Exploring the Spatial Relationship between Human- Tiger Conflicts in Peninsular Malaysia and Sumatra.

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ABSTRACT:

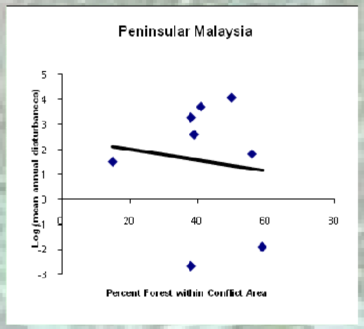
Large-carnivores and humans are increasingly in conflict as humans encroach on their natural territory. As a result, many large-carnivores species have become endangered due to habitat destruction, prey reduction and retaliatory killings from conflicts. No global internet database, however, exists to document, monitor and evaluate these conflicts, particularly to take advantage of the growing spatial resources available. Using human-tiger conflicts in Malaysia and Sumatra as a case study, this project explores how such a database could be created. GIS was used to conduct multiple analyses on the data obtained about these conflicts. We conclude that a database would require data to be compiled according to a protocol based on these spatial scales: Point, Sub-State Polygon and Provincial.

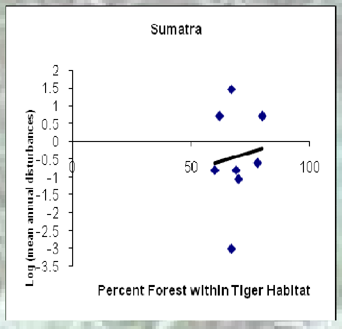
INTRODUCTION:

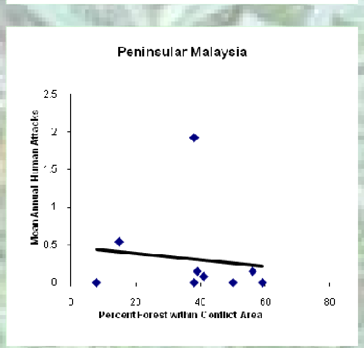
Peninsular Malaysia and Sumatra are home to two endangered subspecies of tigers: the Malayan (*Panthera tigris* jacksoni) and the Sumatran tigers (*Panthera tigris* sumatrae). The major factor in their declining population is human-tiger conflicts. Though there has been a significant amount of literature on the magnitude of human-tiger conflicts, analysis of conflict characteristics such as location, conflict factors, and type of attack are lacking (Nyhus and Tilson, 2004). With deforestation, poaching and retaliatory killings, it is no surprise that fewer than 400 of these individuals remain in the wild. However, no internet database exists to monitor, evaluate and give a spatial understanding of these conflicts in order to facilitate management and conservation efforts. Our project considered how such a database could be created and what some immediate challenges would be faced. We explored the forms of conflict data readily available to us and found three levels of spatial data: point, sub-state polygon and province-wide data as well as numerical data. We compared the levels of analysis using three hypotheses: a negative relationship between tiger disturbances (human attacks) and percent forest, a positive relationship between disturbances (human attacks) and percent edge and a positive relationship between disturbance and population density. From our results, we believe that an understanding of the advantages and limitations of different forms of data would facilitate effective data collection and documentation in a global database.

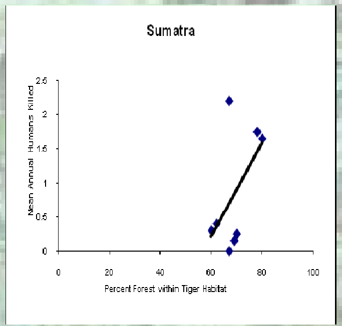
METHODS:

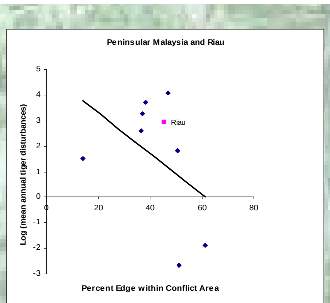
In Figure 1, we were able to separate Tiger Conservation Landscapes (TCL) polygons (Save the Tiger Fund 2007), which represent large areas of habitat with tigers, according to the different provinces in Sumatra. In Figure 2, human-tiger conflict polygons were digitized from a map obtained from the Malaysian Wildlife and Parks Department. Both of these processes were conducted in order to calculate the percent forest cover, compared to the total land use (European Space Agency, 2009), within habitat locations and conflict areas. Percent forest cover overlapping TCLs were also calculated in Figure 3.











From top left (clockwise): Figure a: Percent forest cover within conflict area in Malaysia vs. mean annual disturbance. Figure b: Percent forest cover within tiger habitat in Sumatra vs. mean annual disturbance. Figure c: Percent forest cover within conflict area in Malaysia vs. mean annual human attacks. Figure d: Percent forest within tiger habitat in Sumatra vs. mean annual humans killed. Figure e: Percent Edge within conflict area in Malaysia and Riau vs. mean annual tiger disturbances.

Table I: Specificity and Spatial Scales of Data Types.

Location	Specificity	Riau	Peninsular Malaysia	Sumatra
Spatial Scale of Tiger Conflict	N.A.	Point	Sub-State Polygon	Provincial
Percent Forest	Low	Yes	Yes	Yes
Edge	Medium	Yes	Yes	No
Population Density	High	Yes	No	No
Distance to Conflict	High	Yes	No	No

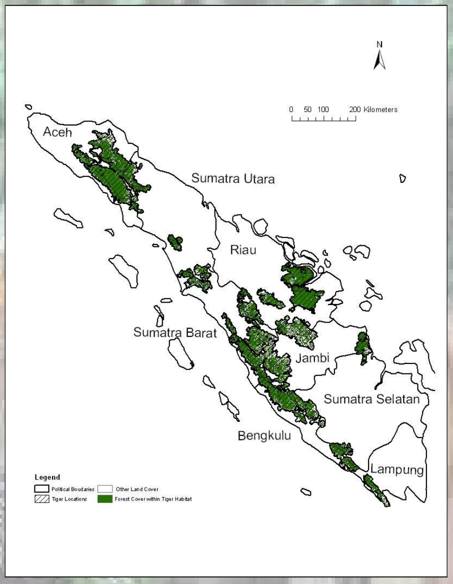


Figure 1: Tiger Location and Land Cover in Sumatra.

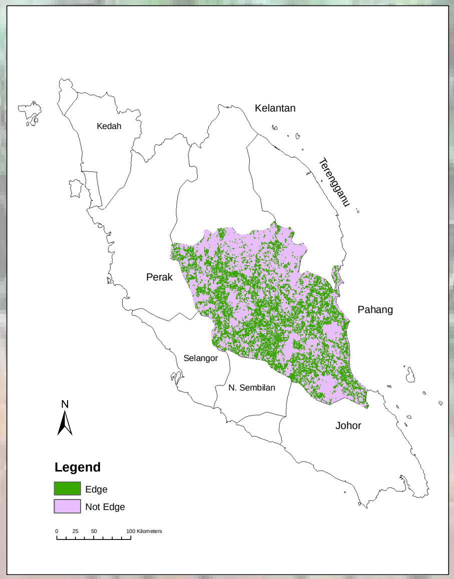


Figure 2: Forest Edge within Peninsular Malaysia's State of Pahang.

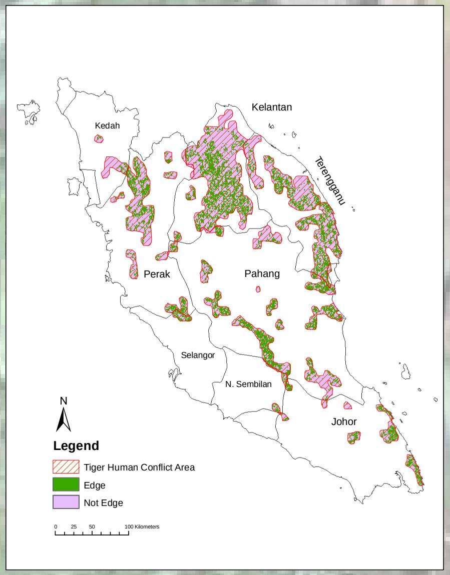


Figure 3: Forest Edge within Human-Tiger Conflict Areas in Peninsular Malaysia.

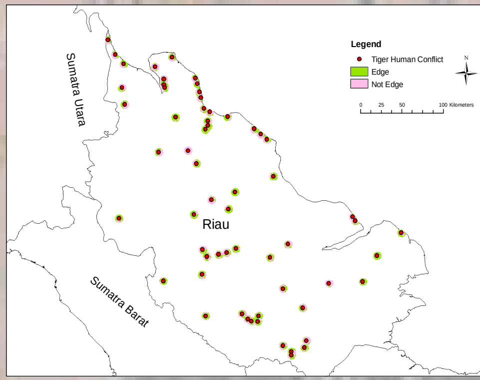


Figure 4: Forest Edge within a 5km Area of Human-Tiger Conflict in the Sumatran Province of Riau.

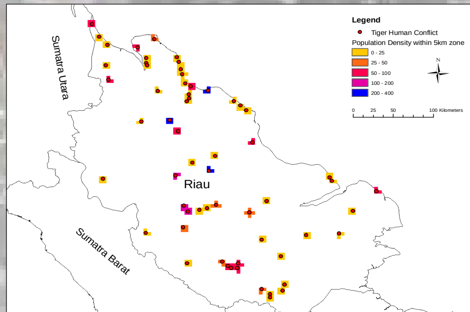


Figure 5: Population Density within a 5km Area of Human-Tiger Conflict in the Sumatran Province of Riau.

METHODS:

Furthermore, a 5km buffer was created around point locations of human-tiger conflicts in order to determine the mean population density (Columbia University, 2009) around each of these areas. Figure 4 represents the amount of forest edge in human-tiger conflict areas in Peninsular Malaysia. In order to determine whether a pixel is a forest edge or not, a neighborhood analysis was utilized in order to find maximum edge (1) and minimum edge (0) values. By combining these values, we determined that any pixel with an edge value of 2 is a true forest edge (an area that serves as a border between forested and non-forested areas). Similarly in Figure 5, zonal statistics were utilized in order to calculate forest edge within a 5km buffer zone of human-tiger conflicts in Riau (Eyes on the Forest, 2008).

RESULTS:

The graphs were constructed from spatial statistics and numerical data. We expected that higher percent forest would show lower tiger disturbances. Figures a and b show that only Malaysia reflects this relationship. We see the same case when comparing human attacks to percent forest (Figures c and d). A graph for Riau was excluded because it would show the same type of analysis. Figure e's negative trendline indicates a negative relationship between percent edge and disturbances. We could only perform a useful analysis of population density on Riau (Figure 5).

Table I describes the levels of analysis we carried out at each spatial order. We assumed population density to have a localized effect on conflict distribution and thus was classified as high specificity analysis. We classified edge as a medium specificity analysis since we assume edges to have less localized influence. We classified percent forest as a low specificity analysis since we assumed it would be most useful to look at the amount of forest over a large area since tigers have large territories. Table I shows that four types of analyses could effectively be conducted on point data, two on sub-state polygons and only one on province level data.

DISCUSSION:

The differences in scale of our data may offer an explanation to our results. Given that the spatial data for Malaysia allowed us to determine a more accurate distribution of conflict area compared to Sumatra, where we assumed conflict areas to be equal to the extent of tiger habitat, we were able to carry out a more accurate analysis in Malaysia than in Sumatra. Although the spatial analysis performed on Sumatra was within provinces we did not classify it as a sub-state polygon because the analysis was based on this assumption. This could also explain the positive trends in both analyses for Sumatra because a higher percent forest could simply imply a larger population of tigers causing more conflicts.

Spatial scale can also provide possibilities to explain the weak association between disturbances and percent forest cover in Peninsular Malaysia. For this region, we had both numerical state-wide data for tiger disturbances and attacks as well as outlines of tiger conflict areas. This afforded us a narrower range for analysis, although the limitations of our data forced us to assume uniform distribution of conflicts within the mapped conflict areas. Because tiger conflict areas are inherently point locations, this assumption perhaps, explains why only a weak relationship was obtained. For example, the results of our analysis show a negative correlation between disturbance and percent edge. Again, this was unexpected. Our assumption was that the more edge near a conflict area would increase the chances of conflict because there would be more chances of human-tiger interactions.

Although the relationship between forest cover and human-tiger conflicts in Sumatra were not evident, Figure 3 represents population density within a 5km buffer area surrounding specific human-tiger conflicts in the Sumatran province of Riau. We expected to find a direct relationship between population density and number of attacks. With 39 of the 62 attacks having occurred where population density was between 0-25 km², we can visually see that the more the population density increases, the lower the chance of human-tiger conflicts are to occur.

Table I shows a hierarchy of how useful different spatial scales are. Point data was most valuable because it allowed us to conduct low to high specificity analyses. Surprisingly, we were able to tease out more analyses from sub-state polygon data than anticipated which made it more useful than province level data. Province level data only permitted low specificity analysis. For example, although population density data was available for Peninsular Malaysia and Sumatra, it was not incorporated into our analysis because the calculated mean population density within a sub-state polygon or province level added no value. Point data allows us to calculate distance to conflict because its high specificity.

Interestingly, most conflict data was aggregated provincial data and thus, was limited to low specificity analysis. Because of this, we were forced to assume uniform distribution of conflicts when using this data for other analyses. Supplementary data such as conflict distributions maps (Malaysia) allowed us to refine the spatial scale of this data but the assumption was still applied within this area. This caused high uncertainty in our results.

CONCLUSION:

Exploring relationships between human tiger conflicts in Peninsular Malaysia and Sumatra with ArcGIS was difficult because of spatial data availability and the incompatibility of different spatial scales of this data. For example, we were unable to obtain basic spatial data due to high costs or restricted access. The scale of data that we did obtain dictated what would become the geographical scope of our analysis rather than the scope we wanted to study. Using Malaysia and Sumatra as our examples, we were able to understand the advantages and drawbacks of each spatial scale as depicted in Table I. Therefore, we suggest that a global database compile and manage conflict data based on the identified spatial scales. This will clearly present the types of analyses that can be conducted on current data as well as highlight existing data gaps that prevent us from analyzing conflicts based on variables of different spatial scale.

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