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Coexistence Study Between Wildlife Keystone Species And Darajat Geothermal Power Plant in West Java, Indonesia

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ABSTRACT

Human activity is inevitably impacting the environment in every environment component including air, water and soil which potentially affect biodiversity. Considered as renewable and eco-friendly, geothermal power plant would still potentially impact the environment including the biodiversity that lives in it. The objective of this paper is to study whether the wildlife could possibly coexist with Darajat Geothermal Power Plant which is located within Taman Wisata Alam Gunung Papandayan (Nature Park), Garut Regency, West Java, Indonesia. The objects for this study are the keystone species at Gunung Papandayan Nature Park which is javan leopard (Panthera pardus melas). Javan leopard is reported to be elusive and rarely seen near the power plant. To confirm the existence of javan leopard near Darajat Geothermal Power Plant facilities, Star Energy Geothermal Darajat II, Limited (SEGD) initiated wildlife monitoring around the facilities with cruising method and camera traps. The result of this study shows that Javan leopard was able to adapt and uses geothermal fascilities such as steam pipeline inspection pathway, suinactive wellpad and roads. This study indicates that the keystone species at Gunung Papandayan Nature Park can adapt and coexist with Darajat Geothermal Power Plant

1. INTRODUCTION

The trends of increasing temperature due to global warming are keep growing up. The main cause of global warming is the emission of greenhouse gasses produced by anthropogenic activities specifically activity that uses huge amount of fossil fuel (Mukhopadhyay, 2013). Therefore, the development of renewable energy has become global concern. Geothermal power is a renewable energy resource that has attracted significant and continued investment with a forecasted growth of 28% power generation capacity (approx. 4GW) between 2018 and 2023 (IEA, 2018; Ng et al., 2021). However, increases in renewable energy infrastructure can also be associated with negative impacts on habitats and species (Ng et al., 2021). There is a numerous overlap between renewable energy facilities and important conservation areas that potentially compromise the goals of biodiversity conservation (Rehbein et al, 2020).

Indonesia is a mega biodiversity country, blessed with abundant geothermal energy potential. With great potential to utilize renewable geothermal energy there is also potential threat of negative impact on biodiversity. A geothermal power plant in Darajat as an example is located at Gunung Papandayan Nature Park area that has high biodiversity. The latest research suggests that at least 101 species of birds, 15 species of herpetofauna and 24 species of mammals including endangered species such as javan surili, dhole and javan leopard found in this area (Junaid and Fariz, 2021). Biodiversity is a comprehensive umbrella term for the extent of nature's variety or variation within the natural system; both in number and frequency. Biodiversity exists as a complex web of life forms that interact with each other in an ecosystem, in a region or globally. Biodiversity drives the functioning of ecosystems through countless reciprocal interactions with the physical and chemical components of the environment (The Royal Society, 2003). Humans' activity near wildlife habitat will likely trigger a conflict between them.

Animals with remarkable adaptation ability might be able coexist with humans despite the rapid changes in their habitat. Coexistence is defined as a dynamic but sustainable state in which humans and wildlife co-adapt to living in shared landscapes, where human interactions with wildlife are governed by effective institutions that ensure long-term wildlife population persistence, social legitimacy, and tolerable levels of risk (Mekonen, 2020). The survival of the keystone species is the most important among the other species. Keystone species are those whose existence affects the ecosystem as a whole (Payton et al., 2002). They include organisms that control potential dominants, provide critical resources, act as mutualists and act as ecosystem engineers. The absence of the keystone species may trigger the ecosystem to collapse.

The goal of this paper is to study the possibility of sensitive keystone species to coexist with human in human's activity area. This paper will represent how geothermal activity could potentially impact wildlife which later can be used to develop conservation plan to manage the potential impact. The subject of this research is javan leopard (*Panthera pardus melas*). Javan leopard act as top predator to control the population of its prey and stabilize the ecosystem.

2. METHOD

2.1 Study Site

Research was conducted from March to December 2022 in a Darajat Geothermal Power Plant located in Pasirwangi Village, Garut, West Java, Indonesia (coordinate 07°11'09"- 07°15'40"S and 107°41'54"-107°45'40"E). Darajat Power Plant is located within Taman Wisata Alam (Nature Park), Hutan Lindung (Protected Forest) and private land around 1740-2200 above sea level in a valley near Mount Kendang which is part of Papandayan Mountains. The location study is narrowed to Nature Park area around geothermal facilities such as well pads, steam pipeline and biodiversity essential area (e.g., water hole).

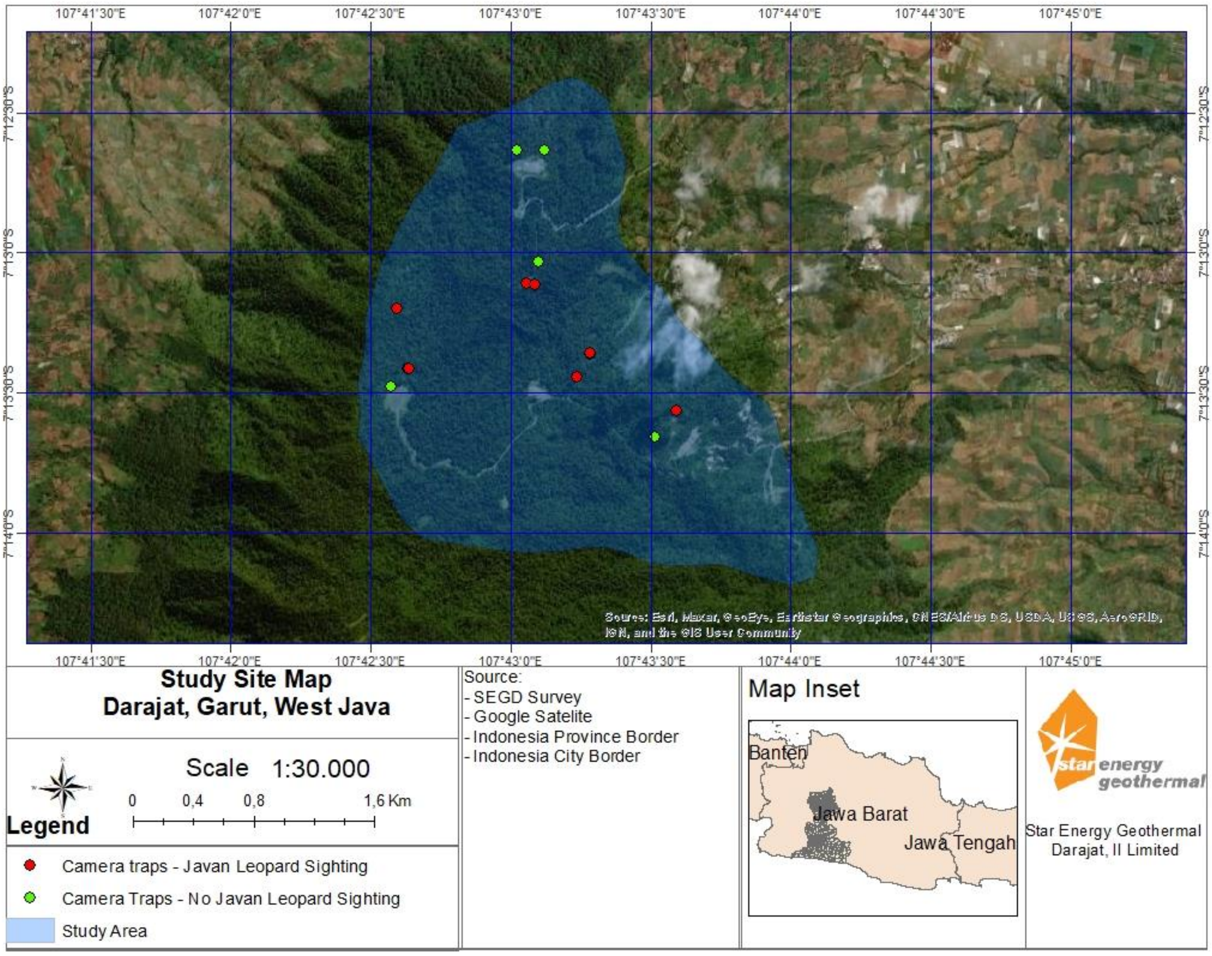

Figure 1 Study location map

2.2 Procedure

Research Data were collected through direct and indirect data collection methodology. Direct data were collected using Visual Encounter Survey (VES) method and camera traps installation. VES data collected by cruising through footpath available at the area (large mammals will be more likely to use these footpath). Indirect data such as carcasses, footprints, faeces, claw marks and other sign that prove existence of javan leopard were recorded simultaneously with VES method. Javan leopard footprints were identified referring to a guidebook (Van Strien, 1983). Camera traps were installed using line transect method, measuring about 1 kilometer in length. 2 camera traps were installed in each transect. The distance between camera depends on the observation of javan leopard signs and their potential tracks in the area. Camera traps installation location were based on sign(s) found in the area. Total of six camera traps were being used in the study, and all cameras are set to record video. The camera surveillance period was set for three month per location and being checked monthly for maintenance and data collection. Camera traps were installed near a track that potentially used by wildlife. Camera traps were mounted on a tree 15-30 cm above the ground depending on the contour of the installation location and camera properties (Molloy, 2018). Field guide is used as a reference to identify species of animal(s) observed or their existence signs (Shepherd & Shepherd 2018).

2.3 Data Analysis

2.3.1 Number of individuals

The javan leopard number of individuals is calculated by identifying javan leopard recorded by camera traps. Face and flank spot pattern were used to identify the individual. Individual's gender was identified from their physical appearances. The home range size of javan leopard and physical barrier were also considered (e.g., farmland, cliff, roads) to determine the individual.

2.3.1 Encounter rate

The data were analysed by estimating encounter rate of the species. Encounter rate was calculated by dividing number of captured pictures of javan leopard with total days the cameras were active, multiplied by 100 (O'Brien et al. 2003; Shahida et al. 2018). Encounter were considered distinct events if occurred more than 30 minutes apart or if the next encounter is different individual.

3. RESULT AND DISCUSSION

Camera traps data collection was conducted for 280 days and successfully identified 4 javan leopards. The leopards were recorded 45 times during the research. The population are consisted of two adult males and two adult females. Some leopards were interested in camera traps that they tried to sniff them especially when the camera traps were just installed or getting moved to other location.

Their curiosity made it possible for the camera to capture spot pattern of their faces and flanks. This facial and body spot features used to identify each of javan leopard individuals. Javan leopard population is shown in table 1.

Javan leopards were captured at four different site locations, which consist of track near S3 well pad, well pad W1, well pad 14 cross country pipeline and a small lake called Situ Cibeureum. Within the observation area, there are several signs that indicate leopard's existence such as feces, footprints, and claw marks. These signs show that leopards were passing these locations frequently. There are four individual captured by camera traps.

Individual	Age Class	Sex
Leopard A	Adult	Female
Leopard B	Adult	Female
Leopard C	Adult	Male
Leopard D	Adult	Male

Table 1 Leopard's population structure

One of the most used footpath is the track near well pad S3. Several individuals were recorded for 20 times in 5 months data collection period. There were three javan leopard individual recorded. The leopards consist of leopard A , leopard B and leopard C. The three javan leopard used this track as part of their home range area. This area is an overlapping area of each javan leopards individual. An overlapping of female's and male's home range is common in leopard (Snider et al., 2021, Muller et al., 2022). This track is an inactive road access to an abandoned well pad. Early succession stage is already in motion. The track is now covered with bushes, shrubs, and perennial seedlings. Most of the road is gone now and only leave a small footpath. These condition makes this location a suitable track for javan leopard since they prefer a spacious footpath rather than vegetation dense track.

Leopard A was also found in a track near well pad 14 cross country pipeline. Leopard A was recorded twice in this area. The repeated encounter in this area shows that this leopard use this area constantly as part of its home range. This track is a steam pipeline inspection path for maintenance purpose. camera traps were installed in this area. Many of leopard's and other smaller mammal's footprints were found on the pipe. Those signs made this area an ideal location for camera trap installation. The steam pipeline lays across the nature park area, so it is surrounded by dense vegetation. There was an individual javan leopard which is not possible to be identifed because the spot pattern are not visible. Considering their territorial nature and homerange area this individual is most likely the same Leopard A that often visit the area.

A javan leopard (Leopard C) was found in W1. This leopard is the same individual with the leopard found in the track near S3 site. The leopard recorded for several times meaning this site is a prefered area inside its homerange area. This site is quite distinguish from the other sites. W1 has various contour type, from level pastur area to a steep mountain peak called Kendang Peak. This area is one of inactive wellpad in Darajat geothermal field site. The site is secluded with minimum disturbance from geothermal activity. The high elevation level, steep contour and rare human disturbance make W1 an ideal site for javan leopard (Gunawan and Sihombing, 2017).

Another javan leopard individual were also recorded in Cibeureum lake. The individual was recorded only on one side of the lake. While on the other side of the lake no leopard individual were recorded. Cibeureum lake is a small lake that located near one of the well pads in geothermal field site. There wasn't any visible existence sign found in this area. Two camera traps were installed at the site. This location was chosen because water sources is usually used by various animals. Wildlife tends to approach water resource to drink. Leopard D used cibeureum lake as part of its home range area.

Encounter rate analysis shows that javan leopard in Darajat has ER value of 15.5%. Camera traps were able to capture 45 picture based on 290 trap days. W1 site is the most visited site among the site sampling areas. The individual that captured in this site is two male adult leopard (Leopard C and D) and one female leopard (Leopard B). The leopards was captured for 45 times in 9 months camera trap installation period. It means that this individual uses this area as part of its core area. Core area is an area which is used more often than the rest of the homerange area and it is morelikely is an area that used to sleep/rest, find shelter and an area with abundant food sources (Burt, 1943). Detection in S3 site is not as often as W1 sites but multiple individual captured in this site including Leopard C. Eventhough Leopard B and Leopard D was seen using this track, the frequency is not as often as Leopard C. In contrast to W1 which is dominated by one Individual, S3 sites sparsely used by multiple individual meaning this location is an overlapping territory area between three leopard individuals.

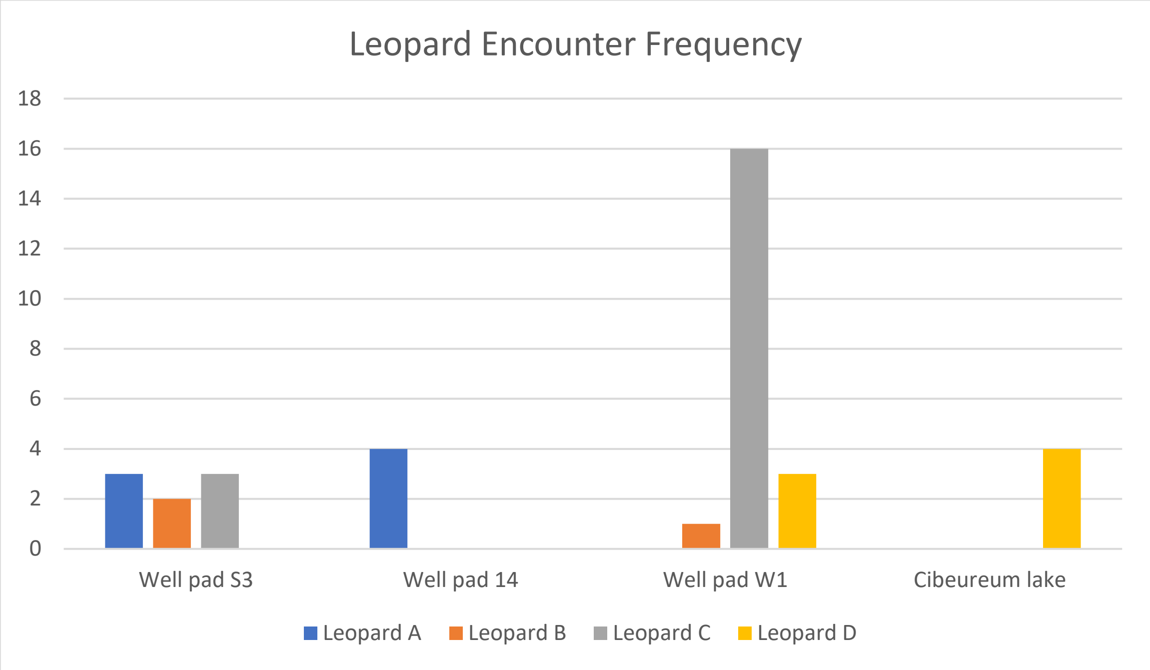

Chart 1 Leopard's encounter frequency

Javan leopard captured in relatively remote area and far from humans activity. Steam mining operation most of the time operate automatically. The company staff only visit wellpad and steampipe once in a while for inspection and maintenance. Wellpad area will be busy and produce high intensity noises only when there is a drilling project or a maintenance program. For example the data collected from SF wellpad. Camera traps were installed near the area for two months but no animals passes by the area. Only small mammals such as tree shrew and birds were captured. It is most likely due to disturbance caused by well drilling process conducted in wellpad SF. Seeing how geothermal production works with its low maintenance and low humans activity it seems javan leopard was able to adapt and live alongside geothermal company activity.

Figure 2 Example of javan leopard sign

Figure 3 Leopard facial spot

Javan leopards can adapt and live near a geothermal powerplant is because the area is a habitat for its potential prey. There are at least 18 identified potential prey found near geothermal activity. The abundance of prey species allows the javan leopard to survive. The primary prey for javan leopard is ungulates and primates (Gunawan et al., 2012). Primates such as javan surili (Presbytis comata) and ebony leaf monkey (Trachypithecus auratus) are frequently seen in various location near geothermal facilities.

No	Family	Latin Name	Local name
1.	Bovidae	Bubalus bubalis	Water Buffalo
2.	Canidae	Canis lupus familiaris	Domesticated dog
3.	Cercopithecidae	Presbytis comata	Javan surili
4.	Cercopithecidae	Trachypithecus auratus	Ebony leaf monkey
5.	Cervidae	Muntiacus muntjak	Barking deer
6.	Hystricidae	Hystrix javanica	Sunda porcupine
7.	Manidae	Manis javanica	Sunda pangolin
8.	Mephitidae	Mydaus javanensis	Sunda skunk
9.	Muridae	Rattus tiomanicus	Malayan field rat
10.	Mustelidae	Herpestes javanicus	Javan mongoose
11.	Mustelidae	Martes flavigula	Yellow throated marten
12.	Mustelidae	Melogale orientalis	Javan ferret badger
13.	Mustelidae	Mustela lutreolina	Indonesia mountain weasle
14.	Phasianidae	Arborophila javanica	Chestnut-bellied partridge
15.	Phasianidae	Gallus Gallus	Red junglefowl
16.	Sciuridae	Callosciurus notatus	Plantain squirrel
17.	Suidae	Sus scrofa	Wild boar
18.	Tupaiidae	Tupaia javanica	Horsefield’s treesrew
19.	Viverridae	Paradoxurus hemaproditus	Javan civet
20.	Viverridae	Prionodon linsang	Linsang

Table 2 Potential prey

Potential prey species in Darajat mostly from family Mustelidae. Overall leopard species prefered to hunt large prey weighting 10-40 kg (Hayward et al., 2006). In Darajat the only prey that fits into this category is wild boar and barking deer. When these prey is hard to find or in dificult times javan leopard may depend heavily on locally abundant small prey which is abundant in Darajat. Abundant prey option species in Darajat is one of the reason javan leopard succeeded to adapt in geothermal project area.

4. CONCLUSION

Javan leopard as one of the keystone species within Papandayan Nature Park is proven to be able to coexist with Darajat Geothermal operation. They are able to adapt to various type of land including brushwood, natural forest, forest patch around geothermal power plant facilities such as well pad and steam pipeline. The reason Javan leopard was able to adapt in geothermal site is the nature of geothermal operation with low maintenance and low human activity and abundance of prey species option. Geothermal power plant operation has potential to operate in-sync with biodiversity conservation. Javan leopard existence as keystone species around geothermal operation is a sign that the ecosystem is healthy and could provide their needs to survive.

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