Southern California Earthquake Center

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Geog 406  Final Report
Dr. Sun
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**Introduction To Poster**

The University of Michigan has identified the need to establish an earthquake educational center. The University has requested a study to identify the best location for their new center. Their initial requirements are as follows:

1. The center must be built on the most famous fault in California, the San Andreas Fault.
2. The location must be on a site with under a 20% slope, with preferences given to less than 20% slope.
3. The site must be within five miles from a major freeway.
4. The site must be close to major metropolitan population centers.
5. Specific land covers have preference over others.

**Hypothesis and Research Question**

Identify the best locations for building an educational earthquake research site that conforms to the identified criteria.

Research questions

- Identify building locations with slope under 20% on the San Andreas Fault.
- Identify building locations given preference to specific land covers.
- What areas of the San Andreas Fault are closest to major population centers?
- What parts of the San Andreas Fault are within five miles of a major freeway?
Methods Utilized for Project.

1. Flowchart to identify data required and procedure methodology for project.
2. Identifying data locations and downloading data.
3. GIS methods that were utilized to create the map or project.

**Raster**

DEM
- Converted SDTS to DEM.
- Convert DEM to slope percent. Reclassified to specific values identified as slope criteria. This step will answer research question 1.

**Land Cover**
- Reclassification of land cover to specific values identified as land cover criteria. This step will answer research question 2.
- Sum Reclassified Landuse and Reclassified slope data to identify the best building locations available. The preference scale is based on one to ten, ten being best. The data is one of the inputs to locate the best location for building.

**Vector**
- Largest Metropolitan Population
  - Selection by location with 20-mile buffer to identify largest metropolitan population closest to freeway and San Andreas intersection. This step will answer research question 3.
• San Andreas Fault Zone and freeway intersection
  • Selection by attribute to identify only San Andreas Fault from the myriad of faults in southern California.
  • Selection by location with five mile buffer on freeway to identify sections of San Andreas Fault close to major freeways. This step will answer research question 4.

4. Combine all of the individual data elements into one map and display results.

Data utilized for project.

• San Andreas Fault zone Shapefile.
• ESRI City Shapefile containing data on population centers.
• U.S. Geological Survey (USGS): California-South Land Cover Data Set.
  Standard NLCD Land Cover Classification System Land Cover Class Definitions.
• Spatial Data Transfer Standard (SDTS)-compliant raster profile transfer, produced by the National Mapping Program of the U.S. Geological Survey (USGS).
Figure 1. Selecting the San Andreas Fault from all others in Southern California.

Figure 2. Land cover of the freeway and fault intersections.
Figure 3. Digital Elevation Models for the Fault and freeway intersections.

Figure 4. Cities within 20 miles and fault within 5 miles of freeway.
Results of the study

The object of this site selection project is to identify the best building location on the San Andreas Fault for the University of Michigan to establish a remote campus for earthquake study. Building on the San Andreas Fault is a requirement from the University. The remainder of the criteria was identified with additional discussions about the requirements. These criteria were used to more closely select a suitable site.

Selection of the site was completed in three distinct phases

1. Identification of methodology and data required data
2. Locating and downloading usable data for the site selection
3. The actual selection of the best site given the criteria.
The completion of the flowchart and data required established the direction and focus to the overall analysis. Without the identification of the methodology and process, completing the site selection would be haphazard and non-directional. Due to flowcharting, a known process for site selection was identified, and with it a minimum of required data was also identified.

Locating and downloading the data was not a simple process. Identifying where the data was located took much longer than anticipated. Reviewing several sites including the USGS, CaSil, and Mapmart sites eventually brought together the necessary data components.

The actual selection of the site utilizing GIS software to quickly sort through the data and render a graphical display of the best land slope and land cover areas was quickly completed. When the best location was identified, a photo of the area was also retrieved for a realistic look of the area.

**Unexpected events**

Even with a flowchart and an identified data set requirement, adjustments had to be made. Some of the selections were originally designed to be made via raster manipulation, but were found to be better suited for vector manipulation than a raster manipulation. This was the case with the buffering of the San Andreas Fault from all of the freeways.

An important aspect of data was identified. Not all DEMs are created the same. The seamless DEM data does not correctly convert within the Spatial Analyst extension of ArcMap. Slopes of 12 million were realized after DEMs were converted into percent
of slope. Different data sets were identified and downloaded for use. MapMart was the best source for useable data.

ArcMap version nine has a special utility that allows for multi-mosaic. Selecting six DEM areas simultaneously expedited the mosaic process. The size of the data files was a factor in the mosaic process. Each DEM was about six megabytes in size. Each mosaic output created another file equal to the size of the combined input files. DEMs accounted for about thirty megabytes, and the mosaic process quickly added another one hundred megabytes of data, expanding the size of the working directory quickly. Land cover reclassification doubled the land cover file size. With the addition of the output JPEG files, which show steps of completion, the working directory again ballooned to a size that became difficult to move from computer to computer.

The order of the analysis is an important aspect that was not realized until after hours of data manipulation were completed. The criteria calls for the site to be near the largest metropolitan population. If this step were completed first, the obvious fault and freeway intersection would have become identified, reducing the workload of data manipulation by 66%.

Conclusions

The process of this site suitability study quickly identified the best locations that were within the established criteria. The creation of a process flowchart was a necessity to properly complete the project. The flowchart was able to establish a process for completion along with identifying the different data set that would be necessary in the analysis.
Utilizing the powerful reclassification tool created a visual interpretation of the flattest and best land cover for the construction site. Tying the output of the reclassification to a color scheme that ranged from red to green delivered a very recognizable way to identify the best location.

Showing the inputs to conform to the criteria gives the poster a step-by-step look. The land cover, digital elevation model, and proximity requirements are visualized by the three insets. Each inset shows a step that will ultimately classify the output area into a small zone for a detailed search.

The identification of the best location of the San Andreas Fault and intersection of the 15 Freeway shows the best of all criteria. With further effort a photo of the site determined that the selected area was not suitable for building. The criteria that were given did not include the requirement of a visible fault scarp, which was going to be the focus of study, and the reason for specifying the San Andreas Fault. Without a visible San Andreas Fault the project was eliminated.

Figure 6. Close up photo of the area where the San Andreas Fault crosses the I 15 Freeway.
Appendix A. List of supporting documentation.

- Original letter for site selection.
- Criteria for Site Suitability Study.
- Flowchart for methodology.
- Land cover translation from Standard NLCD Land Cover Classification System to value assigned to land cover for identifying suitable construction site.
Dear Mr. Consultant: 11/15/04

Please facilitate the identification of land that can be utilized for a remote student location to complete field studies on the San Andreas Fault.

The site will be situated on the fault, close to a major metropolitan area, close to a freeway, and not in a residential area.

Return with a site selection as soon as possible.

Thank you,

University of Michigan
Department of Geography and Tourism
**Site Requirements for New Earthquake Educational location**

<table>
<thead>
<tr>
<th>Given Criteria for location</th>
<th>Specific Criteria for location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Suitable land for building</td>
<td>Average slope of land.</td>
</tr>
<tr>
<td></td>
<td>0-5% 5</td>
</tr>
<tr>
<td></td>
<td>5-7.5% 4</td>
</tr>
<tr>
<td></td>
<td>7.5-10% 3</td>
</tr>
<tr>
<td></td>
<td>10-15% 2</td>
</tr>
<tr>
<td></td>
<td>15-20% 1</td>
</tr>
<tr>
<td></td>
<td>&gt; 20% unsuitable remove from selection</td>
</tr>
<tr>
<td>2. Freeway close</td>
<td>Distance from major freeway. Select possible sites that have an intersection within 5 miles</td>
</tr>
<tr>
<td>3. Close to major population centers</td>
<td>Populations within 20 miles. Select site with largest population center within 20 miles.</td>
</tr>
<tr>
<td>4. Ideal site for building site. See Land Cover Designations.</td>
<td>Land cover preference (5 = Best)</td>
</tr>
<tr>
<td></td>
<td>Barren land = 5</td>
</tr>
<tr>
<td></td>
<td>Brush = 4</td>
</tr>
<tr>
<td></td>
<td>Agriculture = 3</td>
</tr>
<tr>
<td></td>
<td>Forest = 2</td>
</tr>
<tr>
<td></td>
<td>Build up = 1</td>
</tr>
<tr>
<td>5. Must be on the San Andreas Fault</td>
<td>San Andreas Fault Shapefile.</td>
</tr>
<tr>
<td>6. Criteria weighting</td>
<td><strong>Criteria weighting</strong></td>
</tr>
<tr>
<td></td>
<td>Terrain slope at site 50%</td>
</tr>
<tr>
<td></td>
<td>Land cover at site 50%</td>
</tr>
<tr>
<td></td>
<td>Distance from major freeway to select general site. Largest Population &lt; 20 miles to select specific San Andreas Fault area then utilize the land cover and slope data for identification of site.</td>
</tr>
</tbody>
</table>
### Methodology Flowchart

#### Site Slope
- 0-5%: 5
- 5-7.5%: 4
- 7.5-10%: 3
- 10-15%: 2
- 15-20%: 1
- > 20%: Eliminate

#### Landuse
- Barren land: 5
- Brush: 4
- Agriculture: 3
- Forest: 2
- Build up: 1

#### Largest Population Within 20 miles

#### Select by location:
- Fault within five miles of Freeway

#### Criteria weighting
- Terrain Slope at site: 50%
- Landuse at site: 50%

### Select most Populated Area

### Download image for possible selection.
## Landuse designations
Reclassification from specified Landuse value to an appropriate value for evaluating the Landuse for site suitability study.

<table>
<thead>
<tr>
<th>Re-Class Value</th>
<th>Original Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>11  Open Water</td>
</tr>
<tr>
<td>None</td>
<td>12  Perennial Ice/Snow</td>
</tr>
<tr>
<td>None</td>
<td>21  Low Intensity Residential</td>
</tr>
<tr>
<td>None</td>
<td>22  High Intensity Residential</td>
</tr>
<tr>
<td>1</td>
<td>23  Commercial/Industrial/Transportation Barren</td>
</tr>
<tr>
<td>5</td>
<td>31  Bare Rock/Sand/Clay</td>
</tr>
<tr>
<td>None</td>
<td>32  Quarries/Strip Mines/Gravel Pits</td>
</tr>
<tr>
<td>2</td>
<td>33  Transitional Vegetated; Natural Forested Upland</td>
</tr>
<tr>
<td>2</td>
<td>41  Deciduous Forest</td>
</tr>
<tr>
<td>2</td>
<td>42  Evergreen Forest</td>
</tr>
<tr>
<td>2</td>
<td>43  Mixed Forest</td>
</tr>
<tr>
<td>5</td>
<td>51  Shrubland</td>
</tr>
<tr>
<td>None</td>
<td>61  Non-natural Woody</td>
</tr>
<tr>
<td>3</td>
<td>71  Grasslands/Herbaceous</td>
</tr>
<tr>
<td>None</td>
<td>81  Herbaceous Upland</td>
</tr>
<tr>
<td>None</td>
<td>82  Herbaceous Planted/Cultivated</td>
</tr>
<tr>
<td>None</td>
<td>83  Pasture/Hay</td>
</tr>
<tr>
<td>None</td>
<td>84  Row Crops</td>
</tr>
<tr>
<td>None</td>
<td>85  Small Grains</td>
</tr>
<tr>
<td>None</td>
<td>84  Fallow</td>
</tr>
<tr>
<td>None</td>
<td>85  Urban/Recreational Urban Grasses</td>
</tr>
<tr>
<td>None</td>
<td>91  Wetlands</td>
</tr>
<tr>
<td>None</td>
<td>92  Woody Wetlands</td>
</tr>
<tr>
<td>None</td>
<td>92  Emergent Herbaceous Wetlands</td>
</tr>
</tbody>
</table>
11. Open Water - areas of open water, generally with less than 25 percent or greater cover of water (per pixel).

12. Perennial Ice/Snow - All areas characterized by year-long cover of ice and/or snow.

21. Low Intensity Residential - Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.

22. High Intensity Residential - Includes heavily built up urban centers where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80-100 percent of the cover.

23. Commercial/Industrial/Transportation - Includes infrastructure (e.g. roads, railroads, etc.) and all highways and all developed areas not classified as High Intensity Residential.

24. Barren - Areas characterized by bare rock, gravel, sad, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

31. Bare Rock/Sand/Clay - Perennially barren areas of bedrock, desert, pavement, scarps, talus, slides, volcanic material, glacial debris, and other accumulations of earthen material.

32. Quarries/Strip Mines/Gravel Pits - Areas of extractive mining activities with significant surface expression.

33. Transitional - Areas of sparse vegetative cover (less than 25 percent that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).

34. Forested Upland - Areas characterized by tree cover (natural or Semi-natural woody vegetation, generally greater than 6 meters tall); Tree canopy accounts for 25-100 percent of the cover.
41. Deciduous Forest – Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest – Areas characterized by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Shrubland – Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland – Areas dominated by shrubs; shrub canopy accounts for 25-100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of the other life forms.

Non-natural Woody – Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25-100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other – Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Herbaceous Upland – Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. Grasslands/Herbaceous – Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.
Planted/Cultivated - Areas characterized by herbaceous vegetation
That has been planted or is intensively managed for the
production
of food, feed, or fiber; or is maintained in developed settings
for
specific purposes. Herbaceous vegetation accounts for 75-100
percent
of the cover.

81. Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures
planted for livestock grazing or the production of seed or hay

crops.

82. Row Crops - Areas used for the production of crops, such
as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains - Areas used for the production of graminoid
crops such as wheat, barley, oats, and rice

84. Fallow - Areas used for the production of crops that are
temporarily barren or with sparse vegetative cover as a result
of
being tilled in a management practice that incorporates
prescribed
alternation between cropping and tillage.

85. Urban/Recreational Grasses - Vegetation (primarily grasses) planted
in developed settings for recreation, erosion control, or
aesthetic
purposes. Examples include parks, lawns, golf courses, airport
grasses,
and industrial site grasses.

Wetlands - Areas where the soil or substrate is periodically
saturated
with or covered with water as defined by Cowardin et al.

91. Woody Wetlands - Areas where forest or shrubland vegetation
accounts for 25-100 percent of the cover and the soil or
substrate
is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands - Areas where perennial
herbaceous vegetation accounts for 75-100 percent of the cover
and the soil or substrate is periodically saturated with or
covered
with water.