

Spatial Assessment of Potential Conflict of Sun Bear- Human Based on Landscape Ecology in Pasaman

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ABSTRACT

The sun bear is conservation mammal in Indonesia. The ecological problems as conflict among mammals and human often happen around wildlife, the one of the case is the conflict between sun bear (*helarctos malayanus*) with human. In Pasaman where around the anthropogenic landscape is bounded by natural forest as sun bear habitat. In this decade, the story has recorded about ± 16 incidents. The aim of this research is to geospatial modeling the area of potential conflict between sun bear- human. The method in this research is to use natural logarithmic and regression logistic. The tool is geographical information system and maximum entropy. The result of this research, there has found the distribute energy each variable landscape ecosystem. The statistical model of the potential conflict it has spread on landscape ecosystem. The average value of AUC prediction in this model is at number of 0.91. The variable contribution which affect are forest edge at number of 39.2%, the alternative food (plantation) at number of 31.4%, and forest fragmentation at number of 16.9%.

Key words. Sun bear, ecosystem, habitat, spatial modeling.

1. Introduce

IUCN has categorized the sun bears are 'vulnerable' species by the of red list species (IUCN. 2019; Fredriksson. 2005). The *Helarctos malayanus* is one of big mammals in rain forest (Wong. 2004). The sun bears are found at low densities throughout *dipterocarp* and the lower mountain forests, from 0 to 1350 m in elevation (Davies, Payne 1982). It is the smallest of the eight extant bear species. Adults are about 120–150 cm long and weigh 27–65 kg (KLHK. 2019). The sun bear has been observed that they are actually diurnal, being active from just before sunset until two hours after sunset. The bears seem to rest during the hottest hours of the day (10–14h) (Fredriksson. 2012). The generally the large bodied mammal and sun bear often focus in area where food sources is available (Wong. 2012). In the natural habitat the sun bear is "omnivorous" species, with a live circle as principal diet as a largely consisting of fruit, ants, earth worms, bee honey, beetles, larvae, termites, and occasionally small animals, mushrooms, flowers and succulent plants (Wong. 2004; Fredriksson. 2001; Augeri. 2005; Perdude. 2016). When agricultural and plantation expansion the large-bodied mammals through rapid has unmitigated (Wong, Linkie. 2012). In wildlife area, the sun bears are often threatened by human activity, they hunted by human including harvesting for ingredient of traditional medicinal (Perdude, Bonnie. 2016). The conflict among human with mammals is often in transition area, when the mammals crossing plantation and disturbing primary necessary for human live. The

conflict case gives negative impact to both of them (Gunawan et al. 2011). The reduction of natural habitat and available food for these wildlife species can force the wildlife to live closer to human settlements where they enter to forage consequently, wildlife living in the proximity of human increases human and wildlife interaction augmenting the potential for conflicts (Woodroffe et al. 2005). The threat posed by deforestation tends to disproportionately affect large-bodied mammals because of their large range requirements (Liu et al. 2018). In Asia there are Malaysia and Indonesia are the world leading exporters of tropical hardwoods, which originate in sun bear habitat. Although to harvest the trees there has regulation to selective logged, the forest also convert to anthropogenic area such as human settlements, agriculture, rubber and oil palm plantations (Wilson et al. 1982; O'Brien et al. 2003;). That sun bears exist only in primary forest as none were found in logged forests (Wong. 2004).

More than one decade in Indonesia the land expansion for oil palm plantation is un-control. It gives impact to wildlife and disturbing for biodiversity. More impact of expansion the oil palm plantation is the lost habitat, lost animal population. Threatened to animal right is truly important to mitigation conflict area among animal – human. The animal right as movement did not give stream to the rights like the role has happened in human life. The animals do not have characteristic, they don't have intelligence like human. The animal can't to speech and demonstrated to defenses they home. The animal right is not role to make animal be the same

position with human, but it to protecting balance of nature (Kamim. 2014). Nevertheless, the generally the common peoples in Pasaman West Sumatra belonging antagonistic views towards the sun bears causes this animal attack the fruits tree. The sun bear kills the coconut palm by taking out the heart, whereas other animals such as sus scrofa/pig forage attack on annual crops. This argument as contrast as the reasons why peoples often attacking animals (Windler. 2014).

The modern technology for assessment potential conflict among animals – human is Maximum Entropy. This technology can to predict probability of present data to describing area will take same affect with same

variables. Maxent is collaboration spatial analysis and statistic to approach estimates the most uniform distribution sample (maximum entropy) it has compared to background locations given the constraints derived from the data (Phillips et al. 2006). Therefore, a relaxation component, called regularization, has been added to Maxent modeling to constrain the estimated distribution thereby allowing the average value of each sampled variable to approximate its empirical average but not equal (Phillips, Dudik. 2008). The importance output of Maximum entropy to create regulation of the area is the map probability. The map can to describe the distribution and variation from this modeling on the land.

Table 1. Information for 10 study used maximum entropy for modeling sun bear, habitat and biodiversity

No	Researcher	Year	Location	Object	Total variable
1	Nazeri M	2012	Malaysia	Sun bear	15
2	Abidin Z K	2019	Malaysia	Sun bear	11
3	Radnezhad H	2015	Shiraz city	Gazelle	15
4	Kumar S	2009	New Caledonia	Canacomyrca monticola	10
5	Pranata S	2019	West Sumatra	Ravlesia	7
6	Elith J	2010	Western Australia	Banksia prionotes	4
7	Dermawan A B	2018	Baluran National Park	Acacia Nilotica	6
8	Phillips J Steven	2006	South America	Bradypus Variegatus	21
9	Boubli JP	2009	North Western Amazone	Cacajao, Chipotes israelita	23
10	Aryal Achyut	2016	Himalaya	Snow Leopard	9

There are many researcher has applied maximum entropy to many case in wildlife, habitat, ecosystem, species distribution and biodiversity. Recently, conflict between sun-bear and human often occur in Pasaman, there are many causes of this accident. The aim of this research is modeling the potential conflict zone between sun bear – human using geospatial technology and measuring the contribution each variables, to understand what the ecological problems which gives high effect to this problem.

2. Materials and Method

2.1 Study Area

This research is located at Pasaman Regency, West Sumatera Province, Indonesia. The one of area with recorded story about conflict of sun bear and human caused by many reasons. This area with geographical condition of bounded by mountain and hills, the natural forest spread around this place.

2.2 Data

To analyze the data used: the history of the sun bear conflict from the (BKSDA) Natural Resources Conservation Agency, West Sumatra, the satellite images Sentinel 2A from USGS, infrastructure data spatial from the (BIG) Geospatial Information Agency.

2.3 Analysis

2.3.1 Transformation Euclidean Distance ($ed'n$)

Euclidean distance is euclidean geometry based on the concept of distance. This is useful in several applications (Liberti. 2012). The transformation of

euclidean distance is computed from the feature map (Krinidis. 2011). In spatial analysis the euclidean distance has used to measure the distance of each environmental variable in the maximum entropy model (Nabout et al. 2010; Wilson. 2011; Hadieres Nielsen. 2020). Previous researchers used original values of Euclidean distance. The difference in this study is that we make changes to the standardization of euclidean distance values with natural logarithms (ln). We has changes the value of the euclidean distance with the equation ($ed'n$). Where the center of the source has a major effect on the environment and while getting away from the source the value is getting weaker. The variables will estimate the distance value using distance ($ed'n$) transformation. The distance represented by (ed) is massively. There has to be considering the natural effect to around ecosystem is not massive. We must to transform the (ed) to be natural effect using logarithmic natural (ln), this (ed) will transform to euclidean distance natural ($ed'n$) equation:

$$ed'n = (Max\ e'd + 1) - e'd$$

$$e'd = ln(1 + ed)$$

Where:

ed : input parameter (euclidean distance)
 ln : logarithmic natural
 $e'd$: output from logarithmic of ed
 $Max\ e'd$: maximum raster of $e'd$
 $e'di$: transformation of euclidean distance for input parameter.

Where (*ed*) is euclidean distance each variables such as forest edge, plantation, forest fragmentation, habitat patch, and river. These variables will process by *ed'n* equation.

2.3.2 Maximum Entropy (MaxEnt) Modeling

Empirical measurements of the interaction among geographical areas where predicted from empirical spatial interaction data by inverting models which contained spatial separations as one of the explanatory variables (Tobler. 2006). To predict habitat or prediction of sun bear conflict areas (Nazeri et al. 2012; Abidin et al. 2019)

using many variables in MaxEnt modeling. Referring to the concept has described about relationship landscape problems for mammals (Fredrikson. 2006; Prasetyo. 2017; Gunawan, Prasetyo. 29). In this research we update the variables used to the predicting of conflicts that we refer to the conceptual landscape ecological problems, where these variables have differences with the variables used by previous researchers. The table two is list of the variable used in this model. According several researchers this environmental variable where it has strong relationship by the conflict incident.

Table 2. Environmental variable for conflict modeling

No	Variables	Data Sources	Type
1	Forest Edge	Calculate <i>ed'n</i> data set	Continuous
2	Forest Fragmentation	Calculate <i>ed'n</i> data set	Continuous
3	Crop Land/Plantation	Calculate <i>ed'n</i> data set	Continuous
4	Patch Habitat	Calculate <i>ed'n</i> data set	Continuous
5	Slope	Calculate SRTM Imagery	Continuous
6	Rivers	Calculate <i>ed'n</i> data set	Continuous
7	Residential	Calculate <i>ed'n</i> data set	Continuous

The logistic format was used to interpret the model output. It ranges from 0 to 1, where 1 indicates the highest probability of species presence corresponding to the particular predictor variables. The percentage contribution value is counted by the increase in the gain of the model (Abidin et al. 2019; Baldwin. 2009). MaxEnt excludes each variable alternately during the run. The output of this tools contains importance information suc as the quantity of prediction or Area Under the Curve (AUC) and performance of each variable, and contribution variable influences the predictive model (Phillips, Anderson. 2006; Nazeri et al. 2012; Abidin et al. 2019). The range of AUC value is generally from 0.5 to 1; 1 where the indicates the perfect fit of the model, whereas a value close to 0.5 is a fit no better than that expected by random distribution. The interval of AUC with respect to model performance as <

0.7 (poor model performance), 0.7–0.9 (moderately/useful), and > 0.9 (excellent) [29][30].

3. Results and Discussion

3.1 Environmental Variables (*ed'n*)

The graphic illustrate the transformation of raster value each variable Euclidean distance used (*ed'n*) equation in this research. The raster value of original euclidean distance on sources area is 0 and it gradually increase to flowing away from raster sources. The line of (*e'd*) is transformed from original data to be logarithmic natural (*ln*). This raster value of trasformed euclidean distance data dramatically increase in half of total distance, this line graph follows the natural effect of ecosystem. Nevertheless, (*ed'n*) equation transformed the raster value of (*ed'n*), where in variables sources reversed to highest value. The sources of the variable should have higher energy (value) because it as the center and spread affected to environmental around this variables.

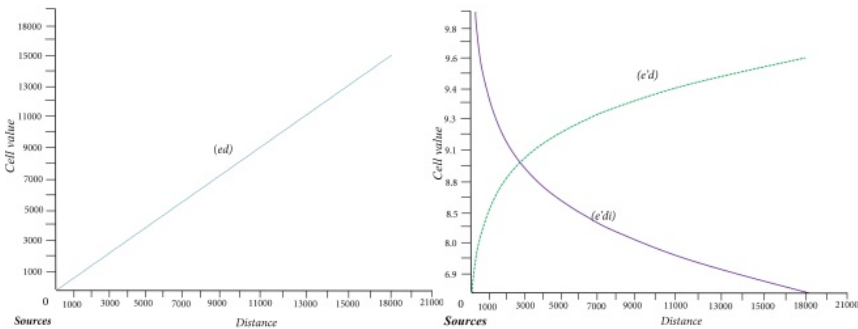


Figure 1. Graph of transformation raster value used *ed'n* of variables modeling

The figure 2 presented the present data as point conflict and result of each (*ed'n*) variable landscape ecosystem for modeling. In the first map namely forest edge is the clearly area of forest boundary, it has given high

influence to habitat around this places. The difference effect is reveal by each map, the forest fragmentation and habitat patch spread in this area, the patterns is not crowded like map of plantation.

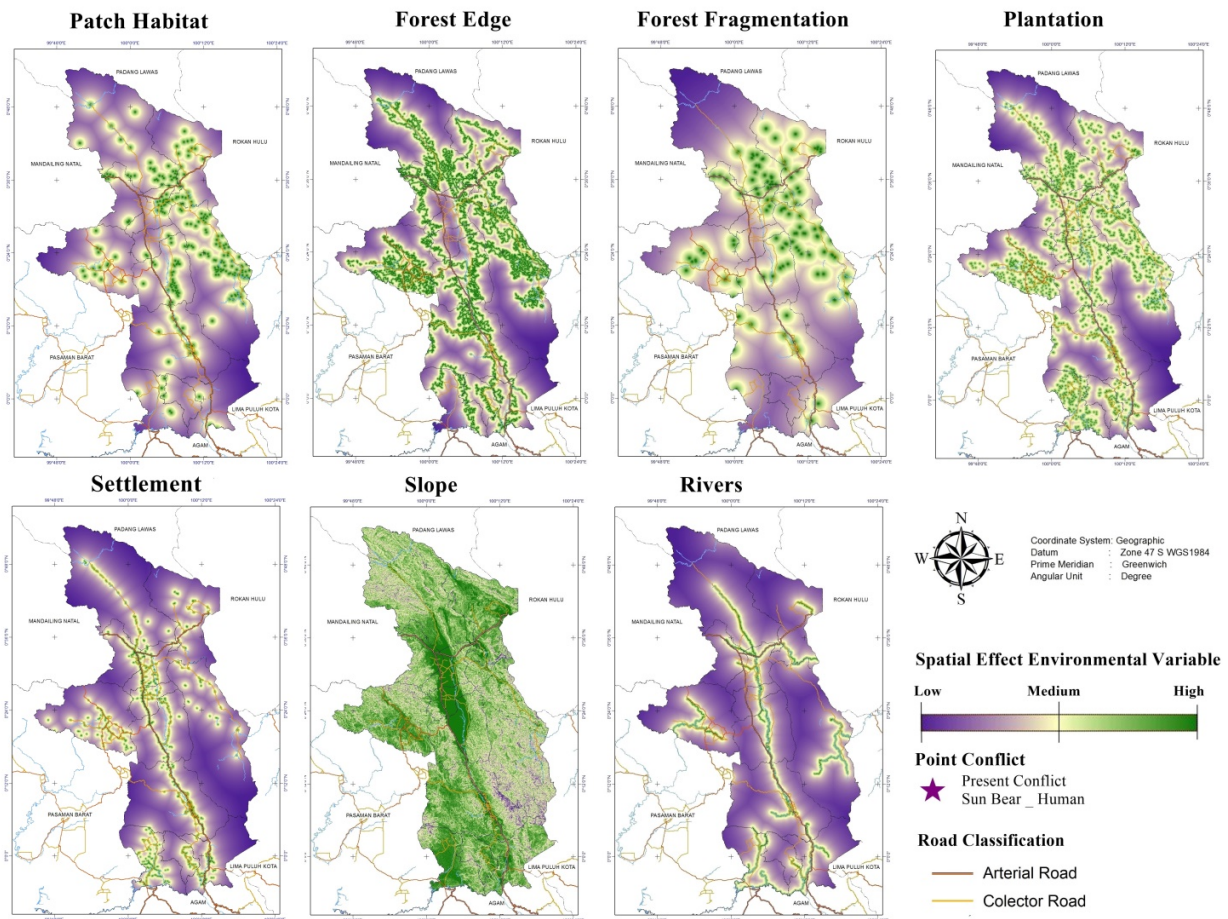


Figure 2. Environmental variables

The highest value from all of raster revealed by purple color and lowest by green. High value in center of variable it has dropped gradually to location around this place. It's mean the energy each landscape ecosystem is strong around center area. When the variable connected is describe the spatial connection. The each variables will integrated in spatial modeling MaxEnt wher the strong area give high influence to conflict and the purple area low energy to support the incident.

3.2 Modeling Potential Conflict

Apply the spatial modeling. There will knows how the spatial interaction among landscape ecosystem the variable to support to identified potential conflict sun bear-human. The spatial analysis to modeling of

potential conflict has used Maximum Entropy. In this process, we used regression logistic as logical for prediction data with 25 random test percentages. The independent variable is the recorded story of conflict by point data in meter coordinate unit. Dependent variable is *ed'n* of forest edge, external food, forest fragmentation, habitat patch, and distance from rivers. The one of many information of this modeling is statistic report. The graphic result of modeling potential conflict sun bear-Human is the representation how the sensitivity and specificity of the effect variable in this model. Result of this modeling there has found the average of training AUC for the replicate runs is 0.9 where perform of this model is excellent, and the standard deviation is 0.030.

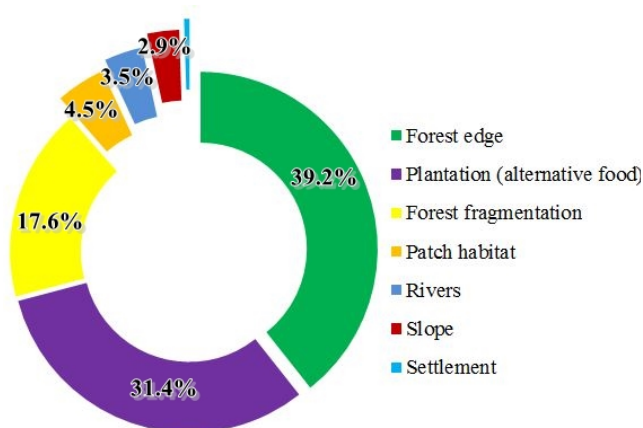


Figure 3. Variables contribution

From this modeling we could observe the variable in high contribution for this modeling. The contribution variable has showed in table 2. The table reveals percent significant contribution of each variable in this model. Overall the each variable landscape ecosystem exposing spatial interaction, it will influence to potential conflict. Forest edge gives biggest contribution in this model. The beginning, the forest as the habitat for sun bear support this model, forest edge contribution is dominant with proportion of this model at number of 39.2%.

Plantation areas may provide the alternative food to the sun bear. It will direct to sun bear movement. This variable contributes with the proportion of 31.4%. Nevertheless, the forest fragmentation gives contribution of 17.6%, this condition where the natural forest has patch disturbance in landscape matrix. Habitat patch contribution at number of 10% has distributed in many locations because this habitat separated from core habitat. The percentage of variable can we absorb as how the spatial interaction among the variable landscape ecosystem to the point conflict.

The last, the result of spatial modeling is a map of potential conflict sun bear –human, the map reveals the area of potential conflict in high to low potential. The map reveals distribution of potential conflict sun bear –human in Pasaman. The area has distributed among natural habitat, semi natural habitat and non-habitat. Overall the potential conflict spread in this area. The conflict pattern is following forest edge, alternative food, and forest fragmentation. There is strong relationship among habitat problems in sun bear conflict area, the problem with the landscape management. The forest disturbance it caused by fragmentation. It transformed land function from natural to semi natural. It caused negative effect such as the problems of the suitable habitat.

Table 4. Distribution of Potential Conflict in Pasaman

No	Sub-District	Potential Conflict (%)			Conflict/area (%)	Land scape ecosystem/ area (%)		
		High	Medium	Low		Forest	Plantation	Agricultural
1	Bonjo	1.4	33.8	64.8	35.1	78.7	10.5	0.3
2	Dua Koto	4.0	52.4	43.6	57.8	82.2	10.7	0.2
3	Lubuk Sikaping	2.6	44.0	53.4	42.6	83.6	6.9	1.3
4	Mapat Tunggul	5.2	38.5	56.3	51.1	57.6	7.7	0.6
5	Mapat Tunggul Selatan	7.7	52.4	39.9	48.4	80.0	9.0	0.8
6	Padang Gelugur	0.7	32.0	67.3	32.8	22.1	18.6	0.4
7	Panti	4.1	39.9	56.0	59.2	66.3	7.8	0.3
8	Rao	3.6	36.4	60.0	54.0	48.8	34.4	0.3
9	Rao Selatan	7.3	41.9	50.8	57.0	24.8	17.4	1.6
10	Rao Utara	5.0	39.2	55.8	33.8	81.3	7.7	0.2
11	Simpang Alahan Mati	0.1	21.9	78.1	50.6	69.5	18.9	0.5
12	Tigo Nagari	0.8	24.3	75.0	29.3	35.1	36.6	1.4

From the table 4, we can observe distribution of potential conflict at sub district in Pasaman. Where total conflict zone in percentage it has compare with percentage of forest, plantation and agricultural area. The

administration sub district Duo Koto, Mapat Tunggul, Simpang Alahan Mati and Panti by the conflict zone more than 50%, however the forest cover around more than 50% and plantation area more than 7%. Despite of this,

sub district Mapat Tunggul Selatan, Lubuk Sikaping, dan Rao utara it belonging potential conflict up the 30% by forest area more than 80%. Nevertheless, Rao Selatan has

potential conflict at number of 57% with forest percentage 24% and 17% plantation.

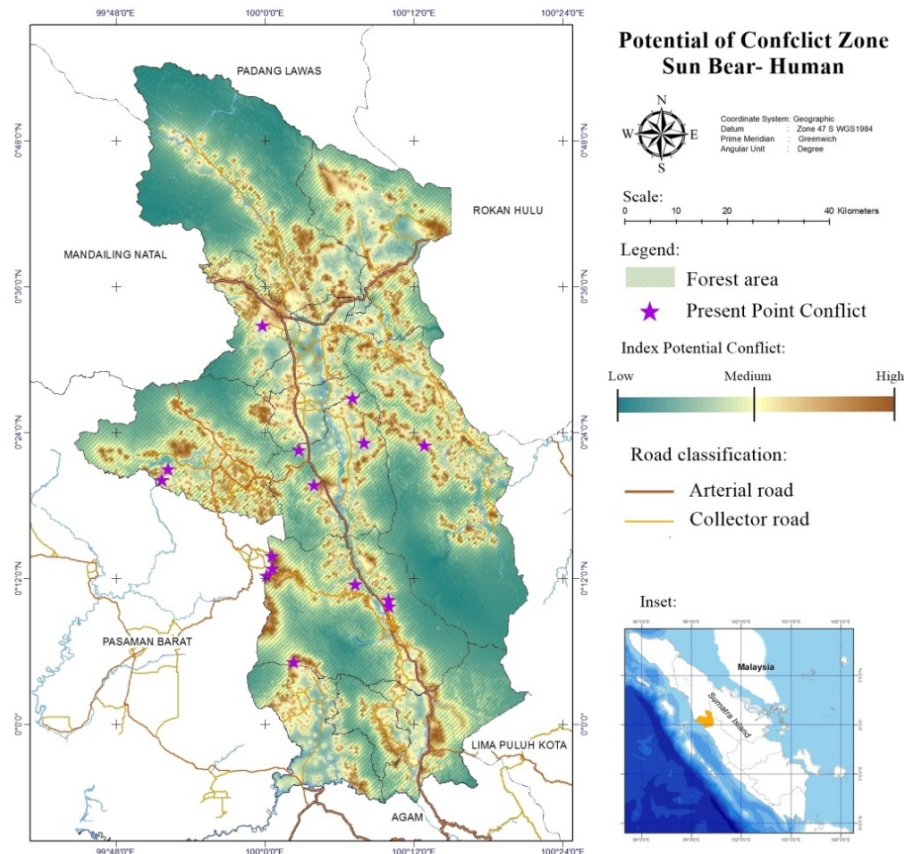


Figure 4. Potential Conflict Zone Sun Bear - Human

3.3 Discussion

By the using the standardization of euclidean distance values with (*ed'n*) there has taken result of modeling more realistic with actual geographical condition. The conflict pattern is not massively but following indicator and variable. There has reveal how affect interaction among ecosystem to support conflict incident. Where, forest edge variable is truly affecting to patterns and distribution area of potential conflict sun bear- human. Where the forest edge is boundary between forest to other landscapes ecosystem. This transition area surrounded boundary (forest edge) has strong connection with plantations. The reasons the sun bear easy to move from the edge forest to plantation. The plantation provided alternative food it is the second strongest contribution. Plantation is the significant variable in this model it gives seduction to sun bear, because in this plantation area there are availability of tree and fruit plants as food sources such as the prime is bud palm, and

small worm. Augeri (2005) The sun bears do not migrating, but the home range crossing season directed to food sources. Such as during local and fruit season and mast fruiting or when shifting to alternative food and diversity are highly important for sun bear necessary a like nutritional for them health. Usually, the sun bear has crossing and tracking the plantation areas at night and returns to forest edges during the day (Normua. 2004)..

Despite of the fragmentation, the land expansion is the reason of patch habitat. This model has reveals about the small size habitat and sprawl in area influence the circle of sun bear movement. It has been increasing the barrier of ecological connectivity related to threat of conflict between sun bear- human. Where sun bear habitat it has separated by semi natural and other landscapes. This condition push the sun bear to cross the semi natural habitat and plantation, tracking through agricultural area to look for food and migrate because the food sources in small habitat are unable to support the sun bear necessary

to life. In this movement from patch habitat to core habitat by crossing plantation, where in this area has availability alternative foods such as tree and fruits. In this research the human activity in land expansion to open agricultural and plantation is vulnerable to conflict in transition area (forest edge). From the patch habitat and isolation area, the sun bear will do crossing anthropogenic and semi natural area in Pasaman. Sethy (2012) In some cases, species may not depend on in these patches, but merely use them for food or temporary shelter. While large mammals like sun bear is unable to survive in small size of fragments habitat. The landscape dynamics influence the natural habitat it has given impact within isolated patch and disturbing ecosystem connectivity. The importance one as component of sun bear to survive most animals is the ability to access suitable habitat, food, mates, vegetation cover, security, and home range to across landscape (Augeri. 2005).

Fragmentation effects to isolation habitat patch, edge effects, can independently and synergistically influence the availability and abundance of critical resources, as well as competitive and density-dependent interactions for those resources. IUCN (2019; Augeri. 2005) The essentially, sun bear distributions in these sites are patch habitat and fragmented across the landscape matrix. Effects of habitat loss in the spatial distributions, isolation, and between-patch interactions of flora and fauna assemblages in a landscape may depend on organism biology, but sun bear movements across edges. As conservation biologists, building functional ecological networks habitat patches of sufficient high-quality and, simultaneously, efficient linkages allowing individual transfers among these habitats (Baguette. 2012).

The human activity to expansion area for semi natural, plantation, agricultural and anthropogenic is response this conflict. The map of potential conflict sun bears-human in Pasaman, it has reveals the distribution and index conflict zone on many landscape. (Fredrikson. 2005) Some studies has reported the incidence of sun bear conflicts within oil palm and mixed plantation areas. Most conflict cases reported in the plantation area is around forests (Normua et al. 2004; Baldwin. 2009). Sun bears conflicts are concentrated at the forest edges and plantations nearby. It must be direct for management and conservation plan at this region is needed to move (Normua et al. 2004; Fletcher, Fortin. 2018). Potential of conflict was high in transition areas close to the forest. These human disturbances the forest area to develop plantation, it can prevent access to productive forage

areas, reduce the abundance of key ecosystem resources and availability fruit productivity and distribution (Normua et al. 2004; Wong, Matthew. 2012). In wildlife the forest edge as interior has detected potential on mammals. There is more vulnerable (O'Brien. 2003). The land competition is highly-contrasting around forest edges and fragmentation. It can force an organism to reduce home range if animal I variety of patches habitat, because from some patches to movement between them will be less preferred or profitable (Augeri. 2005; Weiskopf et al. 2019). The deforestation gives threat to tends to disproportionately affect large-bodied mammals, because they have large home range. This competition for land resources between people and animals and predation of animals on humans and the other way around, i.e. hunting, are important aspects of the conflict potential (Rude, Roper. 1997; Mattso et al. 1996). The increase land competition to because human un-control land development. The land expansion from natural to be anthropogenic or semi natural is has altered is massive to develop for plantation. This activity gives real treatment to habitat as dropped habitat capacity (Hanif et al, 2017, 2019).

Effective conservation actions should thus not only be focused on protecting their natural habitat and enhancing the connectivity of sun bear populations, but also curtail the illegal trade of sun bears and their derivatives (Hanif et al. 2019; Kangabam. 2019). The Size of habitat patches and so metrics that incorporate the area of the patches should be considered (Gunawan, Prasetyo. 2013; Rahman et al. 2020). The comparison among conflict percentage by the forest and plantation is linear. The dynamic total of percent of forest has followed by conflict zone. When the percentage forest is so large the conflict zone is small. However, we had found unique data when we divided conflict zone to three classes. Not all of area by forest percentage on large area more than 50% belonging potential conflict in class high by small area, however many of sub district has covering by conflict in class high by large area. Nevertheless, there are many area sub-district has covered by forest percentage less than 50% belonging potential conflict in class high in small size. From this data we take inference, the ecosystem on the land is unity. To handling conflicts can't be done based on administrative boundaries, but through a cluster of ecosystems that are interconnected, have connection and interacting. There with known of potential zones of bear conflict. The institution and sector that has the power and rescue to sun bears, by conflict

management strategies in the spot conflict areas. The weakness in this research is the conflict data is not completed because we only using the legal data from government.

4. Conclusions

From this model, where has estimated the spatial interaction among variable of type of landscape ecosystem. The variation of matrix ecosystem has connection and influence potential conflict of sun bear-human. The spot zone of conflict in transition area around forest edge, and plantation because from this place the sun bear could easily do the movement to find alternative foods in plantation area. To recue conservation mammals like sun bear, for management conflict of sun bear-human, we can't to do by administrative area because the land ecosystem is unity. The ecosystem has cluster and connection.

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