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'Site Suitability Analysis for Intensive Livestock Production in South Australia'

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Abstract

Intensive meat production possess environmental and socioeconomical threats to the society. This study represents the identification of the suitable site of the intensive poultry farm production. Central Bio-physical region of South Australia is selected as a study site. The area of the study site is 2865 sq.km. It has a diverse land use type. The study includes study of land cover types, EPA activities, Conservation and Protection zones, Ramsar areas and slope for the selected study area. Methodology includes several predetermined use of ArcMap tools; such as, Buffer, Clip, Slope and Extract. Furthermore, the result shows eight elected areas. These areas are mapped using the google earth map after analyzing all the predetermined criteria. This study will help to present the use of Geographic Information System (GIS) for remote sensing analysis, urban planning and land conservation and management.

Key Words: Geographical Information System, ArcGIS, Poultry Farm, Site Suitability.

1. INTRODUCTION

The swift in population growth, consumption is rising a high meat production demand. The broiler production farm requires intensive farming system to keep continue process of chicken meat in terms of qualitative and affordable product. But without pasture and suitable site it is not possible to produce good quality, affordable meat in a limited resource as in South Australia, Central Biophysical Region has same kind of problem. Furthermore, the rapid growth in the broiler farm can enormously cause socio- environmental damage.

Australian people consume various type of proteins, among them chicken meat is the most preferable source of food. According to PoultryHub (2019) measured that annual prodction and processing of chicken meat in Australia is around 664 million. For the processing and production purpose of broiler chicken meat there are numerus types of production systems and machineries

are available. As Federal Government (2015) emphasised that, the free range, conventional, and organic methods are most common systems in Australia. Moreover, the maximum number of poultry farms are situated in metropolitan and CBD areas with limited adjustments. According to Wijayanto *et al.* (2016) states that, adaptationand considaration of the sustainable development standards and identification of proper production site can be the solution to decrease the antagonistic costs in the broiler production.

Nevertheless, an implementation of new development strategies in urban area attracted poultry farm businesses to establish new production industries in regional areas (PoultryHub, 2019). Therefore, there are need to develop intensive production system for poultry farms by selecting suitable site. Identify the suitable location for the poultry farm production considering the EPA guidelines. And obtaining the current land use data in south Australia. Considering land cover and land use data (including, urban and rural areas).

Why Site Suitability Analysis?

"Suitability techniques are essential for informed decision-making. Main valuable decision an analyst makes when using this tool is the determination of how relative values, or weights, are to be given to two or more combined factors" (Steiner *et.al,* 2000, p. 200). Moreover, site suitability analysis can be useful for urban planning and land management authority with land use area and plan.

Collins et al. (2011) Cited in Brail and Klosterman (2011) suggest that, the GIS (Geographical Information System) is an essential tool can be beneficial for site suitability analysis by mapping agricultural land use change and urban, and mining. Site suitability analysis is one of the most appropriate spatial patterns can be utilised to predict land uses change conferring towards detailed necessities, predilections, or forecasters of around commotion.

2. STUDY AREA

Central Biophysical Region, South Australia (Fig. 1) is separated in four different biophysical subregions including, Central Eastern Hills, Central Hills, Lake Plains, and Willunga Basin. The total area of the Central Biophysical Region is 2865.11 km² (Department of Environment, Water and Natural Resources, 2017). Moreover, the area Central Biophysical Region in South Australia is covered by various land cover types including, croplands, vegetation, evergreen or semi deciduous forest, deciduous forest, shrublands areas or grasslands and artificial areas (Fig. 2) (SA Data, 2018).

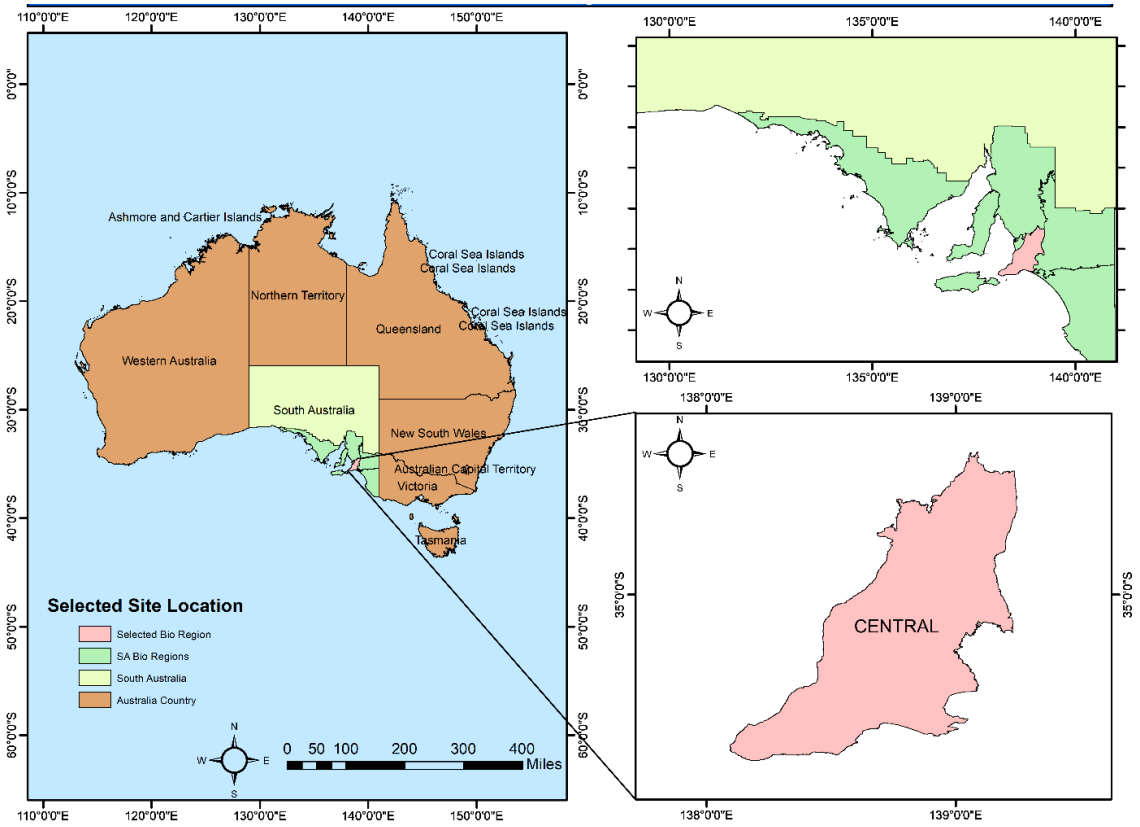

Figure 1. Central Biophysical Region areal map South Australia.

3. DATA COLLECTION

Central Biophysical Regions data were collected from Australian Bureau of Statistics Census data 2019, Department of Planning, Transport and Infrastructure, 2018, and a secondary data source providing local council of South Australia data (Table 1 below). Moreover, data collection process also includes, some critical data and information by using land-use maps using ArcGIS, Google Earth maps, and topographic plots. The digital analysis was done using the Geographical Information System (ArcGIS version 10.1).

Table 1. Data sources

Data	Type	Source
Guidelines and Standards	EPA activities	Department of Environment and Energy
Transport	Roads and Land use types	Department of Planning, Transport and Infrastructure, 2018, data.sa.gov.au
Conservation areas	Water Protection Zone, Murray Protection Area, Ramsar Conservation Zone	data.sa.gov.au

Data Type: Shapefile Feature Class
Projected co-ordinate system: GDA 2020 South Australian Land Development Zones
Projection: Land Development Zones
Geographic Coordinate System: GCS GDA 2020
Datum: GDA 2020

4. METHODOLOGY

Some criteria are predetermined to identify the suitable sites for the intensive broiler farm production system in the selected region as following.

- Land use types
- Roads for accessibility
- Water protection areas
- EPA activities
- Murray Protection zone
- Ramsar conservation zone

All of these factors are used to map the suitable site. For the proposed analysis, weighted site selection analysis is used. Clip tool is used to cut out the features only for selected bioregion. Considering the EPA guidelines, water protection area and river Murray protection areas is identified. All these features, major roads, EPA activities, industrial areas, Ramsar reserves, Murray protection area and water protection area are clipped to the study area.

Furthermore, Buffer tool is used to create a buffer zone around the EPA activities (500 meters) and major roads (200 meters). Similarly, Conservation areas and industrial areas have been identified by using the feature datasets from the Data.SA. 2000 meters buffer is used for the Ramsar conservation reserve as shown in the Figure 5.

Following are the Buffer distance considered for the selected criteria.

Table 2. selected criteria for analysis

Feature	Selected Buffer Distance
Roads	200 m
EPA Activities	500 m
Water Protection Zone	2000 m
Murray Protection Area	2000 m
Ramsar Conservation Zone	2000 m

The flowchart of the gradual processes is shown in figure 2 to identify the suitable site for intensive poultry farm production. It includes identification of land types and use, determining

environmental activities, protection zones, conservation zone, major roads and EPA activities. Tools such as, clip, buffer, slope and reclassify are used frequently for the analysis.

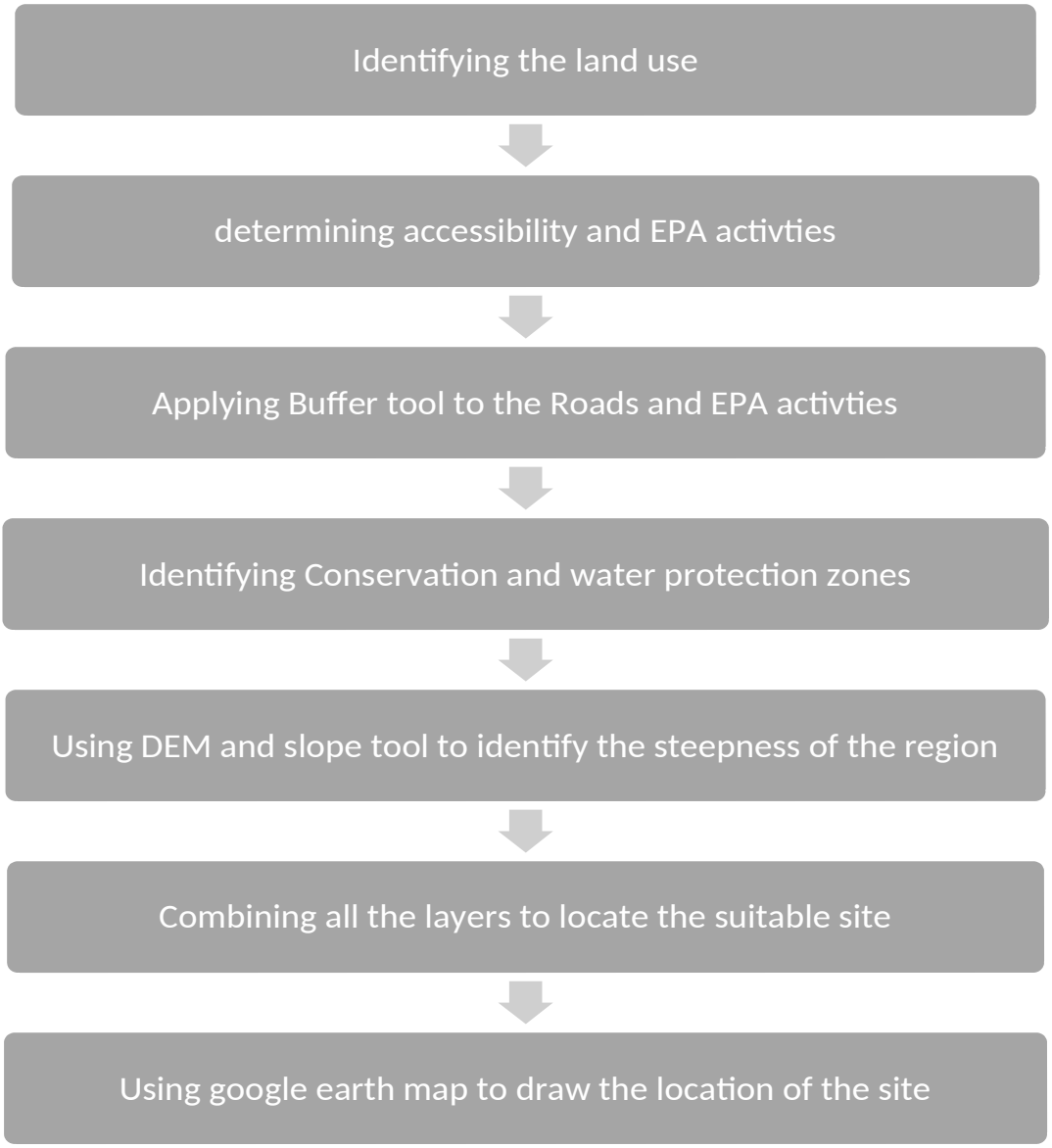

Figure 2. Process flowchart to identify the suitable site

5. RESULTS

Firstly, types of land use (Figure 3) have been identified using the land cover data. The map is showing several land uses types within the region, such as, irrigation, vegetation, artificial land use, grassland etc.

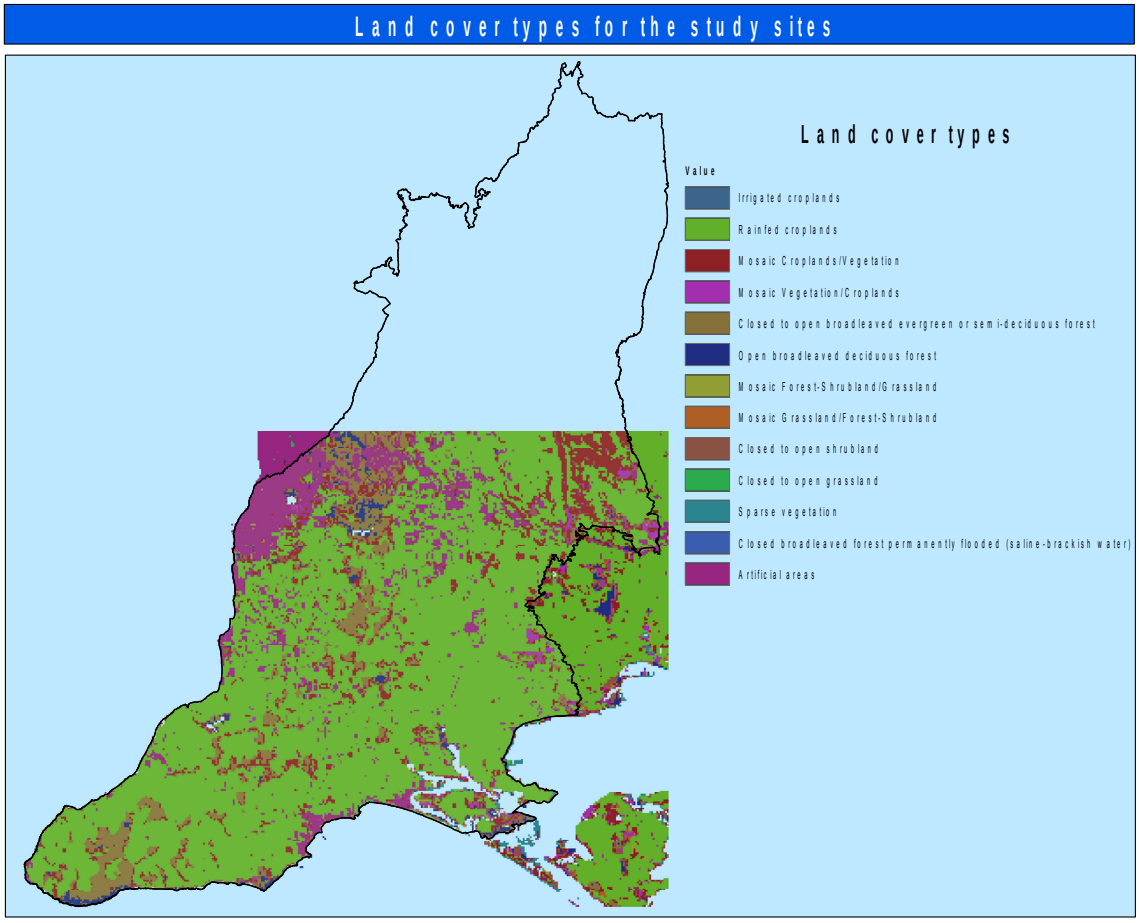

Figure 3. Various Land cover types in Central Biophysical Region, South Australia

Figure 4 and 5 represent the mapping of the predetermined criteria for the decision-making. It suggests the location of the EPA activities, Roads, Conservation and protection zones, industrial establishments and Ramsar conservation zone. Buffer tool is used to create a buffer distance zone (Table 2) for the selected criteria.

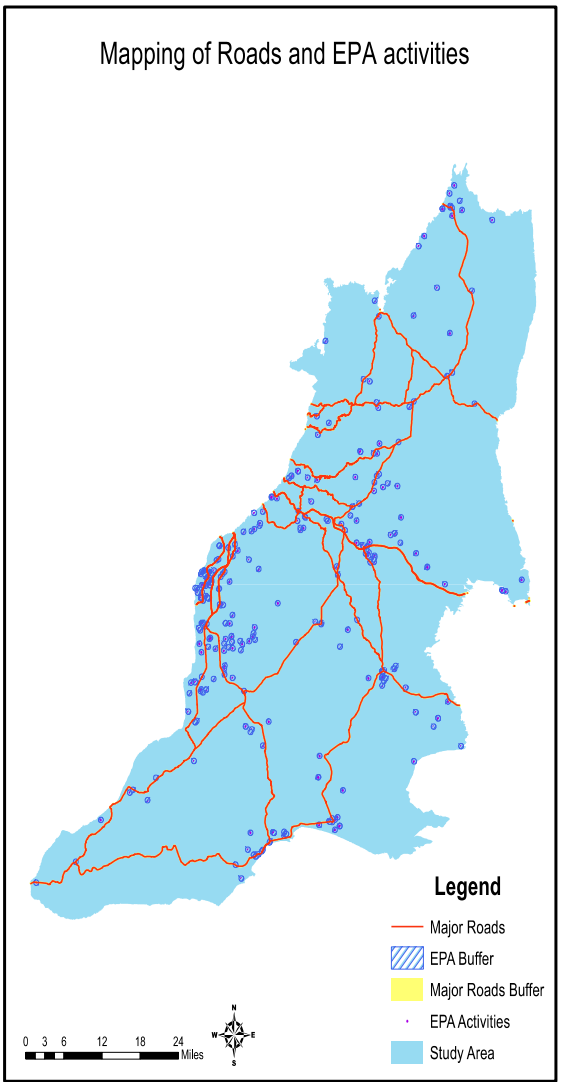

Figure 4. Roads, EPA Buffers and Activities in Study Area

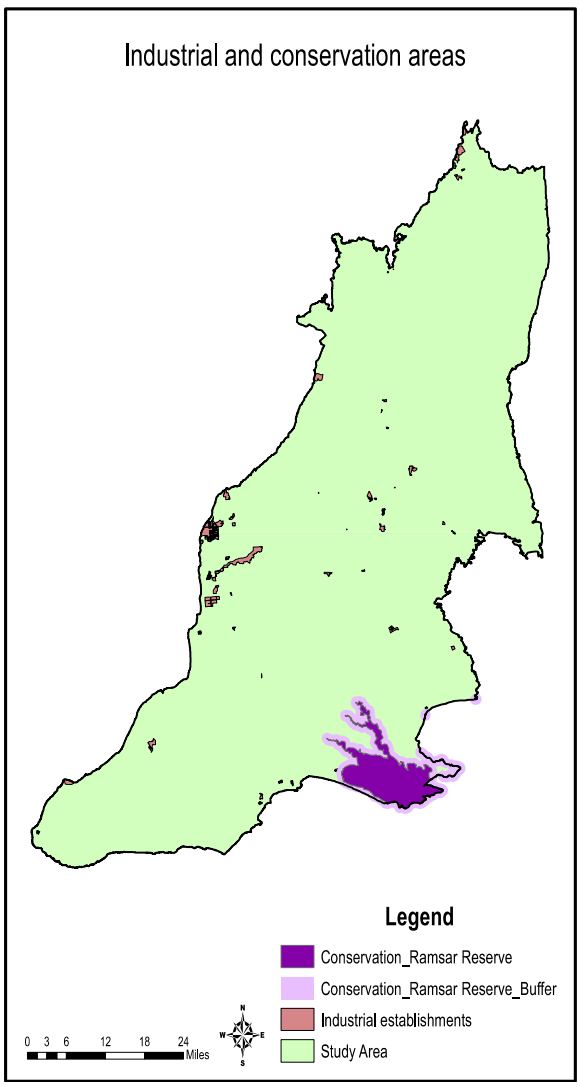

Figure 5. Conservation Ramsar Reserve and Buffer in Study Area

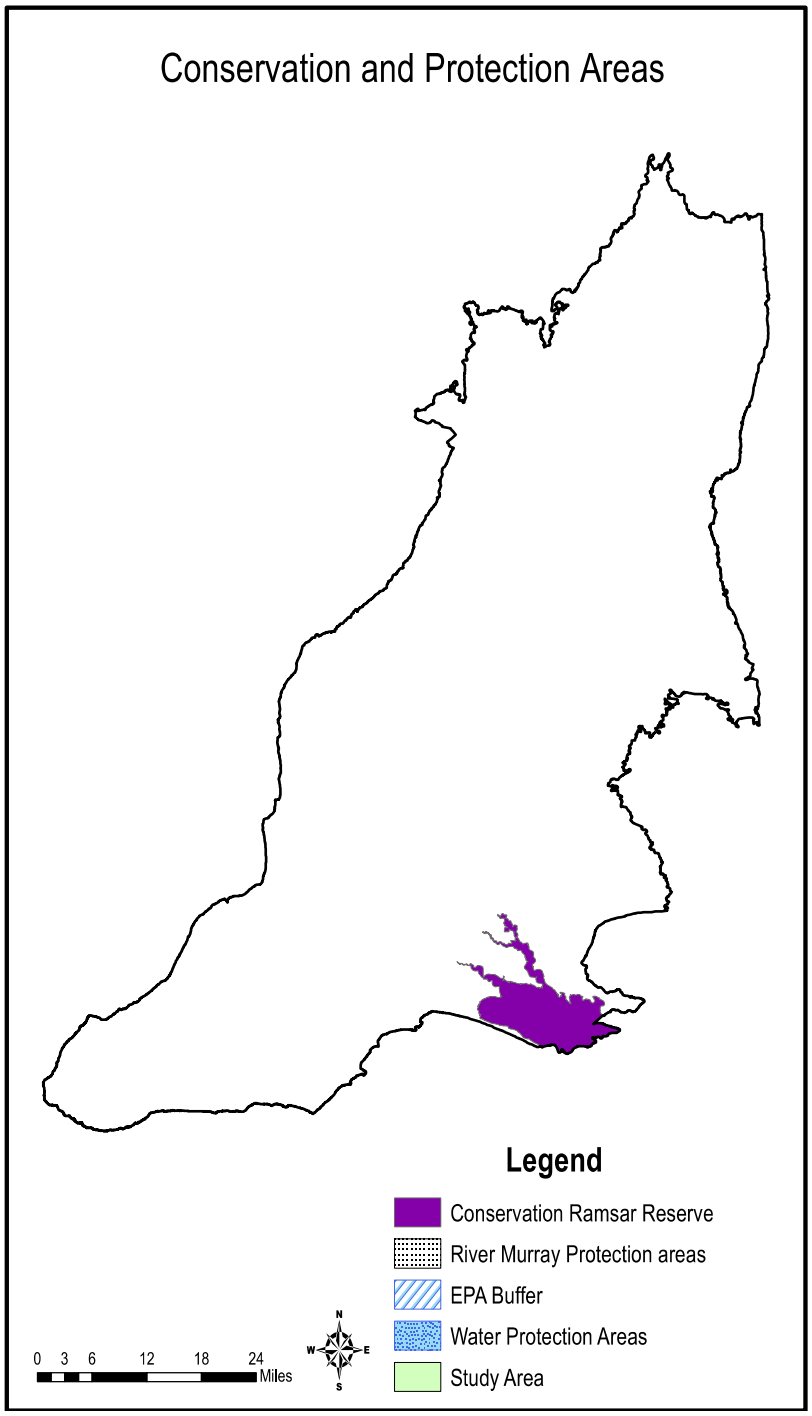

Figure 6. Water Protection Areas, River Murray protection areas

Figure 6 represents the overlapping of the all selected criteria. This map helps to extract the suitable locations within the study area. Furthermore, the slope analysis and reclassification is used to identify the best possible areas for intensive production

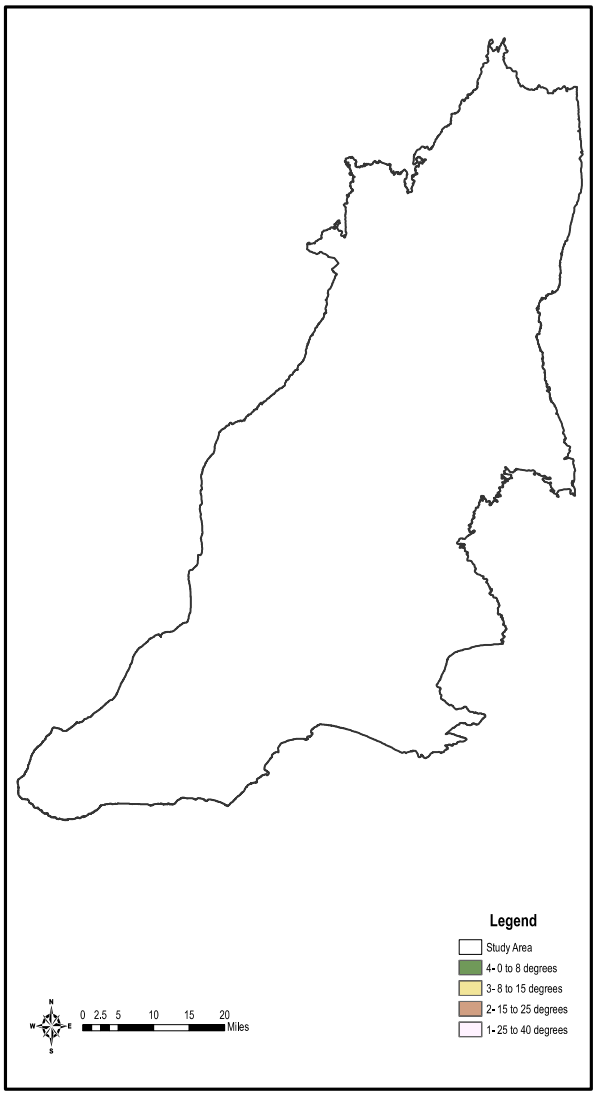

Figure 7. Various Slopes degrees in Study Area

Figure 8. Various categories are classified in Study Area for suitable site

DEM 9-sec is used for the slope analysis Figure 7. The degree of slope is from 0 to 39 degrees for the study area. The slope is reclassified as shown in the figure 7, where the highest weight is given for the minimum slope, 0 to 8 degrees (4), 8 to 15 degrees (3), 15 to 25 degrees (2) and 25 to 40 degrees (1). Furthermore, the hill-shade effect and slope are used to categories the flattest to steepest land covers for the study area. These categories are classified from most suitable site to the not suitable site as shown in the figure 8. All of the features are clipped to the study area. When all the layers are combined to acquire the suitable land for the intensive poultry farm production, following map results are achieved.

Following map Figure 9 is showing the overlapping of all the considered criteria to identify the suitable site for the selected region. Areas which are having appropriate slope and excluding the conservation or protection areas are considered and sites are selected based on the google earth as shown in the map Figure 10.

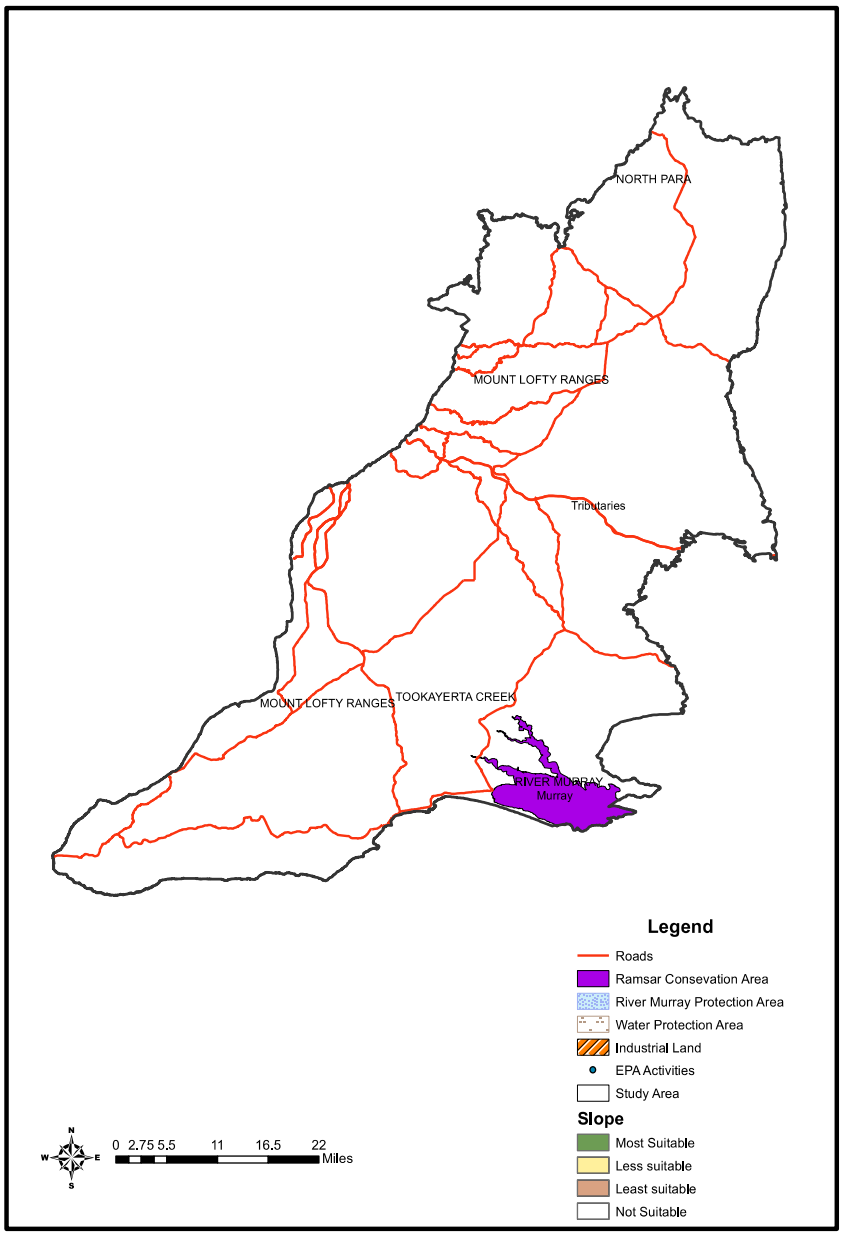

Figure 9. overlapping of all the considered criteria to identify the suitable site for Central Biophysical regions

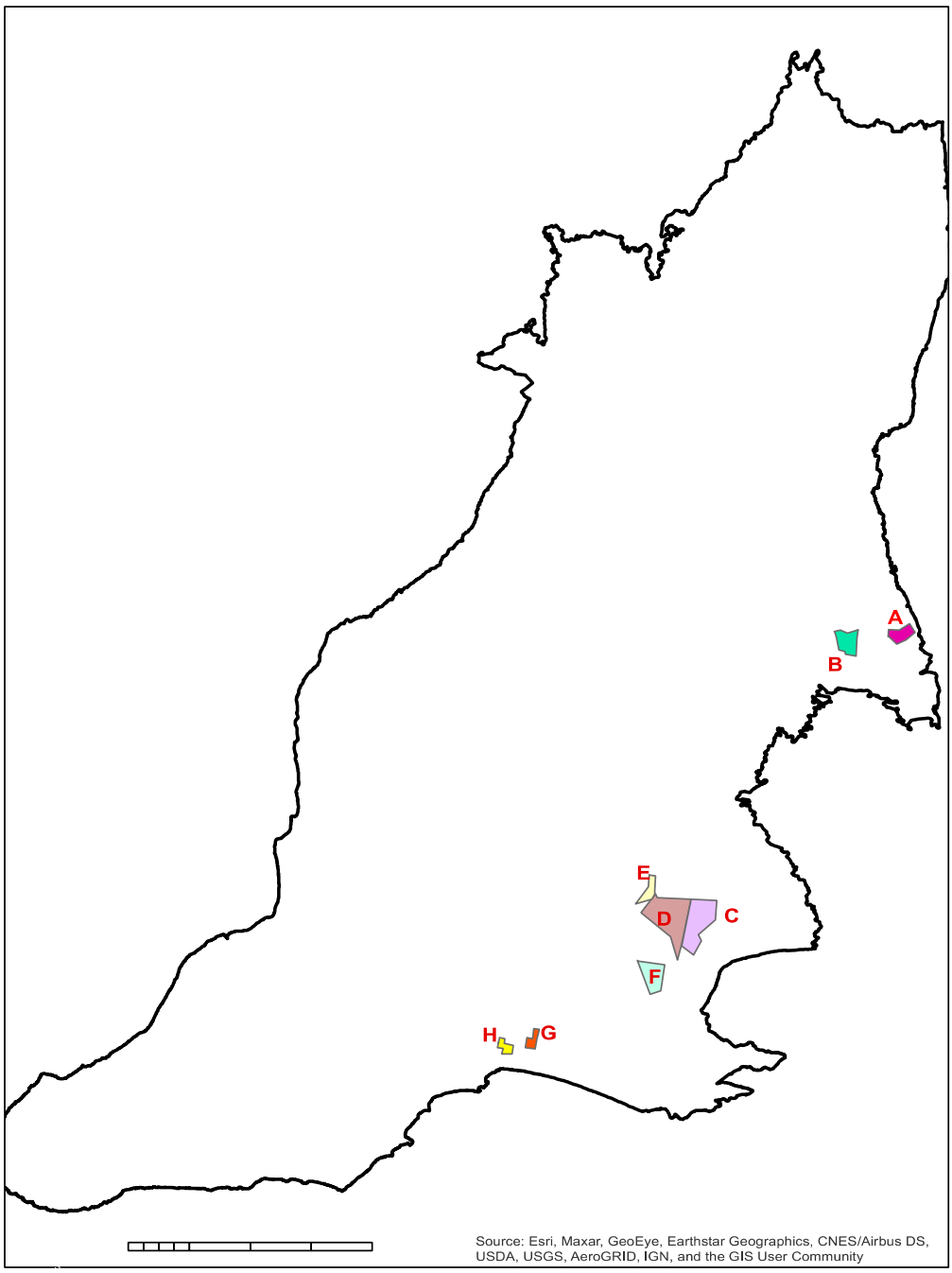

Figure 10. Selected sites based on the google earth

All the suitable sites are shown in the Google Earth map for the selected region. There are eight sites are identified after applying all the layers and land cover types for the study area. The total area of the sites are shown in the Table 3 in Sq. km.

Table 3 Details of all the selected sites

Selected Land sites	
Given Name	**Area**
A	5.68 sq. km
B	8.27 sq.km
C	21.68 sq.km
D	28.88 sq.km
E	4.50 sq.km
F	10.68 sq.km
G	2.90 sq.km
H	2.88 sq.km

6. LIMITATIONS

The analysis refers to how GIS can be sued for mapping a suitable site, assessing the land use and other criteria regarding the land management. The same analysis can be done considering more in-depth study considering the following possible factors:

- Soil type and contamination
- Surface coverage
- Groundwater issues
- Residential survey
- Future land use plan
- Demand and supply of Poultry meat

7. CONCLUSION

Applying GIS approaches to the site suitability analysis made the selection of the land process precise and allowed the detailed analysis for the socioeconomic and environmental factors for the selected study area. The results are satisfactory and suggest that the site suitability analysis using the ESRI ArcGIS, and predetermined criteria, the assessment can be done precisely within time limitations. Furthermore, with the use of spatial analyst tools such as slope and aspect, degree of the angle can be easily identified for the required site.

The site suitability analysis methodology can be refined and used for the large-scale application for the urban planning and land management. The study highlighted the significance of the using latest data for creating the site suitability map and combining the map with the Google Earth

map, the most precise results can be produced. With additional data and accurate analysis, sites could be reclassified according to the accessibility, resources availability, production consequences and waste management approaches. Considering the current land management and conservation approaches, factors such as, environment and social sustainability would be vital for the accessibility of the fresh, healthy and affordable meat production.

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