

Introduction to GIS: Final Project

Developable Land Analysis for the Island of Hawai'i

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Abstract

When developing new structures it is important to analyze the existing land so that buildings can satisfy political, economic, social and environmental aspects of the society at hand. This analysis will offer insight into how our maps that we created show critical investigation of the contributing factors in the building of the Pineapple Palace Resort and Spa. The following report outlines the processes and findings of a Geographic Information System (GIS) analysis that aimed to display appropriate and safe locations for development of a possible resort on the Island of Hawaii. Within this analysis we researched, extracted, manipulated and displayed data in order to evaluate the land and its environmental attributes and limitations. The results of this analysis will articulate three prospective places that will be suitable for development within the land restrictions.

Description of Project Area

For this project we analyzed the island of Hawaii to build our proposed hotel and resort, the Pineapple Palace Resort and Spa. This location has many aspects to analyze when assessing safety considering it is an island surrounded by water causing it to be vulnerable to tsunami dangers and has an active volcano. It also is an island of warm climates so we also took aspects like agriculture and pasturelands into consideration. For our resort we looked for an area that would not be of harm to existing communities, an area that was stable, and an area that would meet our needs of a luxury resort. With our proposed building project, we wanted to ensure a minimal amount of damage to the existing community and land. To do so, we looked at areas of existing streams, current land use, and critical habitats on the island. We also wanted to ensure that we find a stable and suitable location for constructing this facility because of surrounding lava flow hazards, tsunami evacuation zones, and flood hazard zones.

Our data analysis consists of many different layers that must be taken into account when proposing a resort that will have many economic benefits for Hawaii with a minimal amount of environmental impacts. Land use describes the distinct land boundaries that humans have utilized including urban, agricultural, rangeland, forest land, water, wetlands and barren lands. Another layer of interest includes the vector data of hotels. Taking the location of other hotels into consideration will help us constitute a place that will allow for enough development in it's own unique area, which will also help our hotel's economic success. Roads also pose as a layer of interest due to their ability to shape human traffic. We wanted our hotel to have a close enough proximity to a major road that it was accessible yet still remote enough from traffic. Furthermore, taking river data into consideration will help benefit our analysis. Understanding the path of rivers will help us find a safe place to build without disrupting such fragile river ecosystems along with their surround riparian zones. Volcano and Tsunami hazard zones must also be taken into account, as it is important to build our hotel in a place where people will feel safe. Lastly, species classified as endangered plants

make up a layer of concern. These areas are also very important when considering the prosperity of Hawaii's diverse natural environment.

Methodology of Analysis:

In order to determine where we can build the Pineapple Palace Resort and Spa we need to conduct an analysis on the land, combining various layers of data we find to be “unsuitable for development.” This includes the hazards associated with lava flows, tsunami evacuation zones, areas of threatened and endangered plants, urbanized and agricultural land, and areas with other hotels, rivers, and major roads nearby. Each layer had different attributes that needed to be deciphered in order to effectively assess the area; therefore, we needed to individually manage the data before conducting any type of assessment.

In the lava flow layer, each area had a different hazard code (1-9) depending on its location and time since last lava flow. To decipher these codes, we had to look at the metadata provided by the State of Hawai'i Office of Planning. In the metadata, they described what each number represented. For example, they categorize code 1's as “Summits and rift zones of Kilauea and Mauna Loa, where vents have been repeatedly active in historic time. Boundaries are defined by eruptive fissures, cinder cones, pit craters, and graben and caldera faults. Zone 1 is where lava flows originate,” and code 9's as areas involving the “Kohala Volcano, which last erupted over 60,000 years ago” (http://files.hawaii.gov/dbedt/op/gis/data/vhzones_n83.txt). We needed to fully understand the metadata in order to group the codes into 4 categories: areas of low hazard, moderate hazard, high hazard, and extreme hazard. After doing so, we were able to create a colour scheme that effectively communicated the data but was also easy on the eyes. For the purposes of our final analysis, we only focused on areas of high and extremely high hazard because those are the areas directly affected by the active volcano.

In our analysis, we added the stream and road layers to show areas where development is not possible. Moreover, the road layer was added to ensure that we are building the Pineapple Palace Resort and Spa in an area that is easily accessible. We decided to buffer all the streams by 30 meters on both sides to minimize the impact of tourism and waste from the hotel on the river systems. Doing so will ensure that stream ecosystems and wildlife remain preserved and un-impacted by the resort. Because we want the Pineapple Palace to be located away from the noise and disruptions that come from highways, we decided to buffer the highways by 2 km on both sides. To do so, we classified the different types of roads in the data as either highways or local, side streets and we had to, again, look at the metadata provided by the government to group the different lines into the two categories. We decided not to put buffers on the other roads because, as mentioned above, we would want the hotel to be in a location where tourists can access the hotel and explore other towns easily, but we chose a location not close to an existing road, we could build a road to the hotel. Because we were not able to create a buffer only on the highways using the base data, we went into the attribute table to select all the highways. We queried “CLASS” = “A31” OR “CLASS” = “A35” which were the codes for the different highway types, and then created a new data

layer titled “highways” using the selected attributes. We were then able to buffer just the highways.

To further our analysis, we had to consider the existing land use throughout the island. To do so, we looked at the attribute table and recognized that the “LanduseCode” column changed with area. Codes ranging from 11-77 classified different types of land use; therefore, we had to refer to the metadata to help us decipher these codes. For example, codes 11-17 represented urban and built up land, 21-24 represented agricultural land, 31-33 represented rangeland, 41-43 represented forest land, 51-54 represented water features, 61 and 62 represented wetlands, and 71-77 represented barren land. Because each area had one land use code (i.e. 14), to simplify it, we had to group the areas into the categories listed above. We then renamed the grouped data to the areas they represented and created an appropriate colour scheme to effectively show the different areas of land use. Keeping our overall final map in mind, we then decided to classify the data by areas we could not develop. Taking into consideration different ethical and environmental issues, we decided that we could not build on urban and built up lands, agricultural lands, wetlands, and water features and that we could develop on rangeland, forestland, and barren land. After we reclassified the data, we then grouped the areas where we could not build and renamed it “Urban, Industrial, Agriculture, wetland, and water.” For our final map, we removed the areas suitable for building because we wanted only display the areas where development was not possible.

Furthermore, we decided to assess the areas that have threatened and endangered plants because it is not ethical to build on or near sites that further endanger these species. We had to examine metadata provided by the Hawai’i Office of Planning to rename the groups of data to the varying degrees of threatened and endangered plant concentrations. Ranging from little to no concentration to a very high concentration, we had to create a colour scheme that communicated our data in a way that was easy for map users to decipher. Although we classified all the groups initially, we ultimately combined the very high concentrations and high concentrations of endangered species for our final map as the areas where we could not build, which left the areas of medium, low, and little to no concentrations to build on. Therefore, we removed the areas we could build on and only showed the areas we decided were unethical to build on for the final map.

Our final layers we decided to consider were the location of other hotels on the island and tsunami evacuation zones. Because we want our hotel at least 2 km away from another hotel to give our resort some level of isolation regarding traffic, noise, and overall luxury, we decided to buffer the point symbols. Furthermore, it would not be wise to place a hotel in the tsunami evacuation zones because, on the rare occasion warnings like these go into effect, there will be a mass panic among the thousands of guests who will have no other place to stay should they evacuate at night. Both layers further contribute to the total area on which we cannot build.

Overall, for our final map, we layered the different data sets to highlight the areas on which building the Pineapple Palace Resort and Spa would not be possible or ethical. For

simplification, we unioned the tsunami evacuation layer and the volcano hazard layer together and renamed it environmental hazards. From each individual layer, we removed all the areas where we could potentially build in order to focus solely on areas we could not build. Our final map emphasizes and breaks down the areas that are unsuitable for development with the white areas being possible construction sites.

Error and Uncertainty

Although this analysis attempted to incorporate all necessary layers and minimize error and uncertainty, there will always be a level of uncertainty and error that exists. There may be error within the data we chose to download and within the representation of that data because of how we chose to manipulate it. There is always a level of error in the data because even if the data is taken from a trustworthy source, we can never be sure that the methods that were used to obtain the data were accurate and complete.

There are also levels of uncertainty in our own analysis because we manipulated and simplified the data in order to make it applicable to our project. For example with our lava hazard layer there were 9 different classifications for the level of hazard, but to make it easier to show our analysis we grouped together many of these classifications. We ended up with 4 groupings: extreme hazard, high hazard, moderate hazard, and low hazard. This is where a conversation of ethics can come into play regarding manipulating data. Although we have not changed anything, we did group it in order to show what we wanted. We then chose that only the extreme and high hazard areas would be where we cannot build. Simplifying the data can create uncertainty because the viewer of our map is unaware of this generalization of the data and where the extreme and high hazards actually lie. It also can create more uncertainty if our data is then used for further research or analysis.

Further Research and Recommendations

Although we attempted to analyze as many areas of concern for building this resort as possible, further research can be conducted in terms of socioeconomic and environmental concerns.

As far as socioeconomic research, we could have looked into existing hotels and resorts on the island and whether or not they held competitive advantages over the location of our resort. As well, we could have located our resort close to major tourist attractions, shopping malls, or famous beaches to further attract guests. With more research on this matter, we would be able to narrow down our three proposed locations to the most ideal location for the hotel.

As far as environmental concerns, further recommendations are to look into the soil composition of the island and more in depth information on the volcano hazard zones. When searching for data to analyze, we were unable to access a complete data set of soil composition for the island of Hawai'i. Therefore, further research into finding a data set with the soil composition would eliminate our uncertainty in the stability and longevity of the locations we have chosen. The soil composition data will also help to solidify an ideal

location out of the three that we have chosen. Furthermore, on the volcano hazard zone map, we grouped three different codes into the moderate hazard zone and four different codes into the low hazard zone. Due to this grouping, we are unsure of the range of severity within the moderate and low hazard zones. Therefore, with further research on the volcano hazard zones, we would be able to identify whether or not we can build a hotel in a moderate volcano hazard zone.

While taking the this new information into account, there is a possibility that we could find a better location for our hotel or confirm that one of our three chosen locations is the most ideal.

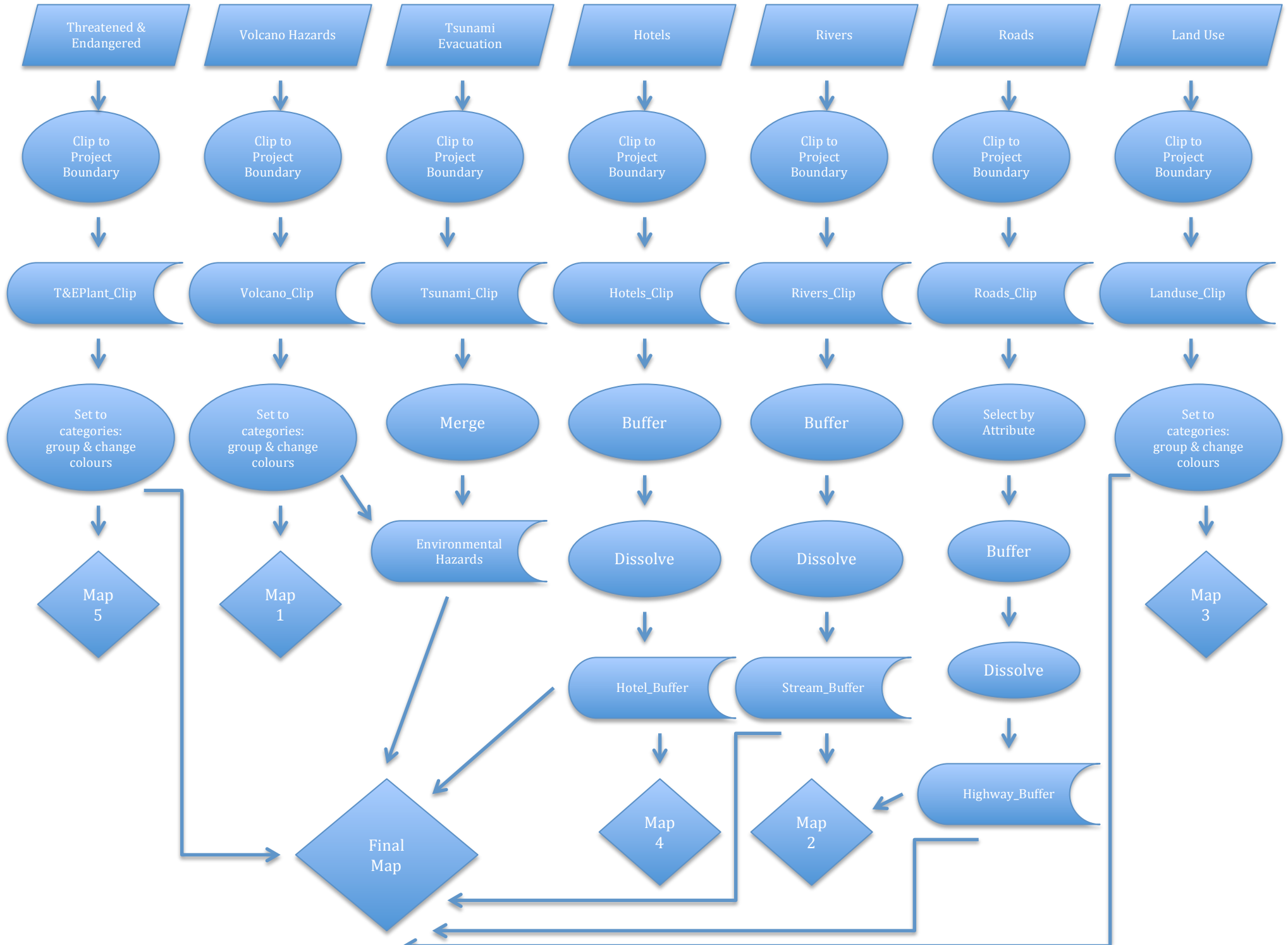
Discussion and Results

Through looking at the areas of land-use, endangered plant species, lava and tsunami danger zones (on which we did not want to build), and including the choices that we made concerning how close we wanted the roads, streams, and existing hotels to be; the space on which we could build was limited. It is important that our analysis was thorough and that we did not build in areas of high risk. Through analyzing the location of other hotels on the island of Hawaii we noticed that most of the hotels are located along the coast within the tsunami evacuation zone, which was interesting to note. We conducted a hazard analysis and made sure not to build within this evacuation zone in order to ensure the longevity of our resort for both economic reasons and for the safety of any visitors and clients. Because we wanted to avoid tsunami evacuation zones, there were limited areas where we could build right along the water considering we wanted the hotel at least a maximum of 2 km away from existing hotels and did not want to occupy land of endangered plant species. There were areas closer inland that were not close to any existing hotels or resorts, but this meant there were also not many existing roads. But as far as developing a resort, expanding road access was determined to not be a problem for this proposed project.

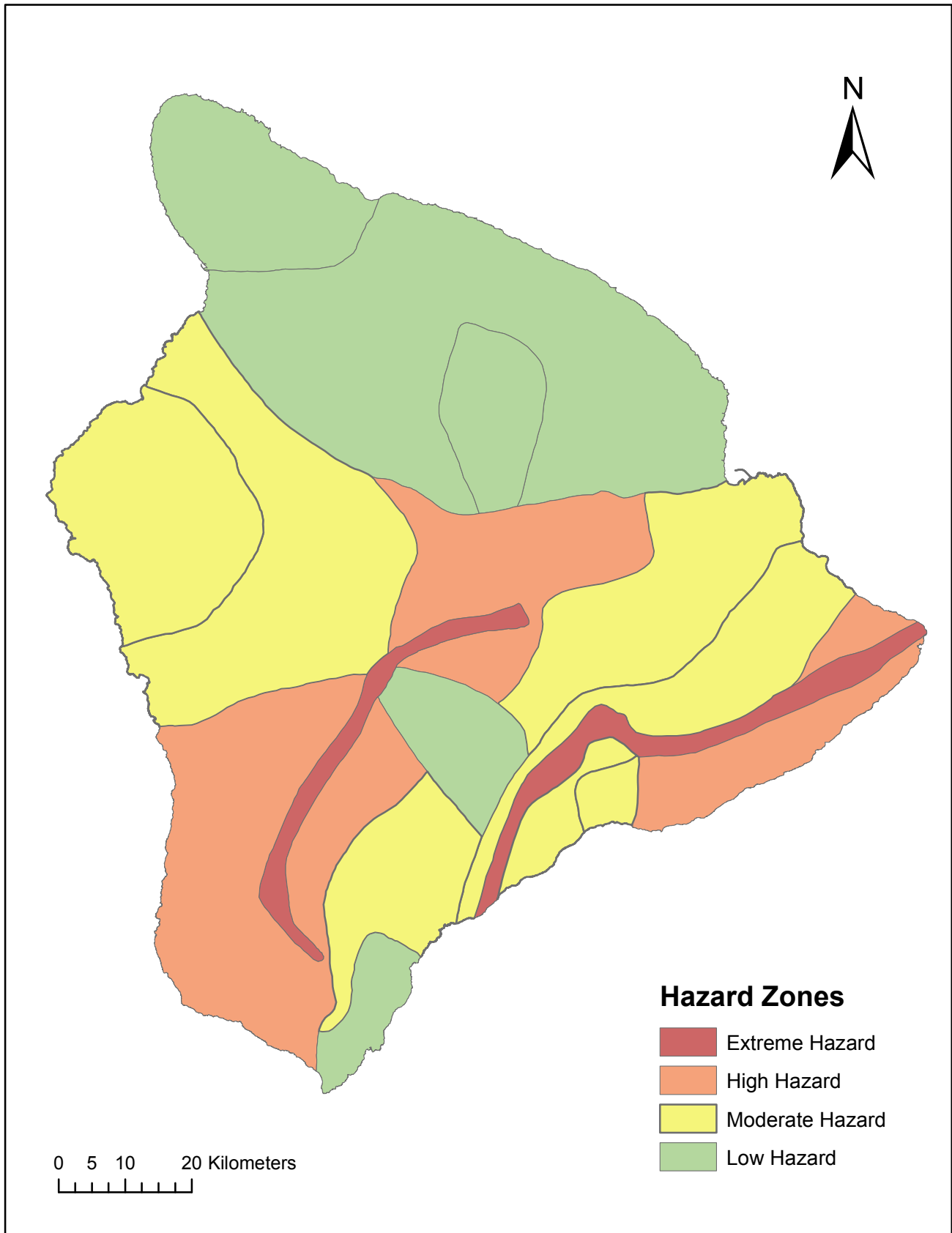
Although there could have been many other locations where we could build, we decided on the top three areas for the Pineapple Palace Resort and Spa (yellow stars on the final map). We chose the locations because they were 1) close to the coast 2) near a main road and 3) away from any hazardous area. Because these areas are near the coast, guest will be able to access the beach by foot, and because the hotel will be located out of the tsunami evacuation zone, should a tsunami warning be put in effect, none of the guests will have to leave the resort and find other places to stay. Furthermore, these three locations are at optimal distances from main roads, which will allow tourists to explore surrounding areas and access other attractions while still limiting the amount of disruptions from major highways.

In order to fully assess how safe our locations are, we need to take into consideration data layers that we were not able to access, such as soil layer composition in relation to liquefaction susceptibility. Regardless of the data that we are missing, our results show that with careful planning and consideration, building the Pineapple Palace Resort and Spa is permissible on the Island of Hawai'i.

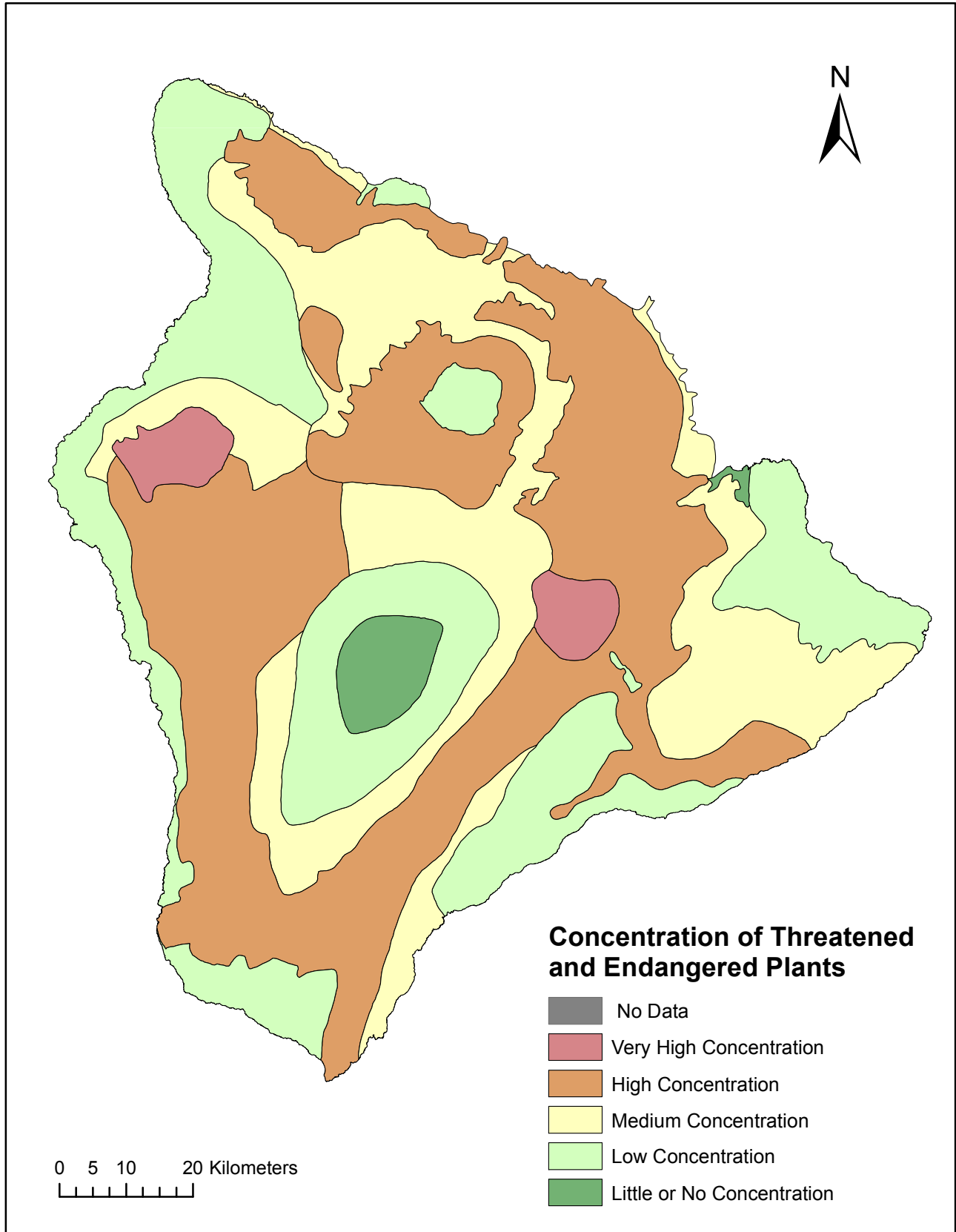
Flow Chart



Volcano Hazard Zones Island of Hawai'i

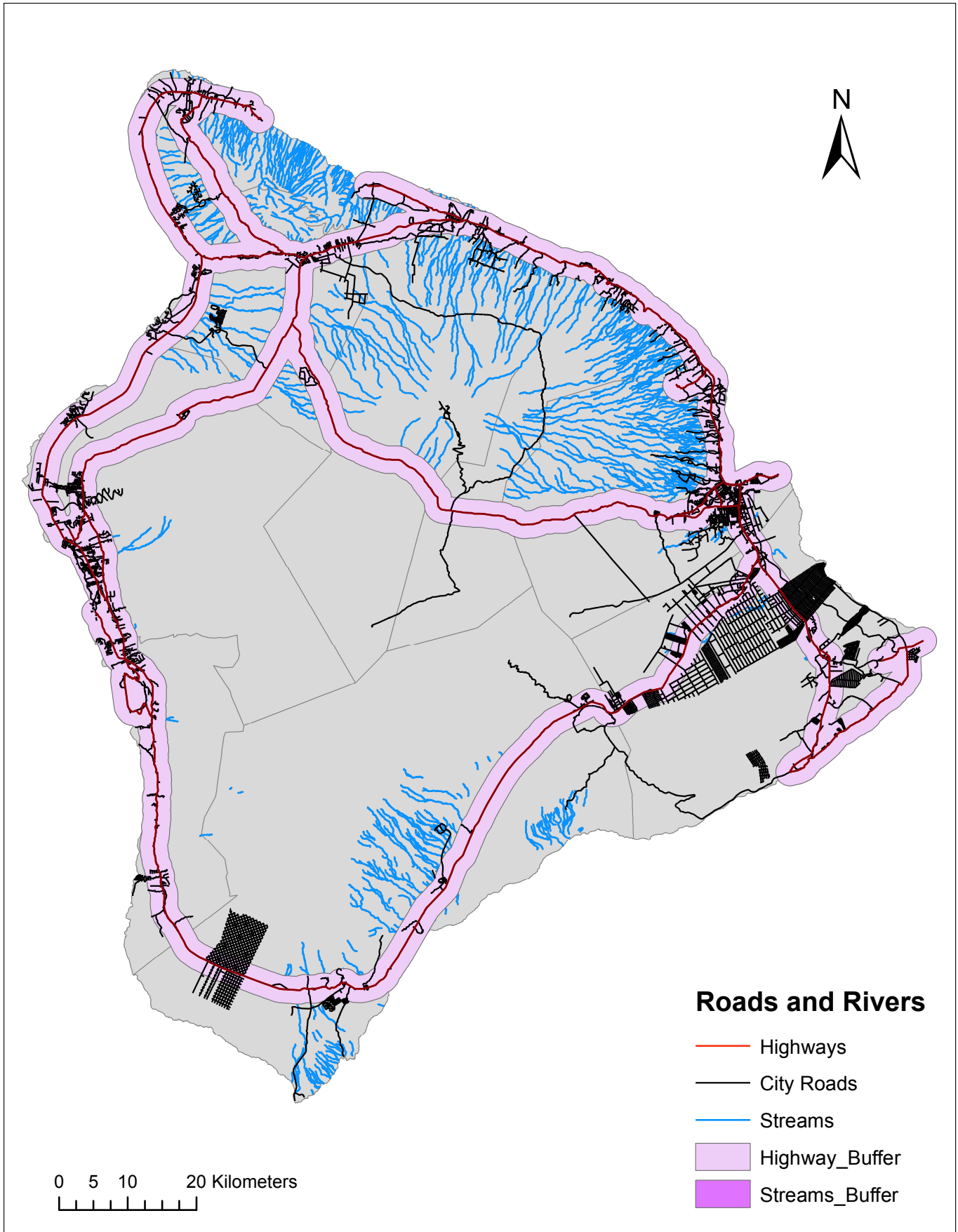


Threatened and Endangered Plants Island of Hawai'i

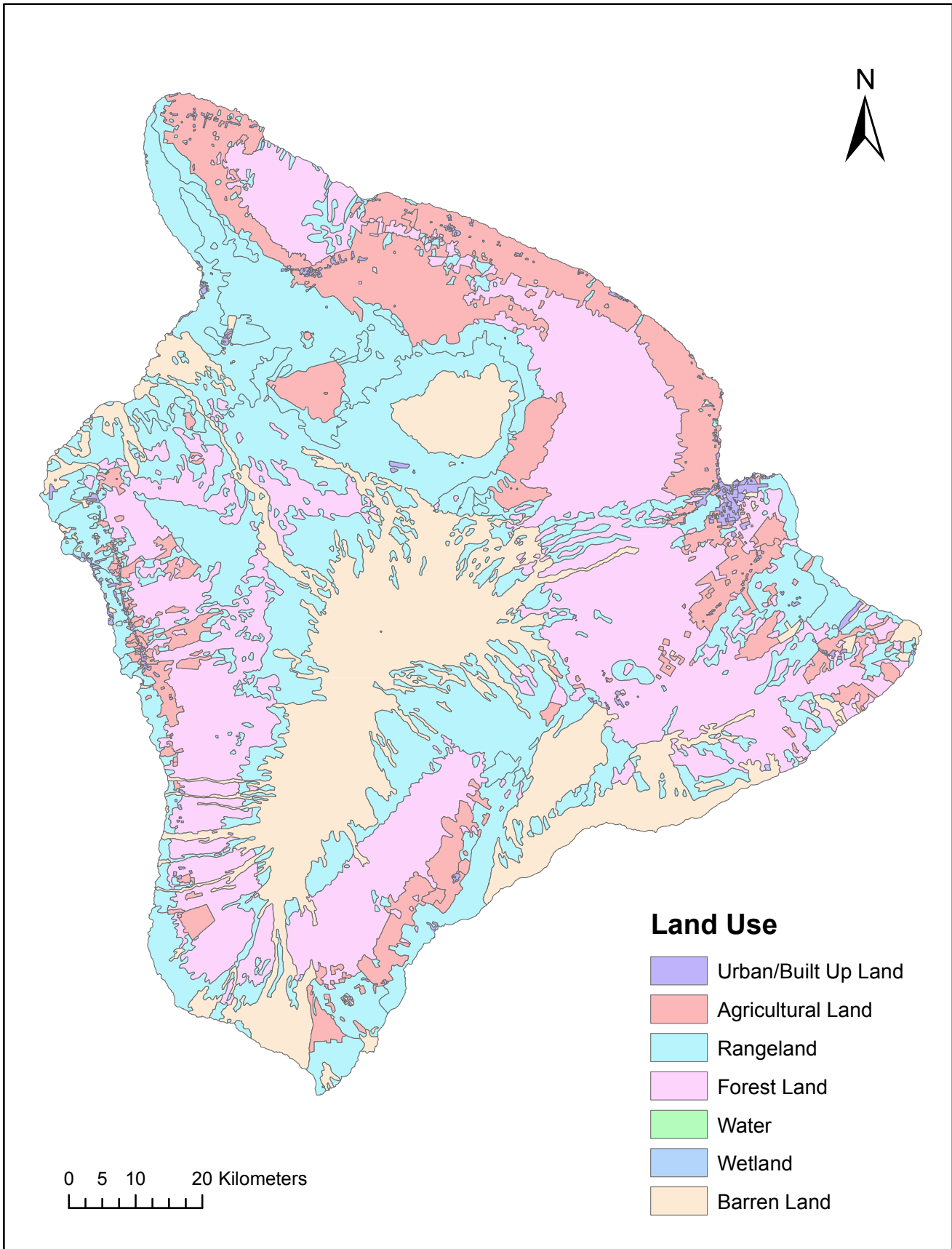


Source: State of Hawai'i Office of Planning

Roads and Rivers Island of Hawai'i

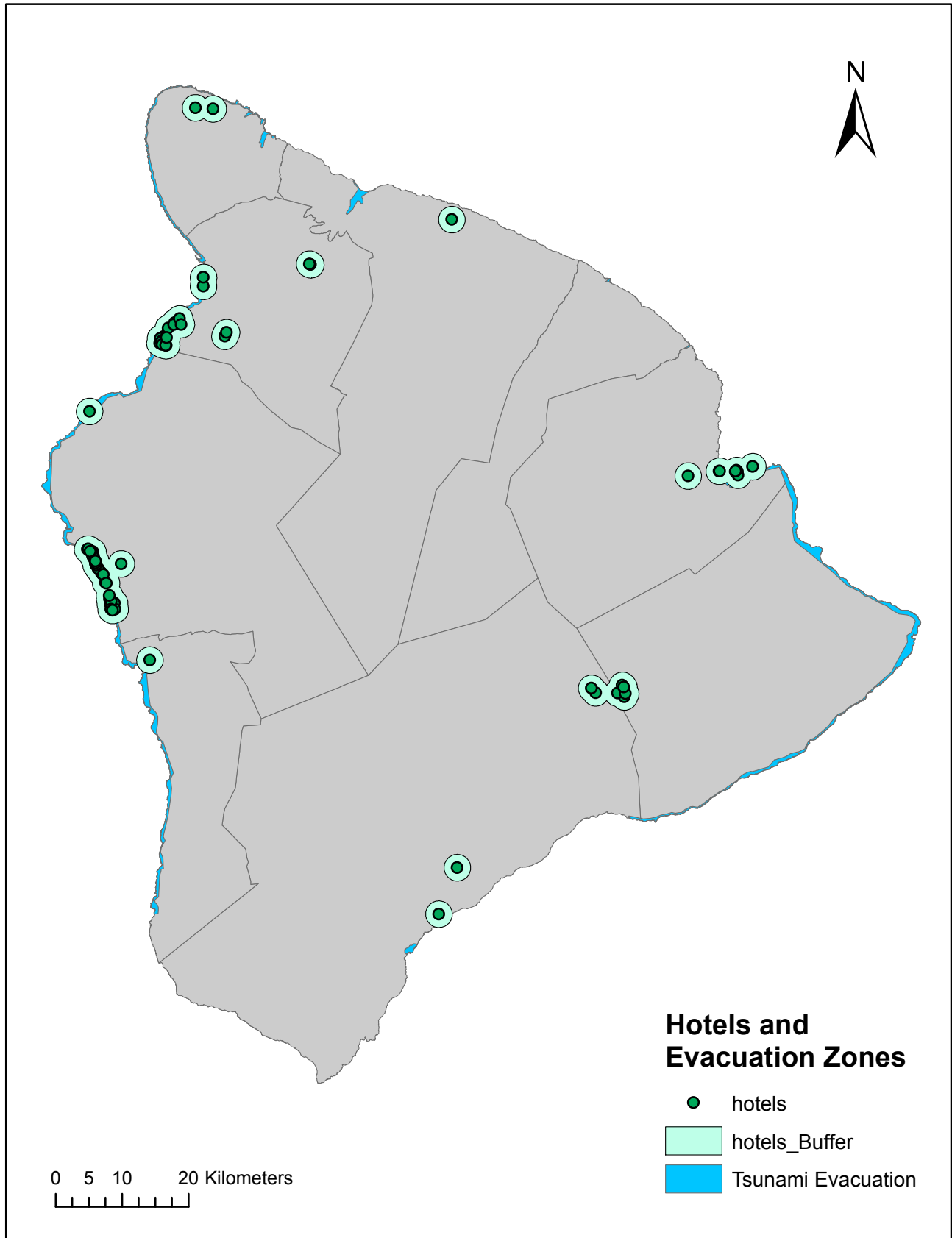


Land Use Island of Hawai'i



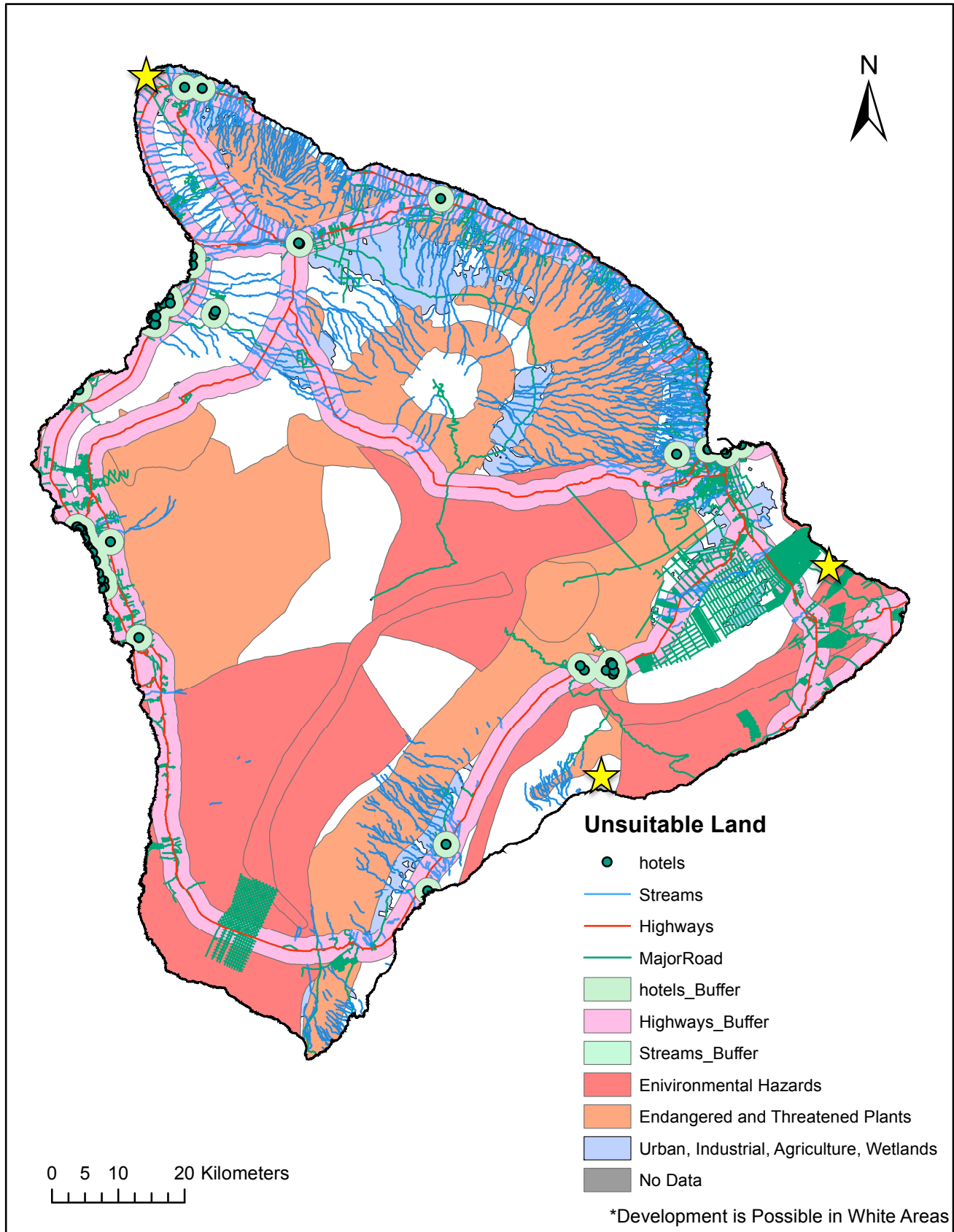
Source: State of Hawai'i Office of Planning

Hotel and Tsunami Evacuation Zones Island of Hawai'i



Source: State of Hawai'i Office of Planning

Land Assessment for the Development of the Pineapple Palace Island of Hawai'i



Source: State of Hawai'i Office of Planning

Bibliography

State of Hawaii: Office of Planning: <http://planning.hawaii.gov/gis/download-gis-data/>