PRIORITY SUSCEPTIBLITY OF CRITICAL BIOLOGICAL AREAS IN THE ANGELES AND SAN BERNARDINO NATIONAL FOREST USING MULTI CRITERIAN DECISION ANALYSIS

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INTRODUCTION:

Focusing on the critical areas, the goal of this project is set to use a Multi-Criteria Decision Analysis using ranks to weight the following criterion of transportation, land cover change and critical biological areas and then classifying the National Park boundaries of Angeles and San Bernardino national forests as levels of prioritization from very high to low priority.

The project shows the critical biological areas and other areas of interest in both the forests that are in need of monitoring and resources especially in the case that these areas are prone to land cover change and are in close proximity to transportation facilities such as roads and freeways. Transportation Corridors run through Angeles and San Bernardino was chosen as an important criterion for this research since they are a source of CO2 emissions and sound pollution. Critical Biological Areas, which come from previous data, shows where endangered plants and animal habitats are. Land use zones will mask the data and results around the Southern California National forests. The Land cover change raster data shows the levels of increase and decrease for forest cover and shrubs. The way in which the classification results will be digitized will come from two of the following geoprocessing analyst tools Weighted Overlay and Raster Calculator.

STUDY AREA:

The study area chosen covers the National Forests of Angeles and San Bernardino in Southern California. These regions have a hot warm to hot summer Mediterranean type of climate that sees many potential influences on its dynamic ecosystem. The Angeles National Forest, an urban forest that is located in the San Gabriel Mountains and Sierra Pelona Mountains and was established by Executive Order in 1892 December (*USDA - U.S. Forest Serv*ice). The forests consist of ever-changing population and manages the watersheds within its boundaries to supply Southern California with necessary water and to save neighboring areas from devastating floods. The forests have the evidence of more than 10,000 years of human history. It covers an area of over 650,000 acres with five wilderness areas which are designed nationally. Most of the forest area is covered with dense chaparral with pine and fir covered slopes reaching the higher elevations. San Bernardino on the other hand is made up of two major divisions, the eastern portion of the San Gabriel Mountains and San Bernardino Mountains on the east part of Transverse Ranges. This forest includes seven wilderness areas. Fires, Droughts, humans and climate change all play a role in health of the both forests. Both forests are connected by small passage way known as Cajon Junction. The Los Angeles basin and surrounding urban sprawl fall south-west of the forest reaching all the way to the Pacific Ocean. The National parks are mountainous park systems that receive snow on occasion on its peaks and is known to have cooler temperatures. To the northeast lies the Mohave desert which is much more dry and hot.

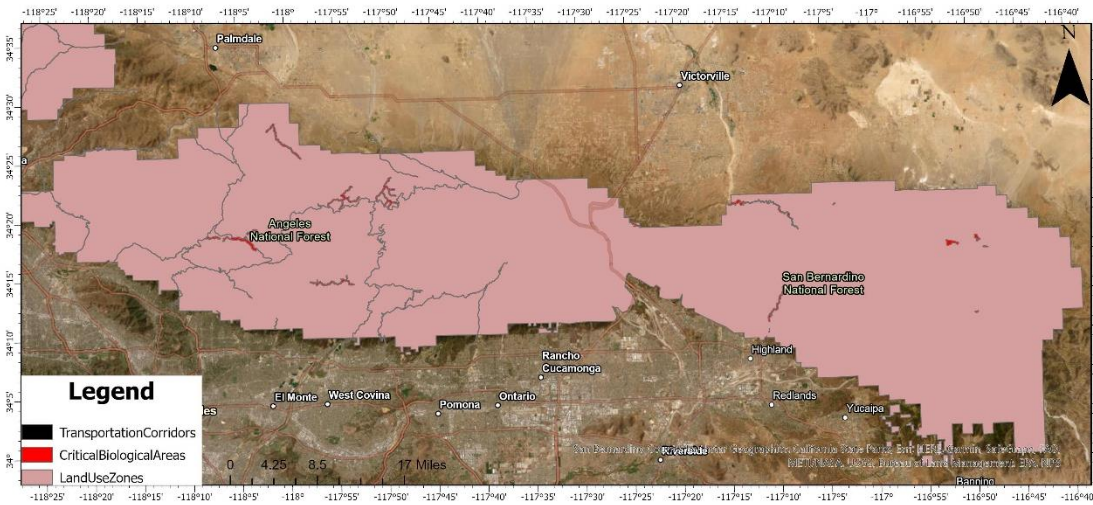


Figure 1: Study area showing the Angeles National Forest and San Bernardino National park with variables Transportation corridors, Critical biological areas and Land use zones.

DATA SOURCE:

Critical Biological data was downloaded from the USDA Forest Service Forest Planning Data set for the Southern California 2006 forest plan amendment. Two data sets were provided that included the vector data and raster data as the following features – Land use zones, Transportation Corridors, Critical Biological Areas, Land cover change.

METHODOLOGY:

The project includes two methods – Data Preparation and Multi Criterion Decision Analysis. Data preparation includes multiple ring buffer, Feature to Raster and Reclassify. Multi-Criterion Decision Analysis includes Weighted overlay and Raster Calculator. All the data collected has the cell size of 30 x 30. The environments for the geoprocessing will be masked to the extent of the land use zones of the national forest parks.

First, Multiple Ring Buffer zones are created for both transportation corridors and critical biological areas with a distance scale of 100 meters, 300 meters, 600 meters, 1000 meters.

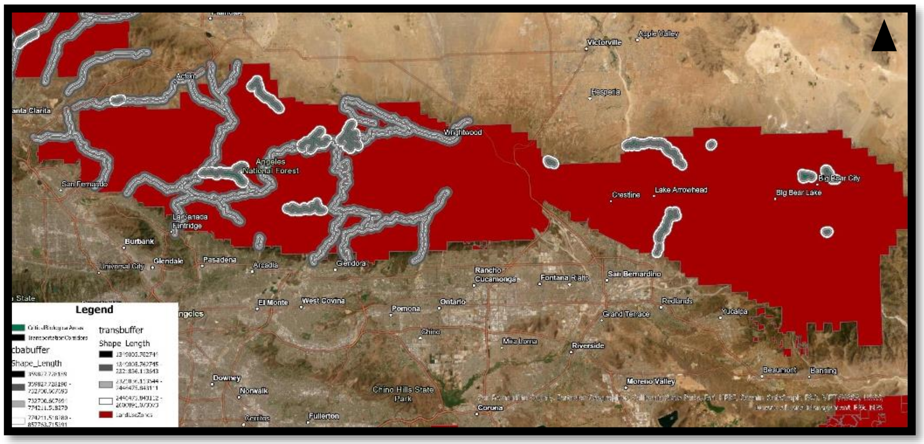
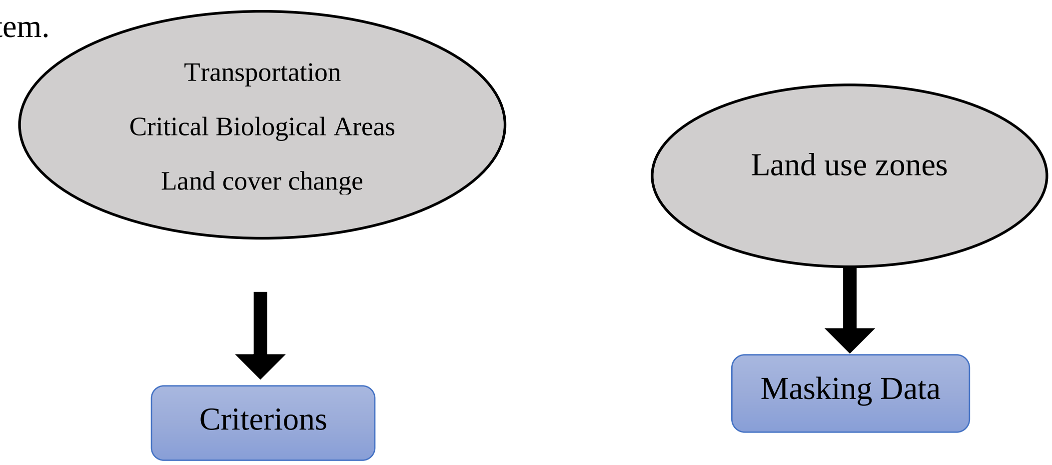


Figure 2: results of multi ring buffer

Second, transportation corridors and critical biological areas datasets were converted to raster data using the feature to raster toolset with cell size equivalent to the land cover change raster. Land use zones will mask the results around the Southern California National forests system.



Third, comes the reclassification. Reclassification of transportation, Critical biological areas and land cover change will use the land use zone shape file to clip the raster data within the national forest boundaries. Ranking of the reclassifications of the buffers will give higher values to smaller distance values. For the land cover change criterion, Moderate priority with value 1 is given to Little or no change and increase in shrub land, and decrease of land cover change is given a high priority with value 2. Higher values represent higher importance.

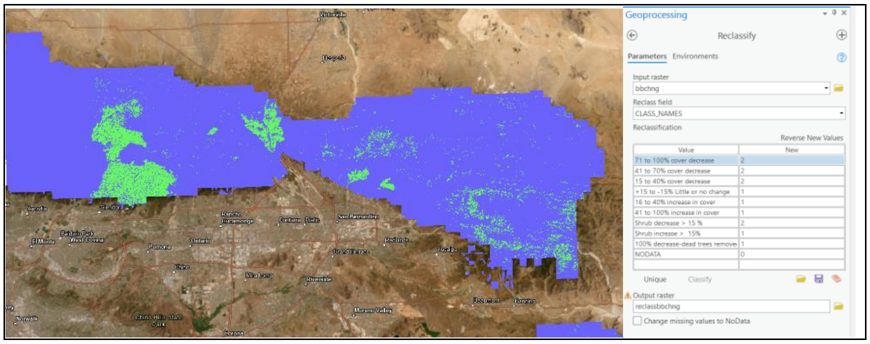


Figure 3: Map showing the study area in blue color and land cover change in green patches. The table shows the ranking given based on the increase and decrease of land cover change.

MULTI CRITERION DECISION ANALYSIS:

For implementing the multi criterion decision analysis, two methods were executed, namely weighted overlay and raster calculator.

WEIGHTED OVERLAY:

In the weighted overlay, a weight of 50% was assigned for the critical biological areas as they are the high priority area and are more vulnerable to changes in land cover, Carbon dioxide and other toxins via roads and freeways, and sound pollution. A Weight of 30% was assigned for the land use change as the critical biological areas are already vulnerable but most prone to immediate change in landcover change specifically tree shrub and habitat loss due to climate change, human development, fire and drought. A Weight of 20% was assigned for the transportation corridors because while it is the least weighted, it is still enough to produce robust results given the fundamental importance of all variables.

RASTER CALCULATOR:

The weights were adjusted for the raster calculator. This is because the weights used in the weighted overlay heavily favored the critical biological areas. This made a result that was not able to evenly distribute the rankings appropriately. Instead the weights were adjusted by lowering the critical biological areas to 0.4 and raising the transportation and land cover change to 0.25 and 0.35 respectively.

RESULTS:

WEIGHTED OVERLAY:

The high priority areas are critical biological areas which are susceptible to negative externalities such as land cover change and traffic pollution as well as other means such as man-made processes and of course natural disasters like fire, droughts and climate change. Below is the map showing the results of the weighted overlay.

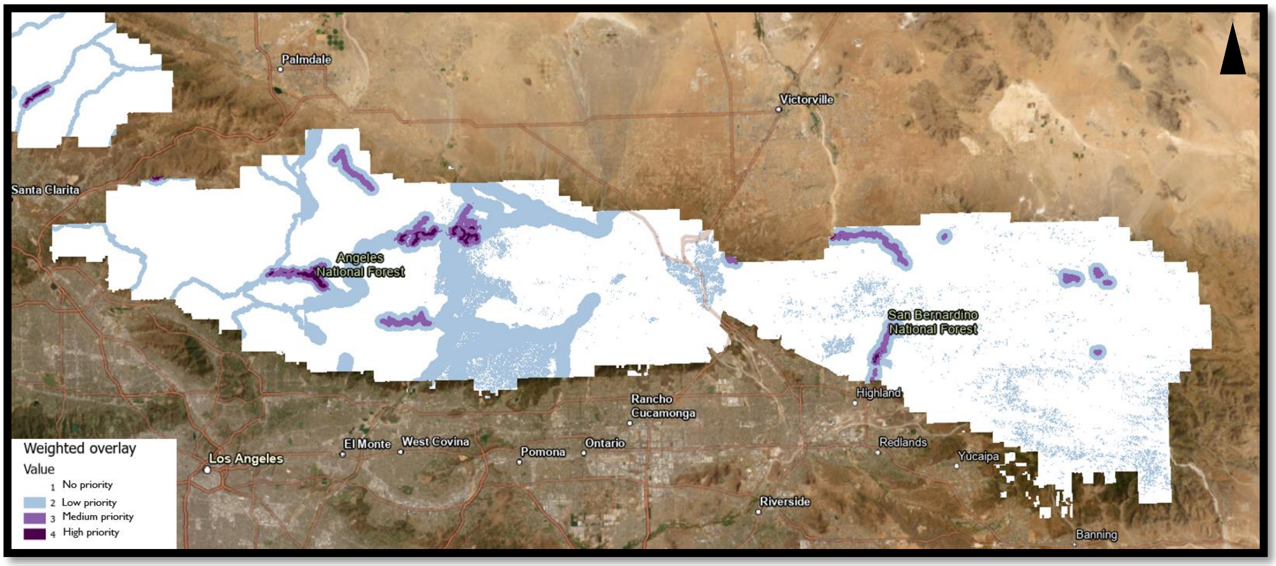


Figure 4: Weighted overlay results showing priority areas of the critical biological areas of Angeles and San Bernardino National Forests.

Out of 40 plus critical biological areas according to its attribute table, three distinctive critical biological areas were found to be more decisively prone to the negative externalities of land cover change decrease and traffic pollution. (figure 5). While the rest of the critical biological areas displayed should still be considered a priority, only these three cases showed substantial and robust results.

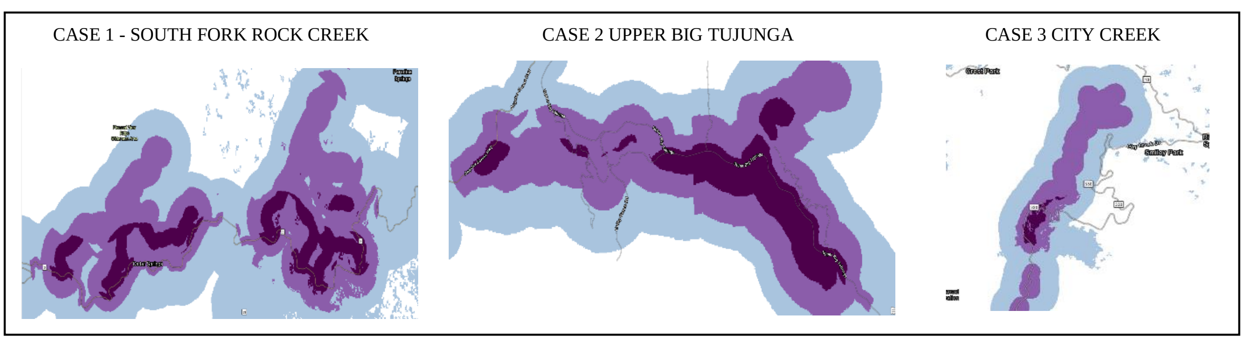


Figure 5: Weighted overlay results showing the high priority areas

Moreover, the above three cases are demonstrated as transecting between all three variables. No other critical biological area shows this. Fragments of two other critical biological areas do show a high ranking, but are not as extensive. Therefore, it will not be covered due to these biological areas extending outside of the jurisdiction of the National forests.

RASTER CALCULATOR:

Despite changing the weights, the high priority critical biological areas were still captured since these are the areas more susceptible to land cover change and traffic pollution such as CO_2 and sound pollution.

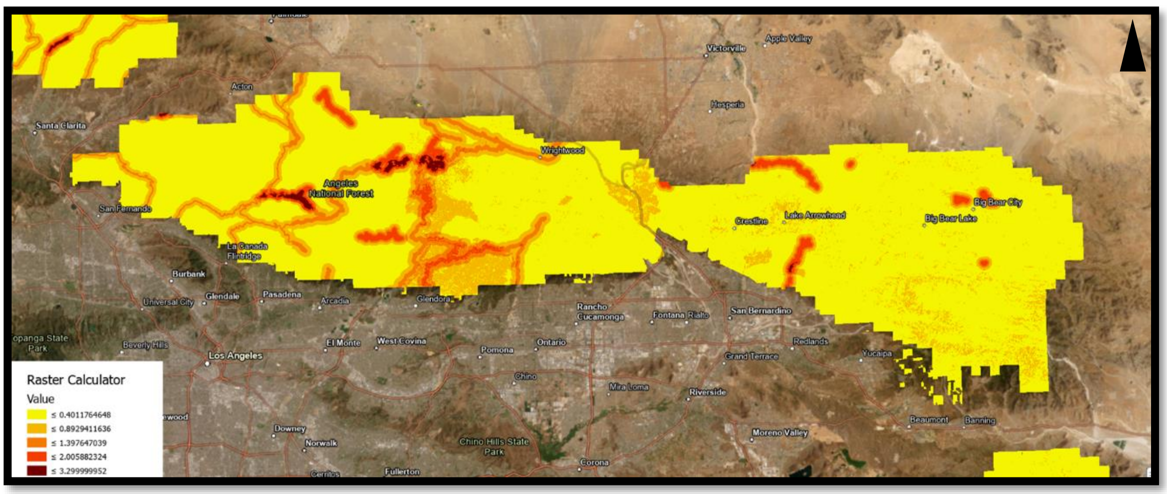


Figure 6: Raster calculator results showing priority areas of the critical biological areas of Angeles and San Bernardino National Forests.

The above same 3 cases (Figure 5) after the weighted overlay process show the same critical areas and were captured nearly identical in relation to the results from the raster calculator (Figure 7).

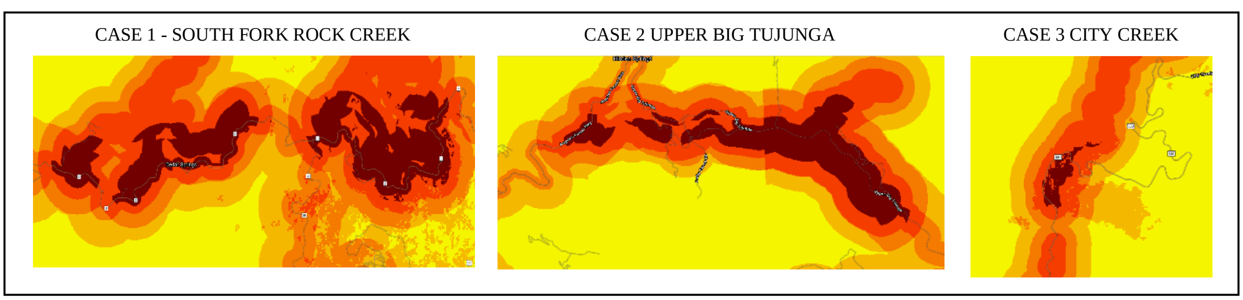


Figure 7: Raster calculator results showing the high priority areas

The critical biological areas, transportation corridors and land cover change were all intersecting resulting in a high ranking. In the case of Cedar Springs (South Fork Rock creek) there is a highway passing through the critical biological area with corresponding land cover change highlighted by medium to dark red patches.

VALIDATION:

Validation of both models can be demonstrated by the nearly identical similarities between classification types and ranking despite differences in the weights and modelling technique. In other words, the data passes the sensitivity analysis because each variable shows a strong spatial reciprocity that cannot be decoupled no matter how the multi-criterion decision analysis is run. This is further highlighted by the continual classification of the same high urgency critical biological areas despite different weights and models or iterations thereof. Places like Cedar Spring (Case 1), Singing Springs (Case 2) and Running Springs (Case 3) should be classified as conclusively highly susceptible to negative externalities such as land cover change and distance to traffic corridors regardless of how the multi-criterion decision analysis is run.

DISCUSSION:

The results of both Weighted overlay and Raster calculator model are good enough to capture the high priority critical biological areas. Despite their strong spatial mutuality there exists some problems. One problem with both the models is that there is assigning of medium-level ranks to critical biological areas that maybe shouldn't be because there is no interaction with the other variables. There is also over ranking of the critical biological areas that weren't intersecting the other variables. There is also missing traffic corridors data in the San Bernardino National Forest.

CONCLUSION:

The results highlight the high priority areas that should be given extra care and caution for future planning and development. More so, these highly susceptible areas can be exclusively used for monitoring and research for biologist, conservationists and geographers as well as emergency services. The three high ranking cases that were discussed are real-world scenarios that are in critical need of conservation science in the immediate future. Examples of critical species pinpointed by the mutli-criterion decision analysis include the red legged frog, southwestern willow flycatcher, arroyo toad, and yellow legged frog. In other words, the factors of land cover change and proximity to traffic corridors have exacerbated these particular critical habitats more so than any other. These habitats are in need of immediate attention for researcher, geographers and wildlife conservationists to protect from the negative effects of land cover change and traffic pollution.

REFERENCES:

Aditi Sarkar, 2013, Amit Ghosh, Pabitra Banik, "Multi-criteria land evaluation for suitability analysis of wheat: a case study of a watershed in eastern plateau region, India," *Pages 119-128; Taylor and Francis Online*

Argantonio Rodríguez-Merino , Pablo García-Murillo , Rocío Fernández-Zamudio "Combining multicriteria decision analysis and GIS to assess vulnerability within a protected area: An objective methodology for managing complex and fragile systems" Science direct *Ecological Indicators Volume 108*, January 2020, 105738

Understanding Weighted Overlay, ESRI, https://www.esri.com/about/newsroom/arcuser/understanding-weighted-overlay/

Weighted Overlay (Spatial Analyst), *ESRI – ARCGIS PRO, https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/weighted-overlay.htm*

Cal fire - United States Department of Agriculture - US Forest Service – Caring for the land and serving people, https://www.fs.usda.gov/angeles

Monica Bond Curt Bradley, "Recommended Critical Biological Zones in Southern California's Four National Forests: Los Padres, Angeles, San Bernardino , Cleveland" *Published in : Center for Biological Diversity*

Ron Janssen, 2001, "On the Use of Multi-Criteria Analysis in Environmental Impact Assessment in The Netherlands," *Institute for Environmental Studies, Vrije Universiteit, Amsterdam, Netherlands. J. Multi-Crit. Decis. Anal. 10: 101–109 (2001)*

L. A. Ieradi, M. Cristaldi, D. Mascanzoni, E. Cardarelli, R. Grossi & L. Campanella 1996, "GENETIC DAMAGE IN URBAN MICE EXPOSED TO TRAFFIC POLLUTION," *ELSEVIER-Environmental Pollution, Vol. 92, No. 3, pp. 323-328, 1996*