitability map (SM) for the poultry farm. The weights assigned to each factors was combined using the equation:

$$SM = \sum_{j=1}^{N} weight\ of\ e\ factor\ (w_j) * map\ of\ factor \quad [1]$$

where w_j is the weight for the jth factor and N is the number of factors used in the study.

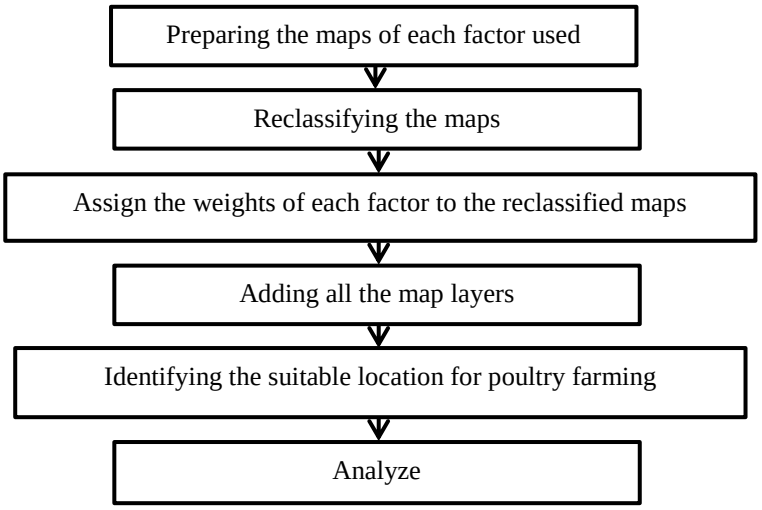

Fig. 3. Flowchart in overlaying the maps.

3. RESULTS

3.1 Factors of Poultry Farm

There were 15 farms surveyed were located in district 3. The factors were selected depending on the number of votes gained during the survey. Elevation was important in the land suitability, since high elevation has a high risk of erosion and landslide.

Land cover, landslide and soil type were selected from the literatures. Land cover served as the major basis on which zone was suitable for poultry farming. Landslide prone area was selected as one of the factors considering the

topographical status of Davao City which was mountainous. The slopy areas were known to be high risk of landslide, thus considering it helped in determining the suitable location for poultry farms. Soil type has a different absorbability. However, soil type played a role in the erodability and the absorbability of the area. Places with high erodability were not good for poultry farms, which may cause damage.

3.2 Maps Generated

The maps that were collected such as elevation (Figure 4) obtained from Geo – Safer UP Mindanao, land cover (Figure 5) from PhilGIS website, landslide prone (Figure 6) from NOAH website, river (waterways) (Figure 7) from the website of UN – HDX, road network (Figure 8) downloaded from PhilGIS website, and soil type (Figure 9) from Geo –SAFER project. Land cover, landslide prone, river network, road network and soil type map were clipped to the political boundary map of Davao City. Land cover, river and road network, and soil type were converted to raster 200 m by 200 m resolution. Elevation map was resampled to 200 m by 200 m resolution for the uniformity of the datasets.

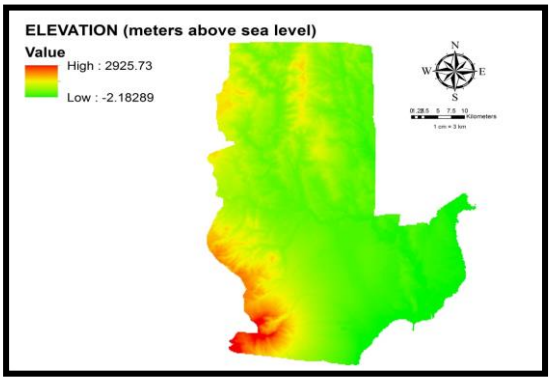

Fig. 4. Elevation map of Davao City.

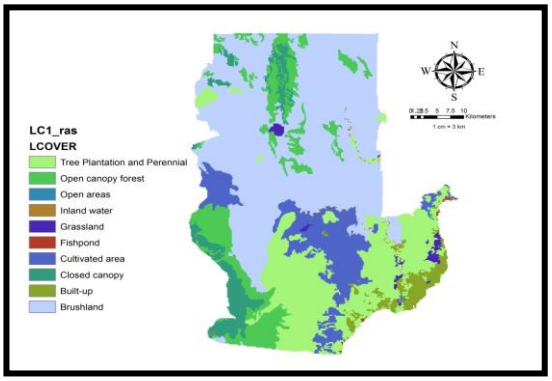

Fig. 5. Land cover map of Davao City.

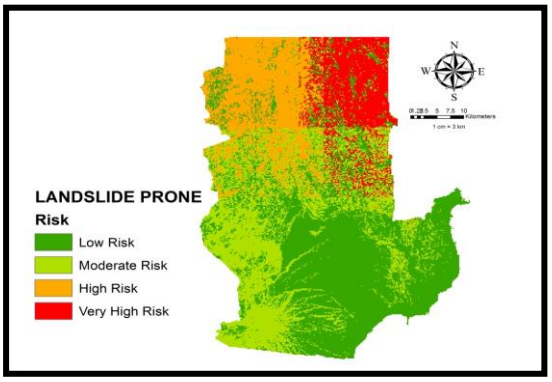

Fig. 6. Landslide prone map of Davao City.

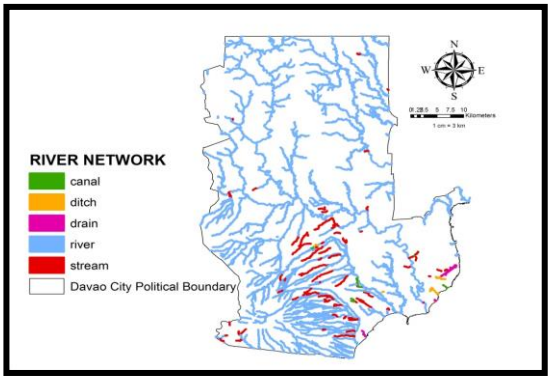

Fig. 7. River (waterways) network map of Davao City.

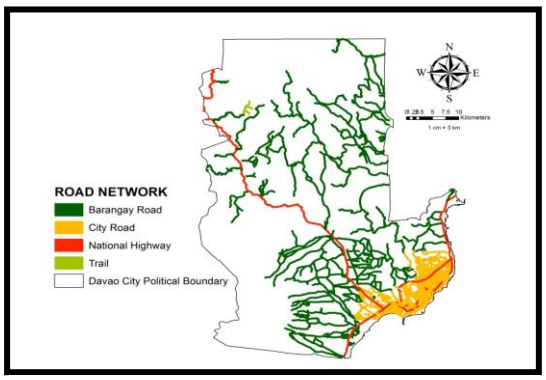

Fig. 8. Road network map of Davao City.

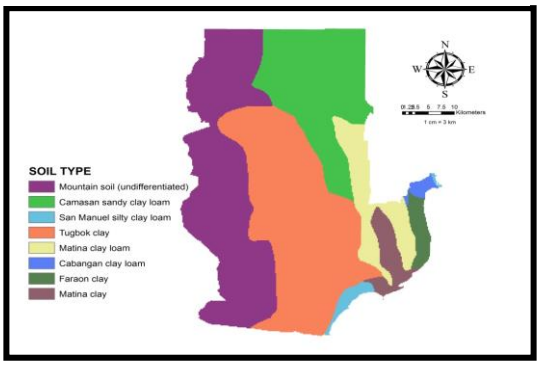

Fig. 9. Soil type classification map of Davao City.

1.1 Weights of the Factor Maps

There were six (6) factors considered namely, elevation, land cover, landslide prone, river and road network, and soil

Table 5. Weight values of each experts and average weight.

Criteria/ Experts	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Average weight
Elevation	0.0856	0.0907	0.0744	0.0689	0.1511	0.1878	0.1098
Land cover	0.6108	0.5828	0.4118	0.4058	0.1078	0.3167	0.4059
Landslide Prone	0.0441	0.0498	0.0452	0.0660	0.1402	0.0956	0.0735
River Network	0.1233	0.1362	0.3709	0.3717	0.1767	0.0346	0.2022
Road Network	0.0572	0.0675	0.0731	0.0678	0.3001	0.2672	0.1388
Soil Type	0.0790	0.0732	0.0246	0.0198	0.1242	0.0982	0.0698

type. The weights of each factor were calculated using fuzzy – AHP method. Fuzzy – AHP was designed to avoid uncertainty of the experts' opinion. The weight values obtained were assigned to the raster map of each factor.

Table 5 showed the experts weight value to each factors. Experts 1, 2, 3, 4 were from the government department, and their top three factors were land cover, river network and elevation. Experts 5 and 6 were from a non-government organization and poultry farm industry, respectively. Expert 5 calculated weight values for the factors showed that road network was the most important in choosing a poultry farm location, followed by river network and elevation. Expert 6 ranking showed that land cover is the top priority, next was the road network and elevation. All of the six experts result in the top three rankings; elevation was in the third rank that must be considered in seeking suitable location considering the factors used.

Table 5 the average weight value of the six (6) factors the most important to least were land cover (40.59%), river network (20.22%), road network (13.88%), elevation (10.98%), landslide prone (7.35%), and soil type (6.98%).

Elevation has 10.98% in choosing poultry farm. The elevation must be considered since Davao city was located in a mountainous area of Mindanao, the higher the elevation more likely to have a high risk of landslide. Most of the poultry farms visited by the researcher the poultry farms were located in a plain area that was far from the mountainous area. The most suitable place for building poultry farm was in the plain area of Davao City. The weight value for the elevation was 0.1098 of the total suitability map. It was meant that elevation has only 11% importance impact for the creation of the map.

Land cover has many different kind of classification. Davao city has 10 present land cover categories. The most suitable for poultry farming that have a brush land and grasslands areas. Built-up area, fishpond and inland water were classified as not suitable for poultry production because it has negative effects to the community that will pollute the air and water. Cultivated area where classified for planting but most of the poultry farms selected a location that was in the middle of the cultivated area. The problem for the agricultural lands was the distribution of the land (for cultivation or for livestock production). Land cover for the five experts' weight values with mean value is 0.40593, 41% for the overall importance in choosing suitable area. In comparison, land cover is four times more important than the elevation.

Landslide prone area map have four hazard code with 1 as the low risk and 4 as the high risk. The landslide depended on the elevation of a certain area together with the rainfall. Landslide prone factor was able to point out where the high risk of landslide areas inside the boundary of Davao City. As shown in Fig. 6, downtown area has a low risk of landslide this was because it is in the lowland area where elevation was low. As the elevation of Davao City increases the risk of landslide was also increasing. The weight value for landslide prone was 0.0735, which was around 7% impact to the whole suitability map. The area with high risk of landslide where located in the high areas which were not highly recommended, aside from landslide the accessibility of the location was a concern.

Davao City river network was differentiated into five categories namely, canal, ditch, drain, river and stream. These waterways were buffered by 25m radius, the distance of the river was considered. According to the requirements given by the housing and land use regulatory board the poultry farm must be 25m radius, this is to ensure that the poultry farms were located started 25meters away from the river. River network was created with many buffers, the suitable area for poultry farms were as far as the river as possible. In choosing a suitable location for poultry farming, the weight value for river network was 0.20223 or 20% importance in the whole suitability map. Rivers must be away from the poultry farm to avoid the risk of flooding.

Road network of Davao City was buffered with 1km radius. The road considered where the main road used of the people, namely national highways and barangay roads. It was resulted that the city area was a not suitable site for poultry farm since it was very close to the road. Suitable area for poultry farms was outside the 1km radius of the road, however only expert 5 showed importance of the road as the top priority in choosing location for poultry production. The poultry resided away from the main road but it must be passable to different kind of vehicles for the development

of the farms. It was pointed out that accessibility was needed for the development of poultry farm but the result from the experts' opinion 0.13879 or 14% importance value for the suitable location.

The soil type was not paid much attention since the poultry farms were concrete made buildings. The most suitable soil type for poultry farm was sandy clay loam and for not suitable was the clay soil. However, soil type has a major role in choosing suitable area for poultry farms. Soil must not be easily to be eroded to avoid landslides, and the absorbability of the soil for the water used in the poultry. Septic tanks were created for the proper drainage but the surroundings must be dry to avoid the spread of disease. In the result weight value from the experts' opinion, soil type ranked last with 0.06981 or 7% weight values. In defence, soil type was not given much importance by the experts since most of the poultry farm buildings were concrete and have a concrete proper drainage for the waste disposal.

3.4 Map Synthesizing

The suitability map for poultry farms in Davao City was created using Eq. [1] by the assigned weights of each factors. Using the weight values calculated using fuzzy AHP and the raster format of the map the suitable map was obtained in Figure 13. The classification used was forced to four classifications with values of [1.0 – 1.5), [1.5 – 2.5), [2.5 – 3.5) and [3.5 – 4.0]. The researcher forced the classification to assure the integer value of the classification. The reclassification was rounded off as 1, 2, 3, and 4, where 1 as the most suitable and 4 as not suitable.

In Figure 13 is the suitability map for poultry farms in Davao City. The suitable map was ranged from 1 to 3.30977. As the value of the index approaches to 1 the high suitability area for the poultry production, otherwise has a low suitability. Most suitable was classified is 1 with bound [1 – 1.5), moderately suitable is 2 with bound [1.5 – 2.5), 3 was classified as marginally suitable has a bound [2.5 – 3.5) and [3.5 – 4.0] as 4, not suitable. The results showed that Davao City can be categorized as most suitable to marginally suitable for poultry farming. Areas near downtown were showed as not suitable. This was because the land cover classification was built-up areas, considering that land cover ranked as the most important in choosing a poultry farm location. The map showed that areas in the highland were classified as marginally suitable or not suitable at all, even though land cover classification was suitable, it has a high elevation and landslide risk. Roads were passable but the waterways were near in those areas.

Table 6 showed the suitable barangays per district for poultry farming in Davao City suitability map. The barangays listed in the table were not complete some were not able to have enough data to be classified. There are 28 barangays that classified as highly suitable for poultry farm. There were no suitable barangays in district 1 (Figure 10), 13 barangays in district 2 (Figure 11) and 15 barangays in district 3 (Figure 12) classified as highly suitable for poultry farming.

Table 6. Highly suitable barangays for poultry farms in Davao City .

District 1	
No suitable barangay	
District 2	
Colosas	Pandaitan
Fatima (Benowang)	Paquibato Pob.
Lumiad	Paradise Embak
Mabuhay	Salapawan
Malabog	Sumimao
Mapula	Tapak
Panalum	
District 3	
Baganihan	Lampiano
Bantol	Malamba
Buda	Marilog
Dalag	Megkawayan
Datu Salumay	Saloy
Dominga	Tamugan
Inayangan	Wines
Lamanan	

3.5 Evaluation of Results

There are 20 poultry farms that were used for the assessment using the resulted suitability map for poultry farms in Davao City. The existing 20 poultry farms' coordinates were located in the moderately suitable area in Davao City shown in Figure 13. Comparing the results and the existing poultry farms showed that the created suitability map was accurate since the poultry farms were operating in moderately suitable areas in Davao City. These existing poultry farms were built years ago and the shifting of zoning might affect the suitability of the areas.

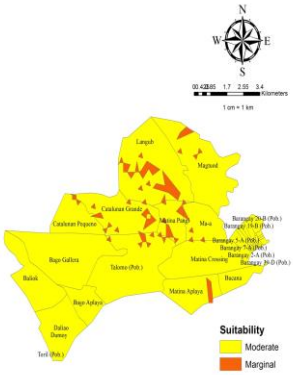

Fig. 10. District 1 suitability map.

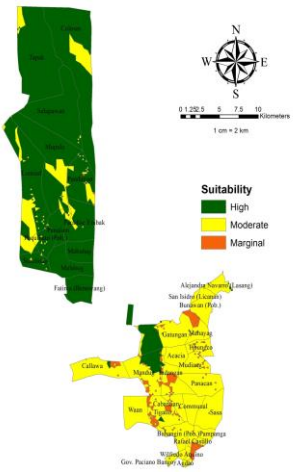

Fig. 11. District 2 suitability map.

Fig. 12. District 2 suitability map.

4 SUMMARY AND CONCLUSION

The study produced a land suitability map for poultry farm in Davao City using fuzzy Analytic Hierarchy Process (AHP) and Geographic Information System (GIS).

There were six factors determined namely, elevation, land cover, landslide prone, river and road network, and soil type. These factors were rated by the experts and combining the useful related datasets have constructed suitable map for poultry farms.

The weight values of each factor were calculated using the fuzzy AHP. The results showed the importance ranking of the factors as follows: land cover, 41%; river network, 20%; road network, 14%; elevation, 11%; landslide prone, 7%; and soil type, 7%.

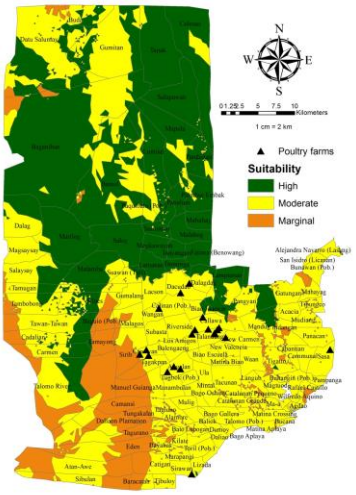

Fig. 13. Suitability map and the existing poultry farms.

Map creation was done in ArcGIS 10.2 software. The GIS tool was used to do spatial analysis of suitable map. The map was converted to raster format and the assigned weight values for each factor. The maps were combined using the ArcGIS tool map algebra. A total of 28 barangays were classified as highly suitable for poultry farming. There were 14 and 15 barangays highly suitable for poultry farming in district 2 and district 3, respectively. There were barangays with no data and were not included in the results.

Evaluation of our results indicated that no existing poultry farms were located in highly suitable area. However, the existing 20 poultry farms were located in the moderately suitable area in Davao City.

Study confined that the combination of fuzzy AHP and GIS in this study was sufficient. However, the accuracy of the results showed that the existing poultry farms resided in the moderately suitable area in Davao City. It is recommended to add more factors like wind direction, and replicate the study in another site.

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