Project Report

CRP 514
Introduction to Geographic Information System

Title:

"GIS Application in Airport Engineering:
Locations of Air Route Surveillance Radar"

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Submitted to,
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"GIS Application in Airport Engineering: Locations of Air Route Surveillance Radar"

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Abstract

GIS has been used by engineers in design and planning the past few years. It is becoming a very useful tool in the process of planning because it has been not only providing an exciting potential data analyzer for geographic information i.e. data/information, but also becoming one of the most important stage in engineering process that is analysis and decision making. GIS shortens the time consumed for the planning and giving reliable results.

This project is to examine the application of GIS in proposing/recommending site locations and settling air route surveillance radar. The planning will carry out to fulfill standard requirements, socio-environmental aspect, economical design led to optimum result which

eventually obtains for the best choices. GIS offers the ability to successfully determine a good location based on selected criteria.

This project was initially undertaken as a way to determine new air route surveillance radar facilities to improve the quality and security of air traffic. After initial analysis, it was determined that many factors are involved in selecting a good location considering environmental impact and effectiveness/cost of the construction. The project works with some of the factors used in selecting the site location. However, it was found that locating air route surveillance radar is very complex and is affected by many factors. Eventually, the sites selected are the best location in where to install the proposed equipment. The exact position will be created manually based on judgment of the planner.

Introduction

The increasing of population and traveling demand from one place to another place needs more infrastructures to be build such as air traffic system planning in order to accommodate people to travel. The air traffic system includes: airport, airways, airlines, air passenger, general aviation, supporting facilities, etc. Air traffic control system is shown in figure 1.

FAA recognizes two kinds of radars:

1. Airport area radars
2. Air route surveillance radar.

Airport radar establishes to protect aircraft for landing and take off. Airport radar is provided by two way radio communication with air traffic

control. Airport radar reduces conflict resolution and optimizes the capacity of the airport.

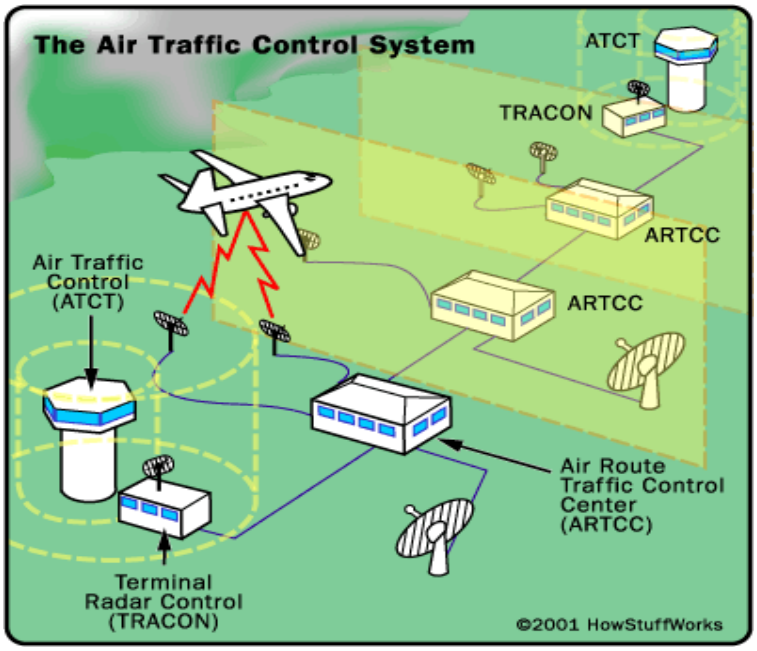


Figure 1. Air Traffic Control System (www.howstuffworks.com)

Air route surveillance radar is a system of long-range radar design to provide a display of aircraft operating over a large area, especially en route aircraft flying the airways. Scanning through a 360^{o} azimuth, the equipments provides the ground base air traffic controller with information on the azimuth and distance position of each aircraft in the airway. Used either in conjunction with other navigational equipment or separately, the radar can be employed to locate with precision an aircraft's position, the reliance on the accuracy of the pilot's reporting. Consequently, there is a substantial reduction in the frequency of voice communication necessary between the controller and the pilot. The radars are being installed on a nationwide basis with a range of 200 mile; they will eventually produce an increase in airways' capacity by permitting a

reduction in separations between aircraft flying at the same altitude (Ashford, 1992).

Besides engineering requirement, site selection criteria for air route surveillance radar have to meet state governmental criteria, accessibility, and cost for land purchase.

Problem Description

California has been gaining tremendous development and increasing of population in US. Besides the increasing of economic growth, California which is also a gateway from Asia and South America in Pacific side has been increasing in the number of air-traffic moving from one to another place.

The government via Department of Transportation is planning to build a surveillance radar system for air traffic. The aim of this project is to provide state of California new air route surveillance system which will be spread out throughout the country.

Engineering Requirements:

a. Installed in 200 mile (322 km) distance between each unit of radars; a standard design from Federal Aviation Administration.
b. 3 km distance from river and streams; soil suitability and preventing flood.
c. 3 km distance from water bodies; soil suitability and preventing flood.
d. 10 km distance from volcanoes; preventing from eruption impact.
e. 5 kilometer from busy area/urban; due to magnetic fields and interference.

State governmental requirements:

a. 10 km from existing airport.
b. 5 km from highway.

Cost:

a. The lower cost of land purchase corresponds with the lower density of people live in.
b. Better to locate on unusable land.

The Study Area

The study area is entire state of California.

Analysis Tool

ArcGIS version 8.1 package.

Microsoft Excell package; is used for adding field and attributes.

Available Data

Data used are from ESRI resources. The layers available are:

1. US Base-map layer
2. US counties layer
3. Airports layer of US
4. Highway layer of US
5. Urban area layer of US

6. River and Streams layer of US
7. Waterbodies layer of US
8. Volcano layers of US

Data are available within the field attribute on each layer. Other data and references are obtained from ESRI website, Airport Engineering book (Ashford, 1992), FAA (Federal Aviation Administration) website, US Transportation Bureau, Aviation Digital Data Service, Department of Transportation State of California, etc.

Analysis

The process begins by selecting the features and creating state of California layers using geoprocessing wizards. US data are selected for state of California only by clipping process. This process applies to all layer and feature needed.

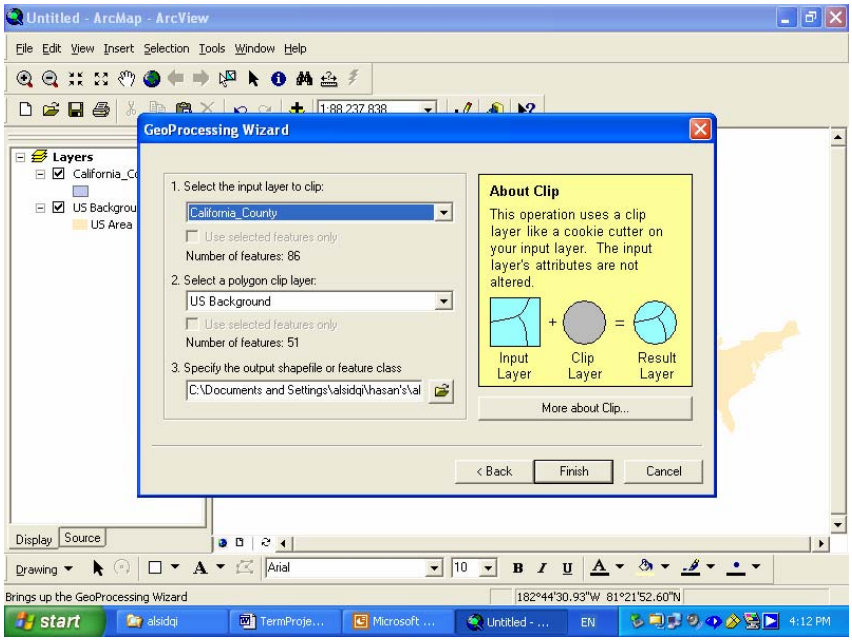


Figure 2. Geoprocessing wizard (clipping)

Once all the data and layers are prepared, the second step is to analyzing spatial data by using buffer analysis. All the area which are avoided or not expected to where the radars will be installed shall be disappeared. Accordingly, only the sites that meet the criteria are displayed.

The last but not least is to create the features i.e. location for radars. It is done through edit session. The maximum distance between each radars should be 200 mi. Each site location is done manually in edit session while looking for the best location by visual means. Preferable site locations are near the highway in order to reduce cost of construction and maintaining the radar units. Then the new layer called radar layer is created.

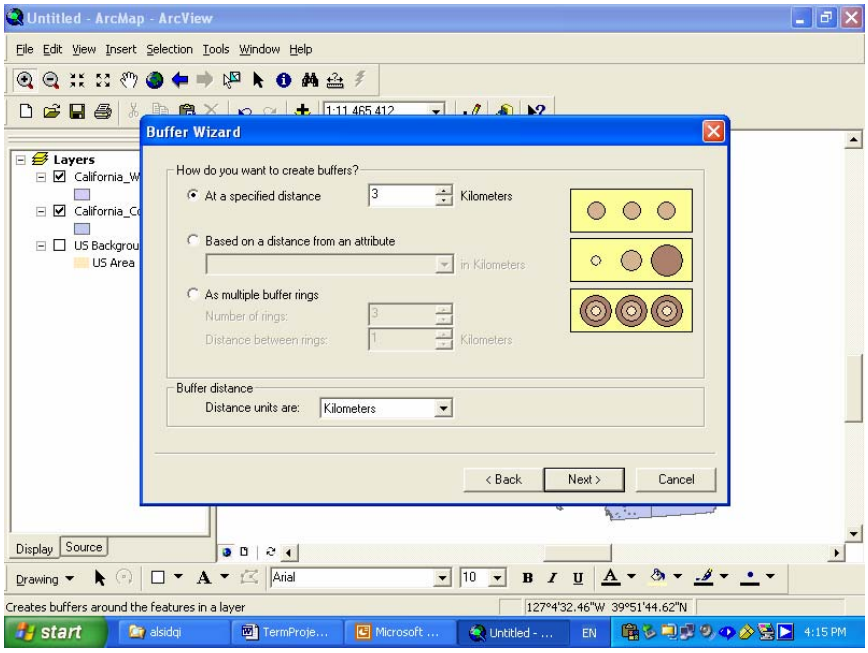


Figure 3. Buffer Wizard

New radar.shp layer along with its geodatabase file only contained FID field. Digitizing data and adding field and attribute is done through editing geodatabase. File named radar .dbf is opened, edited and saved with Microsoft Excel package and stored in the same file.

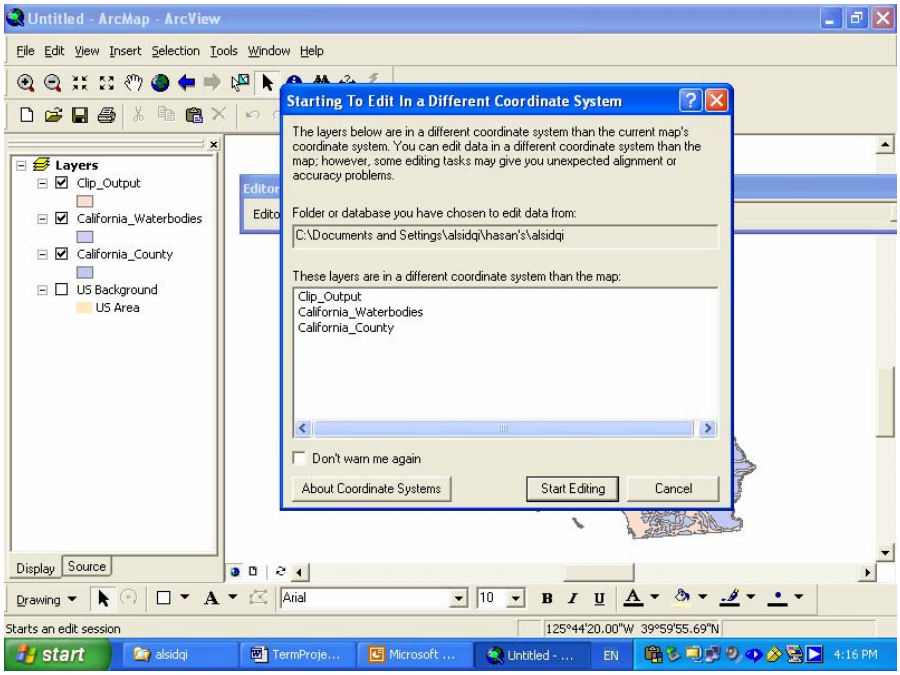


Figure 4. Digitizing New Layer (Editing)

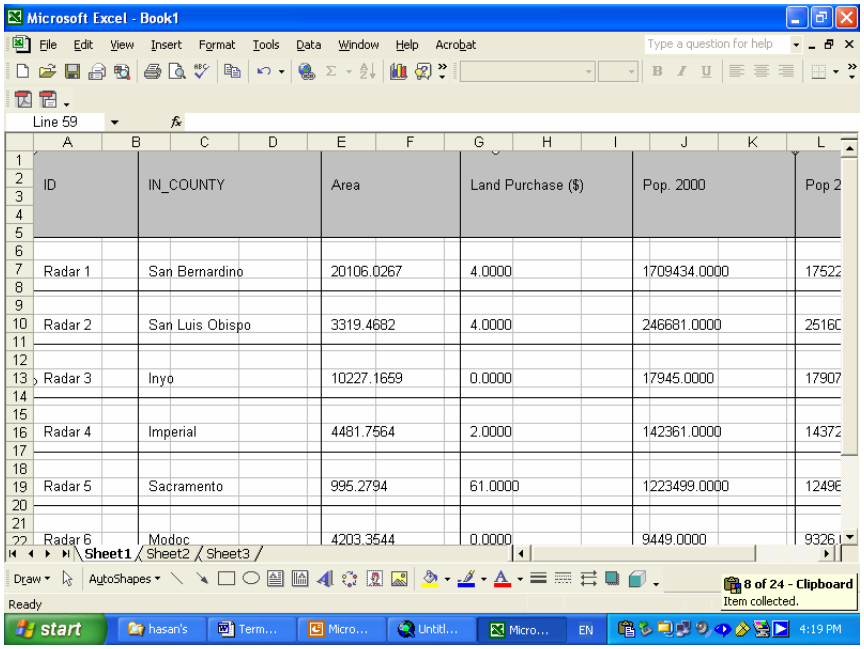


Figure 5. Adding field and attribute in Excell sheet

The process of analysis is presented in the following flow chart (see Figure 6.)

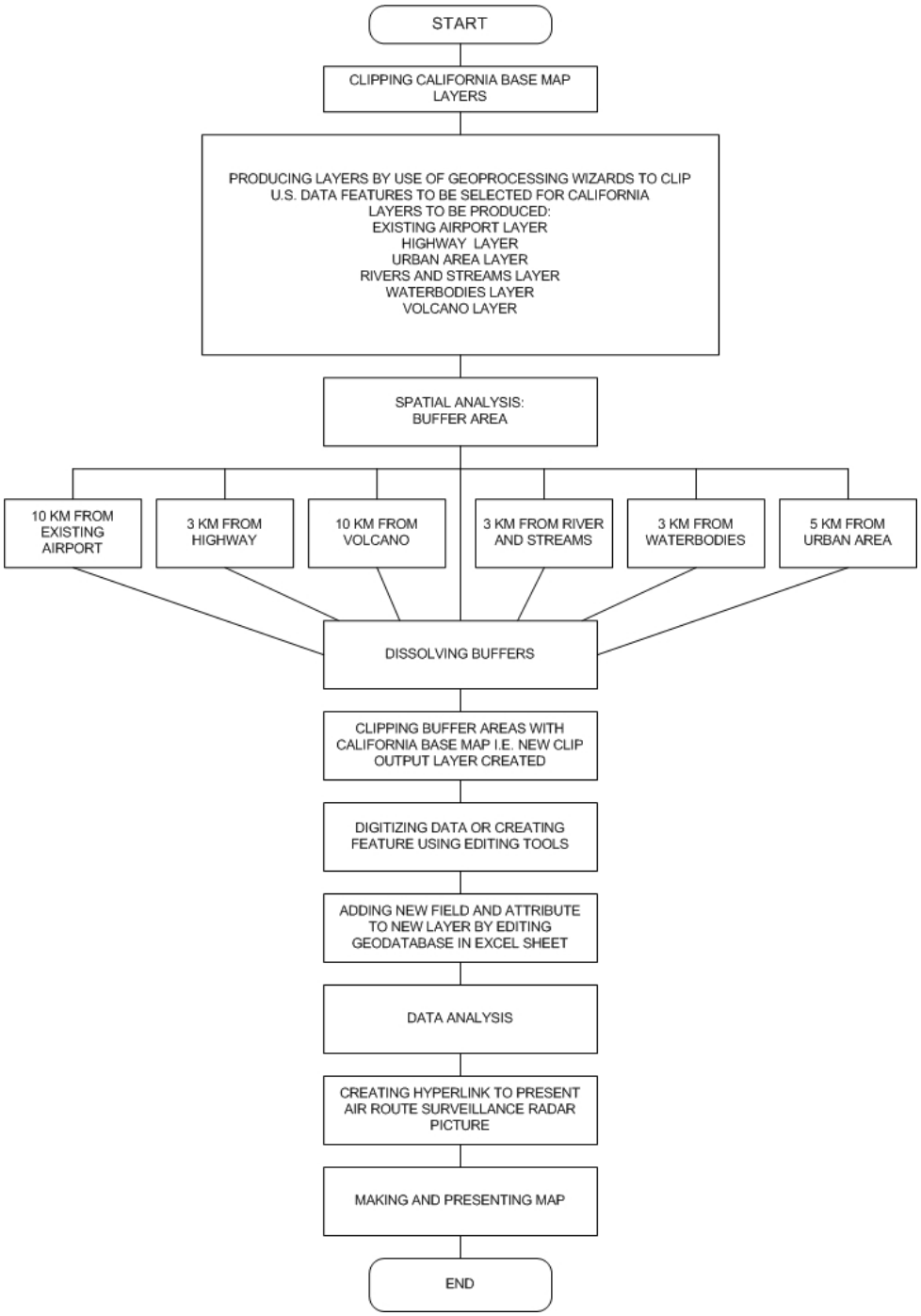


Figure 6. Flow Chart of Analysis

Site Evaluation

The site location evaluation is reviewing the site where the Air Route Surveillance Radar placed. It is estimated from land purchase cost and accessibility consideration and maintaining cost. Potential environmental cost is taken into account if the impact is so significant, otherwise the impact is neglected.

The site location for Air Route Surveillance Radar is presented in a new shape file to be used in other purpose. For the project purpose, the map is also presented in hardcopy.

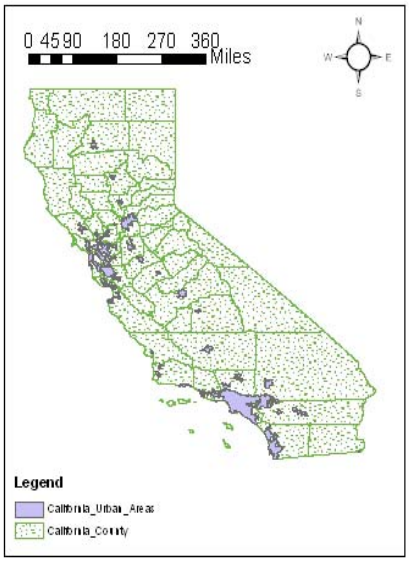
The attributes of a new layer (i.e. radar layer)

ID	IN_COUNTY	Area	Land Purchase ($/m^2)	Pop. 2000	Pop 2001
Radar 1	San Bernardino	20106.0267	4.0000	1709434.0000	1752242.0000
Radar 2	San Luis Obispo	3319.4682	4.0000	246681.0000	251601.0000
Radar 3	Inyo	10227.1659	0.0000	17945.0000	17907.0000
Radar 4	Imperial	4481.7564	2.0000	142361.0000	143728.0000
Radar 5	Sacramento	995.2794	61.0000	1223499.0000	1249624.0000
Radar 6	Modoc	4203.3544	0.0000	9449.0000	9326.0000
Radar 7	Humboldt	3586.4616	2.0000	126518.0000	126226.0000

Figure 7. New fields and attribute for new layer (radar layer)

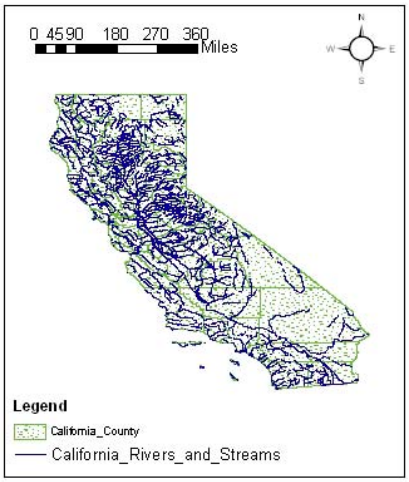
Airport

Buffer of Airport

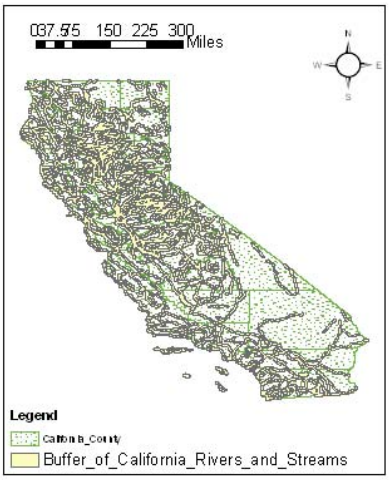


Urban Area

Buffer of Urban Area

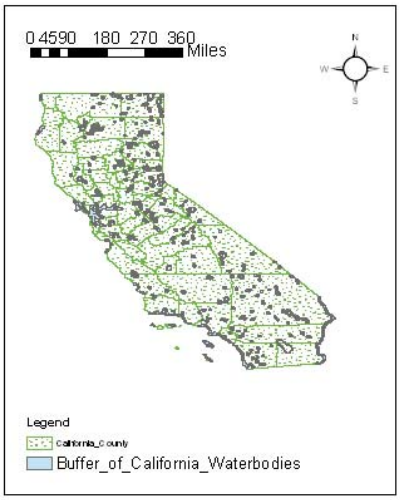


River and Streams

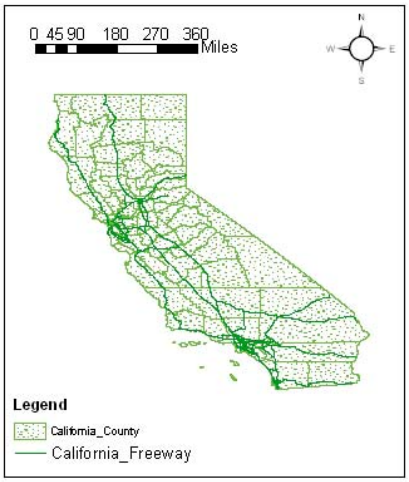


Buffer of River and Streams

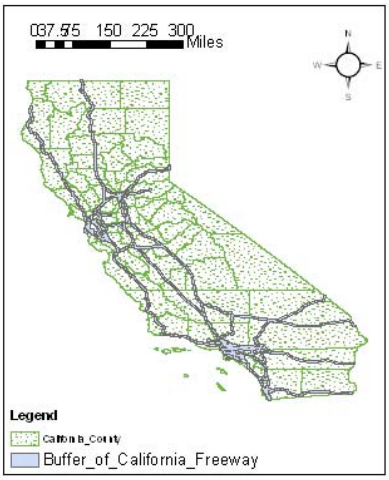
Waterbodies



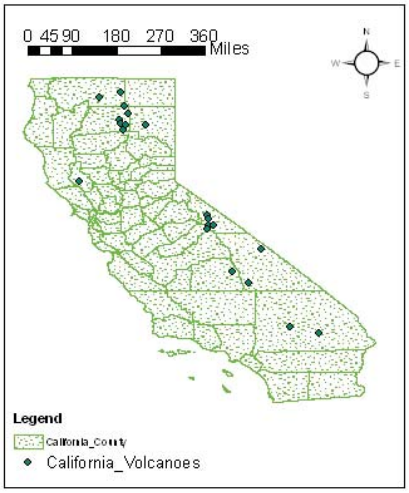
Buffer of Waterbodies



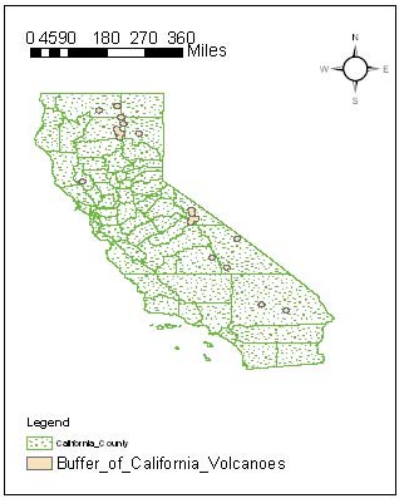
Freeway



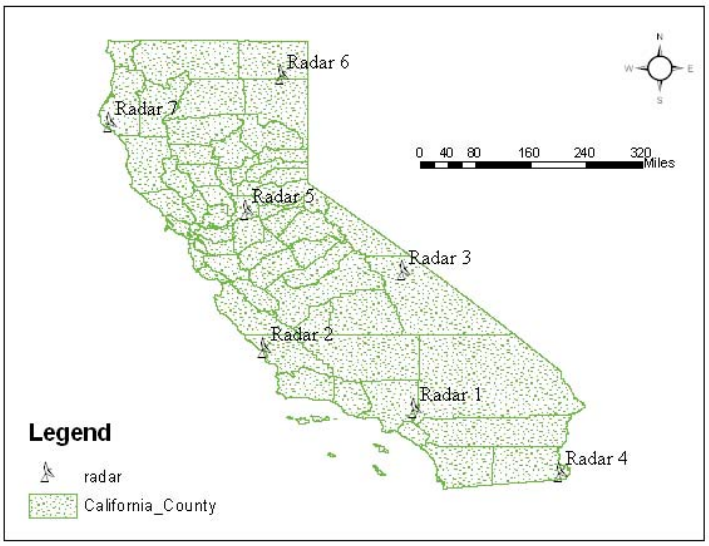
Buffer of Freeway



Volcanos

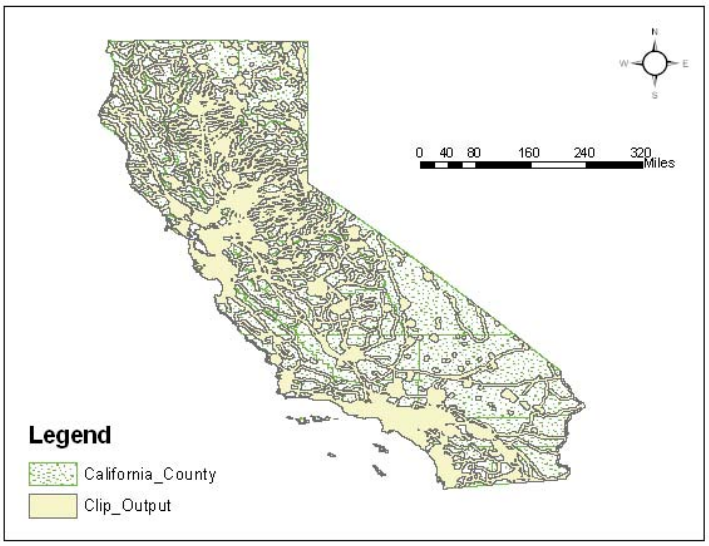


Buffer of Volcanos



Air Route Surveillance Radar

Radar
(www.howstuffworks.com...2003)



Total Buffer

Conclusion

The use of GIS in engineering purposes can take an important role especially in decision making in the future time. The use of GIS significantly reduces time and money. Advantage of GIS as the decision making sometimes cannot be counted, but eventually needed to produce better result and decision.

The application of GIS in this project proofs that the GIS are a powerful tool in engineering process. Within just a few days of works can be done. Obtaining the data is a long process in GIS, nonetheless the analysis and the process doesn't take significant time compared to do it manually.

The result of this project is the new layer of radar positions in state of California. This new radar layer is an asset for the aviation system and engineer in aviation. The new data layer can be used by other users and distributed to where it is need.

References

[1]. GIS-resources in ArcGIS version 8.1 package

[2]. ESRI Website

[3]. FAA (Federal Aviation Administration) and Advisory Circullar.

[4]. Ashford, Norman. Airport Engineering, John Willey & Sons, 1992.

[5]. US Transportation Bureau

[6]. Aviation Digital Data Service

[7]. etc.