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Research Article

Site Suitability Analysis for Local Airport Using Geographic Information System

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Abstract Geographic Information System (GIS) are now recognized broadly as a valuable tool for managing, analyzing and displaying large set of data relevant many local and regional planning and analyzing activities. The complex nature of Airport site suitability issues can be sorted it out using GIS tools. This research will discuss some potential of GIS application in site suitability analyzing considering factors that can affect to the Airports for entire Sri Lanka (considering forest area, tanks, airborne restricted area, and streams) and closer study for Polonnaruwa district, as there is a higher tourist attraction for historical and ancient cities. Anuradhapura and Polonnaruwa districts give considerable amount of contribution for that. Therefore Polonnaruwa district will be closely analyzed considering all the factors that will affect the selection of area for Airports. In this study, the factors considered, will lead to generate areas which are not suitable for local airports in Sri Lanka. Hence using Erase tool under GIS tool box overlay function erase all those areas as not suitable areas for local Airports. Rest can be defined as suitable areas for local airports. Also the buffering tool can be used to identify the most suitable areas by considering land use patterns, road and railway networks.
Keywords *Buffer and GIS; Erase; Overlay; Site suitability analyze*

1. Introduction

Geographic Information system has been applied to many disciplines including geography, forestry, urban planning, tourism planning, land use, site suitability analysis (Ahesan and Marson, 2015) etc. Nowadays GIS is recognized widely as a valuable software for managing, analysing, and displaying large volumes of diverse data related to many local and regional planning activities (Pareta, 2013). GIS can be considered as a tool box of techniques and technologies which is widely applicable to analyse site suitability.

Inhere GIS software is used to propose most suitable location for local airports by considering Environment, Economic, Social and Cultural aspect. Consideration of Environment, Economic, social aspects are as follows:

Environment – distance from forest area, animals and its behavior near to location, weather condition, and main environment effect of selected location.

Economic – Land value, mobilization cost, no of users, road network, distance from other airports, tourism. Effect of industrial, agriculture, service sector.

Social and cultural- distance from residential area, effect of living condition and quality, distance from places which have local people and tourist attraction.

Land use analysis is more important for site suitability analysis of local airports. As it is difficult to identify the nature of land, variation of land usage of particular time duration etc, without land use analysis.

Thus by using GIS software it is possible to find out most suitable locations for local airports which have less effect an environment, animals and community and more effective for economy.

Objectives

Main Objective

- The main objective is to find out most suitable locations for local Airports in Sri Lanka.

Other objectives

- To promote Tourists attraction towards Sri Lanka.
- Provide a proper Transport mode to local transportation system.
- To Prevent Economic, Environment and Social issues which can be occurred during construction stage and after completion.
- Develop peoples' living standards by providing new utilities.

2. Methodology

Following steps were followed to reach the above mention objectives:

- Studying of the background of site suitability analysis and Airport selection.
- Getting familiar with the topic with past research and publications on site suitability analysis and remote sensing and GIS techniques.
- Collecting data from Survey Department of Sri Lanka, from Gazette and from internet and google earth.
- Buffer all data with relevant distance according to Airport site selection techniques.
- Erase buffering areas from base map which are identified as unsuitable areas for Local Airports.
- Verification and discussion on analyzed data.
- Generate site suitability Map for Study area.
- Conclusion about final results.

Data Collection

Main source of data collection was the Survey Department of Sri Lanka. Most of the Shape files which are used for analysis were created based on data given by Survey Department. Following Figures 1, 2 illustrate the shape files which used to analyze site suitability for local Airport.

Figure 1: *Map of Konduruwawa area*

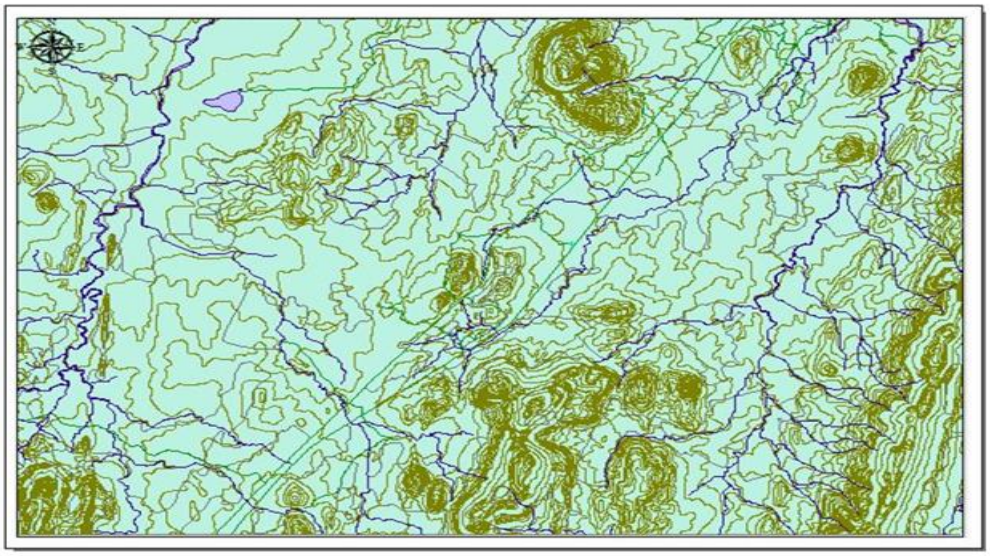

Figure 2: *Forest shape file*

Similarly, tank, streams, road and railway shape file are used.

- The Gazette of the Democratic Socialist Republic of Sri Lanka (EXTRAORDINARY), Air Navigation (Air Defense) Regulation No. 1 of 2007
- Google Earth

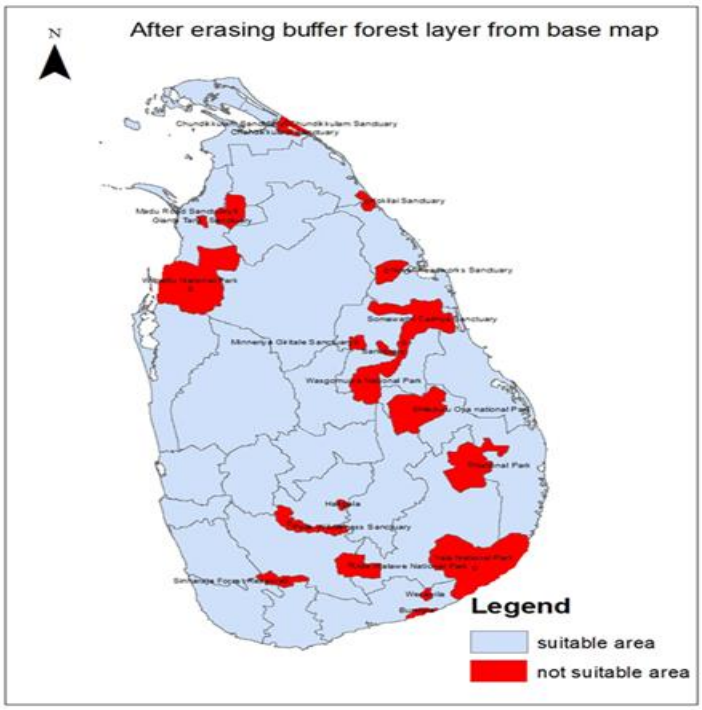

Figure 3: *Base map after erasing buffer forest layer*

3. Data Analyzing and Results

Main tool used for the analysis was ArcMap 10.3 which is one of the premier computer software used for Remote Sensing and GIS studies. Analyzing stage follows the following steps:

Analysis for Entire Sri Lanka

Forest Area in Sri Lanka

Input all Shape files (district, forest, tank, streams and road) which were collected from Survey Department. Then using ArcMap proximity buffer tool buffer forest layer with 1km along the perimeter of the forest boundary and using overlay erase tool erase buffered area from base map as not suitable areas for local Airports.

All Tanks in Sri Lanka

The next step is to consider the tank layer for the analysis. Therefore, first of all using Extract clip tool tank layer should be clip in to the Base map which is after erasing buffer forest layer (Figure 3). Then using buffer tool buffer tank layer with 1km along perimeter of the tank boundary and using overlay erase tool erase buffered tank area from base map after erasing buffer forest layer.

There is another method to do this thing which is buffer tank layer using Base map (Original map) along 1 km from tank boundary and erase this area from the Base map and using overlay Intersect tool get intersection between Base map after erasing buffer tank area and Base map (Figure 4) after erasing the buffer forest area. Both methods are generated same result.

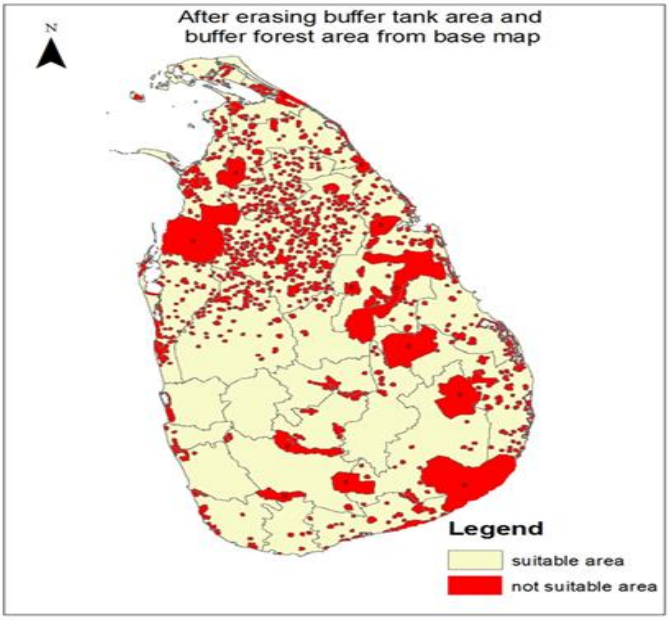

Figure 4: *Map after erasing buffer forest layer and erasing buffer tank base layer*

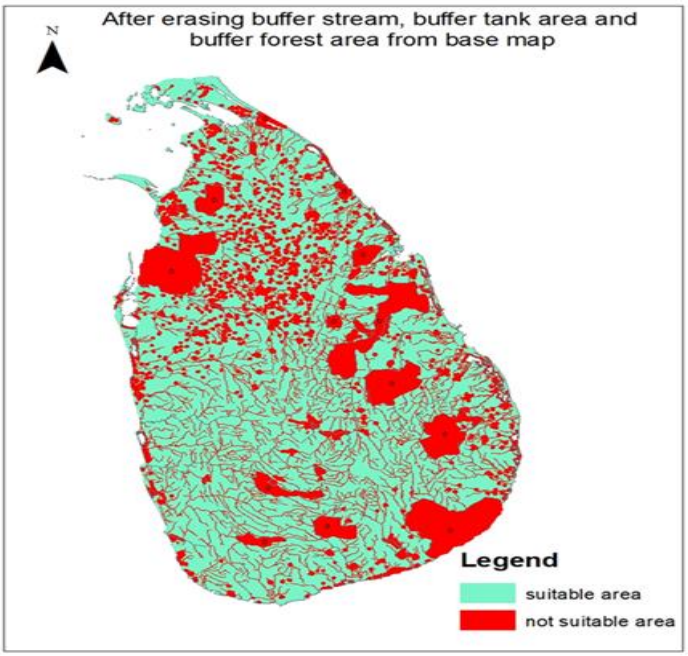

Figure 5: *Base map after erasing buffer stream, buffer forest layer and erasing buffer tank layer*

All streams in Sri Lanka

Same procedure was done which mentioned clause 5.1.2 to analyze stream.

Air Defense Restricted area

This is the final step of the site suitability analysis for entire Sri Lanka. Next steps will be carried out to analyze the closer study area. Because the free data available which relevant to in this study are limited. As the result of that closer study will be carried out in Polonnaruwa District considering Land use pattern later. In this step created shape file for the air defense restricted area (see Figure 5 and Table 1).

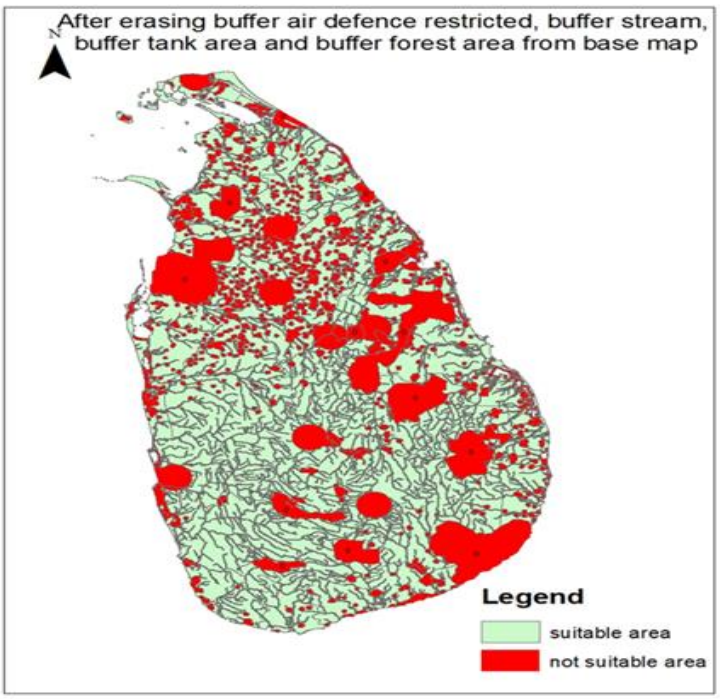

Figure 5: *Base map after erasing buffer air defense restricted area buffer stream buffer forest layer and erasing buffer tank layer*

Table 1: *Suitability of different type of areas for locate airport site*

Type of land area	Suitability to locate Airport site
Build up areas	Very suitable
Sand area	Suitable
Cultivation area, bare and boggy area	Not suitable

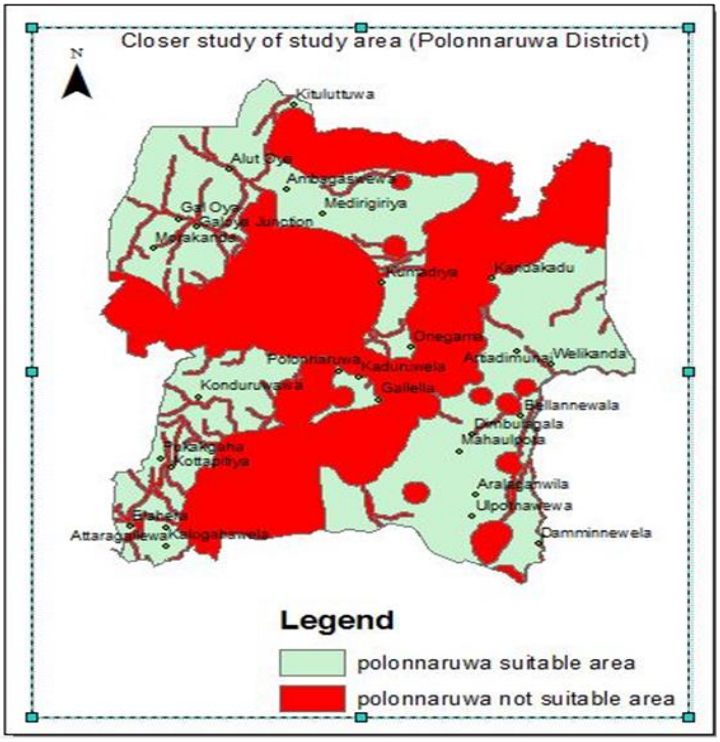

Figure 6: *Site suitability map for Polonnaruwa district*

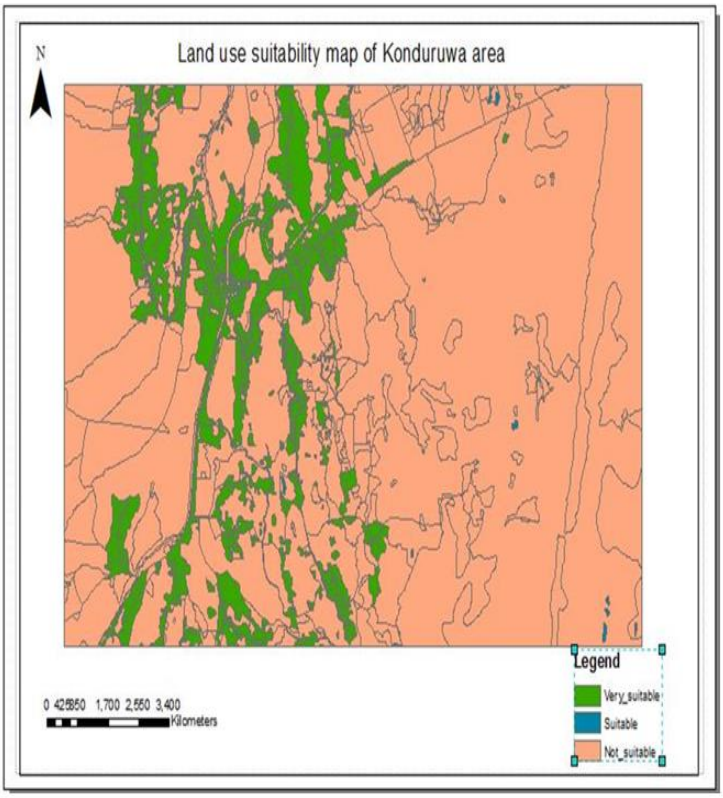

Figure 7: *Land use suitability map for Konduruwawa area*

Analysis of Closer Study Area

After all steps mention in above are carried out, closer study area should be selected based on economic, social and environment facts due to data and resources availability. Therefore scope is concentrated to the Polonnaruwa district. Following map is site suitability map for Polonnaruwa district.

Konduruwawa area was selected among suitable locations of Polonnaruwa district for further analysis. Land use pattern was considered for area to identify the most suitable location for local Airport. Also comparison and analysing will be done for this area to find out final suitable location.

Land Use

Using land use data given by survey department generate shape files. Those shape files defined as cultivation area, bogy area, bare area, rock area, build up area and sand area. Those areas suitability for Airport site was categorized as follows by considering economic, social and environment aspects.

4. Discussion

Basically this study was conducted to find and analyze the suitable locations for local Airports. As mentioned above different factors were considered in order to find suitable locations. All those factors were negative when consider in the suitability of airport site. That's why those areas classified as unsuitable area for local airports. Not only the exact area of forest, tank and streams but also some additional areas also defined as unsuitable areas. As buffering was done for these layer by giving some tolerant distance. It may vary according to the effect of considered factors and regulations of the airports sites or characteristics of itself.

Study area was reduced due to lack of data and resources. Polonnaruwa district was selected by considering tourist attraction and distance from other tourist attraction places. Figure 6 shows the suitable areas for local Airport. This is just approximation. Due to that reason, land use data have to be used to locate exact locations for Airport sites. Among these areas, Konduruwawa, Madirigiriya, Aranaganwila areas can be considered as most suitable areas. Among them Konduruwawa area was selected for further analysis as there weren't sufficient land use data available for Madirigiriya and Aranaganwila areas.

Figure 7 shows land use analysis for 40km^2 of Konduruwawa area. Buildup areas can be identified as most suitable areas for Airport. As they are having already developed infrastructure facilities and services which may increase the tourist attraction. Also these areas have good accessibility and mobility. Those areas are highlighted in green colour in Figure 7. Even though buildup areas are defined as suitable areas, airport sites should be located far from human sensitive buildings such as school, hospital etc. Otherwise it may create social issue, as there will be some disturbance to those facilities due to noise and vibration produced by aircrafts during operational stage.

Cultivation areas, bare and boggy areas in which flora and fauna live are also defined as unsuitable areas. These areas can be considered as environment sensitive areas. Also these areas can be flooded during rainy seasons and it will help to protect other areas from flooding. Environment impact can be eliminated or reduced by omitting these areas as unsuitable areas for Airport sites. As a result of that environment issues which are very sensitive to the community will be not formed during construction and operational stage of Airport.

5. Conclusion

According to the results obtained by analyzing above mentioned data, it can be conclude that Konduruwawa area is more suitable for Airport site. However, only by using Geographic Information System (GIS), it is difficult to propose exact and correct location for Airport site. In that case, a closer social and environment survey has to be done.

In this study, only the site suitability of Konduruwawa area was considered, due to lack of data availability. When considering the available data such as forest, tank, steam, and air defense restricted areas in Polonnaruwa District. Location suitability depend on factors which were considered for analysis and type and purpose of the Airport site. In here basic few factors were considered. There are so many other factors such as Regional plan, Airport use, Ground accessibility, Topography, Obstructions, Visibility, Wind, Noise nuisance, Grading, drainage and soil characteristics, Future development, Availability of utilities from town.

Consideration of all those factors for analysis is big and complicated task. But the analysis with more factors will increase the accuracy of the suitable locations. In order to find the most suitable location for local Airport in Polonnaruwa district, it is need to analyze other suitable location those are showed in Figure 6 closely by considering land uses. After that, the most suitable location for a local Airport in Polonnaruwa district can be identified by comparing those results.

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