

## Ethno-conservation of New Guinea Singing Dog among Tribes in Pegunungan Tengah, Papua, Indonesia

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### ABSTRACT

Interactions between humans and carnivores have been range from positive to negative, occasionally leading to human-wildlife conflict in many parts of the world. While dogs have roles to support humans, wild dogs such as wolf, dingoes, and singing dogs have both potential positive and negative roles for humans. We gathered knowledge among tribes in Pegunungan Tengah of Papua, Indonesia on their interactions with the New Guinea Singing Dog (NGSD) using an ethno-conservation approach. We conducted in-depth interviews using both emit and etic approaches with informants from the Amungme, Damal, Moni and Dani (Lani) tribes, who live in the habitat of the dog. Data were analyzed using phenomenological, content analysis, and analytical induction processes. The four tribes have traditional knowledge about the dog and its habitat, thus forming behavioral patterns, belief systems and cultural values toward NGSD. The ethno-conservation of these tribes is reflected in their culture as results from their ability to identify the dog's sensitivity to the change of environment including human disturbances, water quality and food availability. The tribes also limit themselves to share information about NGSD to outsiders and respect the dogs as their ancestors. Residents of the four Indigenous tribes of Pegunungan Tengah believe that NGSD is the reincarnation and avatar of the dwelling spirits of their ancestors. We discuss the implications of these findings for the conservation of this non-protected species by the Indonesian government, but endemic to Papua.

### KEYWORDS

Carnivores; Human-wildlife relationship; Mountainous habitat; New Guinea Singing Dog; Ethno-conservation; Pegunungan Tengah.

## 1. INTRODUCTION

Ethno-conservation is a conservation research approach which is based on examining language, culture, and biological concept to understand and classify natural resources (Pereira & Diegues, 2010), through the display of beliefs and knowledge, and how humans wisely manage natural resources in a sustainable manner (Diegues, 2019; Pereira & Diegues, 2010). This concept has been applied to protect and guide the sustainable use of natural resources by traditional societies, using their traditional way and emerges from local trans-generational knowledge (Dutta et al., 2014; Kelbessa, 2010; Noon, 1981). Ethno-conservation, which is a branch of ethnoecology based on traditional societies and their knowledge on natural resources. This approach is considered an important tool for conservation and has been identified as new approach for environmental conservation in the end of 21<sup>st</sup> century (Pereira & Diegues, 2010). In addition, traditional knowledge through ethno-conservation has contributed valuable practical and fundamental knowledge for wildlife conservation to fulfill conservation purposes (Berkes et al., 2000; Ulicsni et al., 2019; Uprety et al., 2012).

Despite ethno-conservation being widely used to support various conservation programs, the use of this approach for species conservation is still limited, particularly for wildlife species. Most ethno-conservation studies highlight the importance of plant species, particularly medicinal plants (Singh et al., 2020; Lokonon et al., 2021; Oryema et al., 2021). For wildlife conservation, avian species became a central of attraction for many researchers (e.g., Romero-Bautista et al., 2020; Iskandar et al. 2021) and has resulted in a comprehensive study (Tidemann & Gosler, 2012). Conversely, ethno-conservation for carnivore species is still underrepresented, although several studies were published (Lescureux et al., 2011; Bibi et al., 2013; Asriyani & Verheijen; 2020).

In many part of the worlds, carnivores become a major threat to humans, and conflict with humans results due to these threats (Inskip & Zimmermann, 2009; Johnson et al., 2006; Marley et al., 2017; Sangay & Vernes, 2008). While the conflict affects survival of humans, special attention on this relationship has been resulting human-carnivore culture in many parts of the world. For example, relationships between wolves and Indigenous people of North America was revealed that the carnivores not only are perceived as negative, but also figured as teachers and guides (Fogg et al., 2015). In other part of the world, the perspective on tigers as carnivores are differ among tribes; the conservation implications of these differences was well documented by Boomgard (2001).

Dogs, as part of mammalian carnivores within *Canis* family, have a very strong relationship with humans. Many variety of dogs have been domesticated and trained to help humans (Galibert et al., 2011). However, there still remain several species of wild, undomesticated dogs such as wolves, dingoes as well as singing dogs. For example, hunter-gathers cultures in Eurasia led to the domestication of wolves in the pre-agricultural period (Clutton-Brock, 1992; Smith & Litchfield, 2009; Thalmann & Perri, 2019). However, similar hunter-gatherer activities that involve dogs in Australia has not resulted in domestication of dingoes to become *canis familiaris* (Smith & Litchfield, 2009).

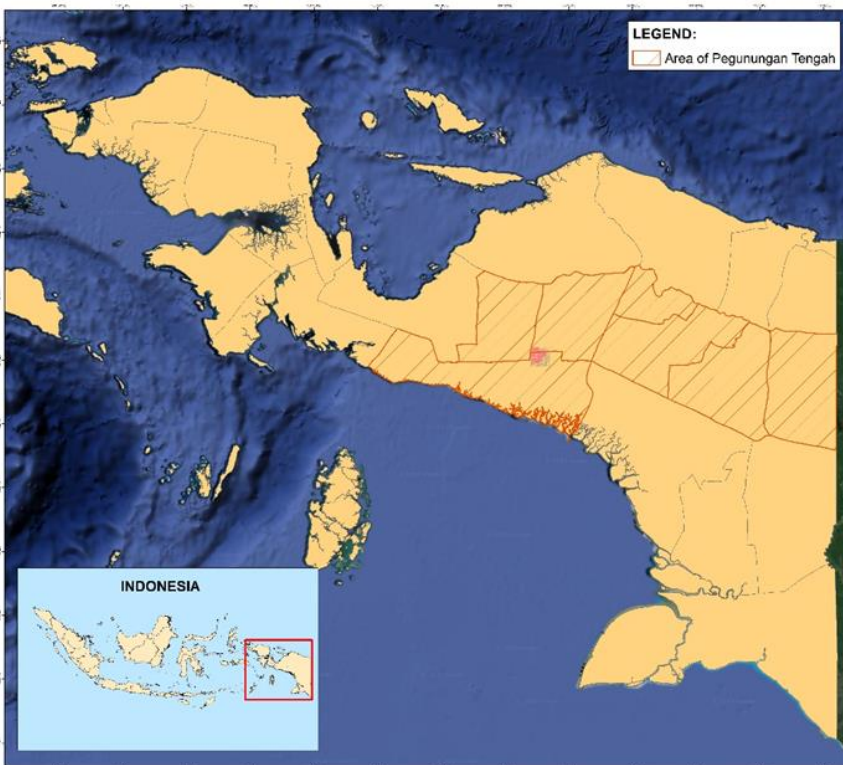
Indonesia as mega-biodiversity country plays an important role for providing habitats for wild dogs, including dholes *Cuon alpinus* (Nurvianto et al., 2015; 2016, Widodo et al., 2022) and New Guinea Singing Dog (NGSD) *Canis hallstromi* (Brisbin et al., 1994; Koler-Matznick et al., 2007; McIntyre et al., 2019). While the dhole is distributed in Sundalands, the NGSD is limited at high altitude of Papua near Grasberg area (McIntyre et al., 2019). As population density in Papua Island is much less than in Java and Sumatra islands, the NGSD may have less interaction with humans in Pegunungan Tengah of Papua Island. Indigenous of the Pegunungan Tengah are the Nayak Tribe, Nduga Tribe, Yali Tribe and Lani Tribe Mee tribe, Moni tribe, Dani tribe Damak Tribe and Amungme Tribe (Somatri, 2008; Veronica, 2013). As these tribes have been living in the same area with the NGSD, they have been interacting with this unique dog species over time. However, information on the relationship between those tribes and the NGSD has rarely been documented.

In the West New Guinea (Papua Province, Indonesia), the NGSD appears in the Dani mythology as a cultural symbol of finding food sources for the Dani tribe di Grand Valley of Baliem (Heider, 1970). For hundreds of years, this knowledge has been used as a guide for maintaining relationship between the tribe with the NGSD and in the form of special abstract symbols. However, documentation of these cultural aspects is very limited. Despite limited distribution and information about the NGSD, this species is not protected by Indonesian or New Guinea governments. Additionally, global assessment for their status has not yet been initiated, making it difficult to develop conservation actions for this species. We aimed to gather knowledge among tribes in Pegunungan Tengah of Papua, Indonesia on their ethical values, cultural values, harvest restrictions

and regulations, prohibitions, division of utilization areas, taboos and norms, customary sanctions, religion, utilization of natural resources according to gender and etc. Pegunungan Tengah is a mountainous area with the highest peaks in Indonesia, which is located in the middle of the Highlands Papua Province and parts of the Central Papua province which are inhabited by mountain tribes in Papua. Administratively, the regencies included are Jayawijaya, Bintang Mountains, Puncak Jaya, Tolikara, Nduga, Yalimo, Yahukimo, Lanny Jaya and Central Memberamo. from their interaction with the NGSD using ethno-conservation approach (Pereira & Diegues, 2010). By gathering knowledge on ethno-conservation of this species in Pegunungan Tengah, we sought to establish a useful basis of information for setting conservations plan for this native dog of New Guinea Island.

## 2. METHODS

### 2.1 Studied species



**Figure 1.** Map of Area of Pegunungan Tengah in Papua within Papua Island of Indonesia

The New Guinea Singing Dog (*Canis cf hallstromi*, Troughton 1957) (NGSD) is endemic to the highland of Pegunungan Tengah of New Guinea Island and is distributed at very narrow range of altitude between 2,500-4,700 m asl (Heider, 1970; Koler-Matznick et al., 2007). This dog does not bark but sings and establishes a permanent social group, which commonly occurs in mammals (Koler-Matznick et al., 2003, 2007). This dog species is relatively cryptic and avoids humans (Bulmer, 1976; Koler-Matznick et al., 2003). The taxonomic status of these animals remains unresolved with the currently available data. Some researchers treat them as a separate species (*Canis hallstromi*)

while others treat them as a subspecies of domestic dogs (*Canis familiaris hallstromi*) (McIntyre et al., 2019).

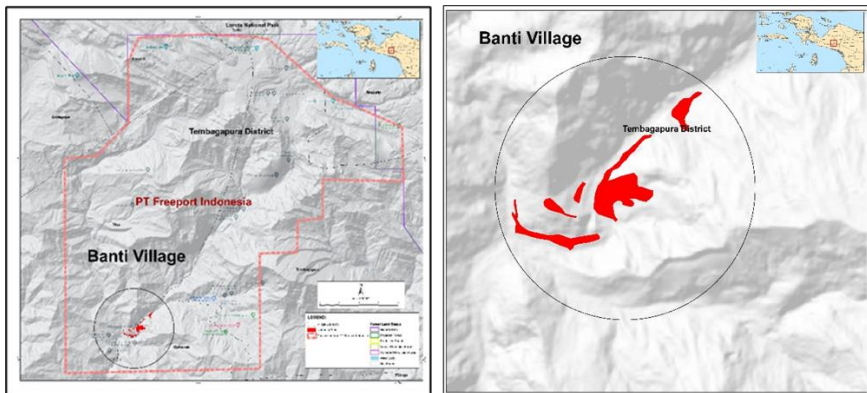
The global conservation status of this dog is still not yet assessed, and the Indonesian government and New Guinea government also do not classify it as a protected species. The very limited information on this species for conservation decision making is due to very few research studies on this species to date. Studies related to their behavior in the East New Guinea (PNG) region was carried out and updated in Koler-Matznick et al. (2003; 2007). This dog is a generalist species and opportunist top predator in high mountain ecosystems (Koler-Matznick et al., 2003; Van Deusen, 1972).



**Figure 2.** New Guinea Singing Dog (*Canis cf. hallstromi*, Troughton 1957) in the study area of PT Freeport Indonesia mining concession.

## 2.2 Studied tribes and area

This research was conducted in Banti Village, Tembagapura district, and Timika district, Mimika Regency, Papua Province, Indonesia. Banti is the closest settlement to the PT Freeport Indonesia concession area, and the residents of Banti Village identify as part of the Amungme tribe, Damal tribe, Moni tribe, and/or Lani (Dani) tribe. Indigenous peoples—defined as those who are traditionally dependent and have close socio-cultural and religious ties to their local environment (Kafiar, 2013) --in Banti Village have traditions that are still maintained. We recognized that only Amungwe tribe is well documented among all tribes in Banti village. The PT Freeport is a mining companies, with activities of exploration, mining and processing ore containing copper, gold and silver in the highland areas of Mimika District, Papua Province, Indonesia, part of Pegunungan Tengah.



**Figure 3.** Map of the study area of Pegunungan Tengah of New Geunia Island, in Banti Village, Tembaga, and Timika, Mimika Regency, Papua Province, Indonesia, consisting of members of the Amungme tribe, Damal tribe, Moni tribe, and Lani (Dani) tribe

### 2.3 Data Collection and Analysis

We assessed perspectives of locals through a qualitative approach. We observed locals and conducted semi-structured in-depth interviews (Bernard, 2011) to key informants from each tribe. Interviews sought to understand informants' interactions with NGSD and how these interactions which may influence NGSD presence. We focused on the local knowledge systems and the traditional concepts related to NGSD using ethno-conservation principles approach.

Direct observation of how locals interacted with NGSD was carried out during field visits in the study area (Figure 1), including responses of locals when encountering NGSD in their neighboring areas. Key informants were selected from each tribe by considering their interaction experience with NGSD. We interviewed 15 informants from Amungme and Damal tribes, 5 from Moni tribe, and 4 from Lani (Dani) tribe. Key informants were selected based on representation of tribes, and recommendation from PT Freeport Indonesia's staff on the persons who have familiarized to communicate with outsiders. This approach was carried out due to our prior knowledge on the limitation of us to gain information related to NGSD form tribe's perspective, as it is known that the knowledge related to NGSD is taboo to talk to outsiders.

Interactions between Indigenous residents and NGSD were identified through phenomenology approach based on emic and etic logic, which exposes social interaction towards different perspective and point of view (Introna, 2017). The emic approach is an insider's perspective, which looks at the beliefs, values, and practices of a particular culture from the perspective of the people who live within that culture. This approach aims to understand the cultural meaning and significance of a particular behavior or practice, as it is understood by the people who engage in it. The "etic" approach is an outsider's perspective, which looks at a culture from the perspective of an outside observer or researcher. This approach tends to focus on the observable behaviors and practices of a culture, and aims to understand them in terms of their functional or evolutionary significance (Dundes, 1962). We conducted content analysis, and an analytical induction process to determine the traditional conservation principles towards NGSD according to the knowledge principles of the four tribes. The analyses were based on our audio and video records; field notes and memo-writing. We coded names and local language terminologies and provide description and conducted comparison among tribes.

### 3. NAMES AND MYTHS

Despite debate on the origin of the singing dog whether as *Canis hallstromi* or as *Canis familiaris hallstromi* (McIntyre et al., 2019), the selected four tribes in our study area each have their own local name for this dog.

**Table 1.** NGSD's local name based on tribe

Tribe	Local Name	Description
Amungme	<i>Penmisim</i>	Differentiate the name with <i>misim</i> ( <i>domestic dog</i> ) and morphological identification (has longer and more forward snout than the domestic dog)
Damal	<i>Pametan</i>	identifies that the dog has sharp face and red eyes, has longer and more forward snout than the domestic dog.
Moni	<i>Sege</i>	Differentiate domestic dogs as <i>wome</i> and consider NGSD as forest/wild dog.
Lani/Dani	<i>Nggewo</i>	identifies that the NGSD has sharp face and red eyes, has longer and more forward snout than the domestic dog.

The Amungme tribe called NGSD *Penmisim*, the Damal tribe called it *Pametan* and the Moni tribe called it *Sege*, the Lani (Dani) tribe called *Nggewo*. We could not find any specific meaning for each name given in each tribe. However, local names often imply long-term interactions between tribes and their environment; as such, we believe that the name given to the dog is a result from their long-term interaction. The existence of a designation of an object in the regional language of an ethnicity is the result of interaction, interrelation, and interdependence in a long period of time between humans and their environment resulting in coding of an environmental element in the form of local language or verbal language. For example, the Amungwe considers their ancestors to be the first humans settled the Pegunungan Tengah of Papua. According to Warami (2005), they call themselves *Amungme*. *Amungme* consists of two words, namely *Amung* which means first or true and *Me* means human so that etymologically *Amungme* means first human or true human.

Each of the four tribes have distinguished the names and morphological differences between NGSD and domestic dog. For example, the Amungme tribes call domestic dog as *misim* and wild dog as *Penmissim*. The tribes also identify that morphologically, the body size of the dog is higher but skinnier than domestic dog. While Moni tribe give a name for domestic dogs as *wome* and consider NGSD as forest/wild dog and has a name as *sege*. The body size and foot palm of *sege* is bigger and larger than *wome*, which is also perceived by the Lani (Dani) tribe. All tribes also identified that the NGSD has longer and more forward snout than the domestic dog. In particular, Lani (Dani) identifies that the dog has sharp face and red eyes. In addition, all tribes also have identified that the dog as having straight-up ears.

Each of the four tribes consider NGSD as their ancestors. This dog is believed to be the incarnation of the ancestral spirit which always helps them. Therefore, it must be respected and guarded, and as a consequence, information about this dog should not be given to outsiders by tribe members. Indigenous residents are not allowed to eat NGSD meat, to kill or injure them, and if they meet the dog, they must feed it. There are sanctions that are believed to occur if a dog is disturbed or killed, such as dying or getting lost in the forest. This belief is similar to the mythology of the local people of the highland in PNG, where wild dogs are carriers of fire and language and are considered ancestral spirits, so they should not be disturbed (Koler-Matznick et al., 2007; Titcomb, 1969).

*"They are our ancestors, we used to live in the same cave. They are older than my tribe. Even though we have parted away since we leave the same cave, they never forget us. Always gives us a sign in hunting and send a signal if there is any danger next to our village"- (Dani Tribe)*

#### 4. PERSPECTIVES ON THE NGSD

Despite different names having been given to the NGSD, the four tribes in Banti village show similarities in how they perceive the dog. All tribes place this dog as wild dog, and do not consider it as a domestic dog or pet. This wild dog is also considered smart, and is turned to by tribes in times of need. For instance, people believe the dog will give clues to help a lost person to find way home. This story has been told by most of Tribes during the in-depth interviews. If somebody has lost their way during trip in mountains or forest, the dog appears unexpectedly, and provides guidance for the lost to find their way home. When they approach their village, the dog will disappear. The informant from Dani Tribe stated that NGSD as older brother help them in various ways when they face trouble in forest.

The NGSD is also perceived by the four tribes as helping to avoid disaster. Based on an interview with Moni Tribe, the NGSD appears as a guide during hunting. It shows people good water sources and gives signal of hazards. The NGSD also serves as supporting informant during tribal wars. If the dog is howling, it announces the presence of enemies and informs that they are approaching.

The four tribes have Protected the *NGSD* tribes by limiting information shared about the dog with outsiders. This is related to the dog's perceived sensitivity to humans, and the resulting belief that they should not be over-exploited. This protection is manifested in the habits of young local residents, who are not allowed to tell outsiders about the dog. For this information, we have got permission by each informant for academic publication as we always asked them during the interview. Young members of the population are not entitled to share this information even if they know little of the information. Limiting information aims to maintain the calm of the dog. Limiting information also helps maintain people's closeness with the dog is maintained, because although the dog can interact with outsiders, certain forms of behavior such as being a helper and traveling companion cannot occur when NGSD interacts with outsiders.

*"We retain information by not discussing NGSD with people outside the tribe. The difference in language makes it difficult for us to communicate with outsiders, talking about NGSD is like talking about bedroom activities, it is not good and inappropriate. Only people who have been recognized as adults in our tribe will know about NGSD" – David Zonggonau (Moni Tribe)*

Since outsiders have also living in the Pegunungan Tengah as consequences of mining activities, information about the dogs were sought by outsiders through direct observation and interactions with locals since 1960's. Not only information transfer about the dogs to outsiders, but direct interaction sometimes was also observed between outsiders and the dog through food provisioning. Therefore, concerns about the behavior changes of the NGSD are growing by locals to lost their believe towards ancestral relationship. Four tribes worry that the change of behavior which is too close to humans will lead to lost some sensitivity towards dangers as well as the reduced spiritual values can lead to neglect of their ancestors. We recognize that the limiting information to outsiders was successfully to protect the NGSD in the past but might not be in current situation. Despite our study is the first exploring four tribes on their perspective on the NGSD and their interaction, but we also aware that prior knowledge on Damal, Dani/Lani and Moni tribes were limited. Therefore, we strongly recommend

to conduct further ethnography studies to those tribes.

#### 4.1 NGSD Sensitivity

The habitat of NGSD in the ethnoecological concept of the Amungme tribe is *Te Aro Neweak Lamo* (Kafiar, 2013; Mampioer, 2000; Simbiak, 2016). This principle explains that the integrity of forests, mountains, valleys, and rivers is their hope, because *Amungsa* or the universe is the place where they live, settle, wander, so that the Amungme people respect and love Amungsa. In ecological perspective, *Amungsa* can be interpreted as a unitary biophysical component of the Pegunungan Tengah's ecosystem where they live. The Amungme consider nature an integral part of themselves. They call the eternal snowy peak of Cartenz as *Nemangkawi Ninggok*. This place is considered the sacred area of the Amungme tribe, with the highest peak (4.800 m dpl) is *Bugara* or the main peak. In Amungme mythology, this peak is a symbol of strength, pride, and peace. The area is considered the area of the spirit of life because it is not inhabited and it is a sacred/forbidden area, the highest mountain peak (Cartenz Peak) as the abode of *Jomun-Temun Nerek*, the ancestors of the tribe (Kafiar, 2013).

NGSD as wild dog have various ability to sense their environment. It is reflected through their sensitivity to detect good quality of water and food quality. According to our informants, these dogs are very sensitive to water quality and often can be regarded as indicator for a suitable water source for consumption. Our informants assumed that in the past, habitat for NGSD still untouched from humans, and the dog ability to seek high quality of water sources still embedded in their behavior. Despite recent change in the habitat and behavior of NGSD, which is more familiar with humans, ability of the dog to detect good quality of habitat can be also be detected from their movement through study involving GPS collar monitoring such as for other species e.g. elephant (Mofßbrucker et al., 2016).

Since hundreds of years ago, these dogs have shared habitat with Indigenous Papuan settlements and trails in the forest. However, their appearance to humans could not be easily predicted. The locals believe that the dog is not pet, and their presence to humans is spontaneously or suddenly. Locals sometime meet them during long distance traveling, hunting and in the war or fighting. They believe that the dog can provide particular sign for them e.g., helping to find walking paths, to helps to find prey during hunt, or to be alarm during war or fighting. As the Amungme, Moni, Dani (Lani) and Damal tribes consider this dog an incarnation of their ancestral spirit, the threats to the dogs also have cultural consequences. If any danger happens to the dog made by humans, there is a sanction to be given by the ancestral spirit. All of these things encourage local people to respect and honor ancestral spirits by feeding them when they meet them, protecting and maintaining their survival. Thus, the act of protecting NGSD is a ritual without a ceremony to honor their ancestors.

Despite the NGSD being very sensitive to humans and not easily approached, this dog's helpful nature is a testament to its natural intelligence, shyness, and capacity to be trained as a hunter or as a social partner (Bulmer, 1976; Meggitt, 1958). Considering the varying perspectives on the sensitivity of the dogs to humans—e.g., they can either can go along with or avoid humans-- we need to better understand the personality traits of dogs towards humans through ecological study (Aplin et al., 2014; Eskridge & Schlupp, 2014; Urbankova et al., 2020) as well as modelling approaches (i.e., Widyastuti et al. 2022) in the future, which will provide valuable information for basis of this species conservation.

The existing company, PT Freeport Indonesia (PT FI) has been carrying out reclamation programs in Grasberg open pit mining area where it serves as habitat for the NGSDs. Activities during the reclamation and previous mining provides additional



food resources for NGSD, through access to remaining foods in the waste area (Figure 2). Additionally, the mining activities also modify areas which is sometimes used by the dogs as their nests, cover or shelter. In addition, since water is well managed, it also provides clean water more accessible for the NGSD in the Grasberg Area.



**Figure 3.** NGSD looking for food in the PT Freeport Indonesia Reclamation Area

#### 4.2 Human and NGSD Interaction

Interactions with humans can have positive, neutral or negative affects (Fahrig & Rytwinski, 2009; Rytwinski & Fahrig, 2013). Interactions between humans and the NGSD can have negative feedback, particularly during accidental occurrence of killing by humans. According to locals, if there is an accidental killing, a group of dogs will protest to the villagers by approaching the home village of the person who has killed their friend, and howling all night long and causing noises. Similar perspectives have been documented in the context of tiger killings in Sumatra (Boomgard, 2001). Howling activity can go on for a long time around the village, usually up to a month. Local residents consider the commotion made by NGSD to be a form of protest and demand an apology for their friend who was killed. The tribal people immediately performed a traditional ceremony led by the tribal leader by offering charcoal, salt and several types of highland orchids. This ceremony is a symbol of the tribe's apology to the NGSD. The materials are placed on the *para-para* (tribune/Altar) which is built right on the road that the dog walks. Informants report that when the NGSD group find the materials from the ceremony, the next night they will stop howling. This situation indicates that apology of the local people has been accepted by the dogs. Neutral affect that has been recorded by Dani Tribe is NGSD and human share same resource of water and area, with the unlimited clean water resources and large of area in Pegunungan Tengah, it gives neutral impact to human and NGSD. Negative impact from interaction that have recorded by the local tribes are some NGSD lost their sensitivity, lost their helpful nature and have become regular dog, they can sense the difference.

*“When I met a NGSD, I drove away the dog and did not feed it. Few days later I got tingling and felt sick, then I remember the dog and then I did traditional ceremony to ask apologize on the occasion by providing charcoal, salt and*

*several types of highland orchids, also slaughtered a chicken at the location where I drove the dog.” (Dani tribe)*

Generally, these dogs do not attack humans or pets and they rarely enter residential areas, although they are very sensitive to the presence of humans. However, several groups are often seen around the Grasberg open mining area can be approached to a distance of approximately 1 m. Meggitt (1958) and Bulmer (1976) reported that wild NGSDs are shy, avoid humans, and never live near settlements, unless captured as puppies and raised by local residents. Bulmer (1976) has reported that the Kalam people, a highland Papuan people, capture their puppies and raise them as hunting partners, but do not breed them. The Eipo tribe in the highlands of Papua (West New Guinea) maintains, raises, and domesticates them as social partners.

## 5. CONSERVATION IMPLICATION

Findings from our study showed that all of four tribes have shown their perspective, and interaction toward the NGSD. Our findings highlighted that tribes in the habitat of the dog have some respect to presence and persistence of the dog as part of their culture. In particular, the perspective on the sensitivity of the dog toward various disturbance have given us clues toward the ability of the dog to the environmental change. This information is crucial to the conservation of the dog in the future of potential multiple disturbance from both nature and human causal.

We also recognized that the knowledge of people on the dog is not centralized on the dog it self, but also to the natural habitat of the dog and humans including their perspective to protect it. Although we were not able to explore all tribes, but we aware that at least the Amungme tribe has been well documented on their interaction with the nature for supporting conservation of this dog. According to Warami (2005), Amungme people believe that the land is the abode of the ancestral spirit, namely *Sulimeni*, the ancestral spirit who guards their land (Peters, 1961; Warami, 2005). Therefore, some locations such as caves, mountains, waterfalls and graves are considered sacred places (Kafiar, 2013). Land is the mother earth. Land as a mother is a cosmology of the area in Pegunungan Tengah of Papua, which stretches from North to South with mountain peaks called "*Ninggok*", meaning the head of the mother, which is a place that is considered sacred. The implication is that land, towering mountains, forests with all kinds of wildlife and plants in them, rivers and all the animals that live in them water and weather elements in high mountain forest ecosystems where they live must be respected and loved (Kafiar, 2013).

Since 1990, the habitat of the NGSD in the Southern Pegunungan Tengah of Papua has been fragmented by PT Freeport Indonesia's (PT FI) Grasberg mining activity. The mining operation have been evolved and changed until now, and have potential to be stopped in the future. As local tribes will be the main actors living in the area as *Ulayat* owners who have rights to their ancestral lands and who have been custodians of NGSD for hundreds of years and after the mining activities, it is important to target conservation priority to strengthen their roles for conservation this endemic dog of Papua. In addition, strengthening their cultural background as what we have found in this study will have valuable contribution for the conservation. The cultural values of the residents of Pegunungan Tengah of Papua can be beneficial for NGSD conservation.

Ethno-conservation-based programs have been applied in conservation actions and programs for wolves in Yellowstone National Park (Fogg et al., 2015). Wolves and wild dogs made important contributions to the lives of Indigenous people by assisting with hunting, acting as sentinels, serving as beasts of burden, and offering companionship (Fogg et al., 2015). Indigenous American believes that the wolf plays an important role

in the maintenance of the number of Bison and Deer in the wild, a controlled number of grazers have tight relation to water quality. Similar approach can be applied in formulating ethno-conservation programs of NGSD in Pegunungan Tengah region of Papua.

While conservation based on the culture is crucial for this region, ecological and behavioral knowledge for this species still relevant to support conservation of the NGSD in Pegunungan Tengah. Despite, there has been little evidence on disturbance in the population of the NGSD due to a lack of research data. Further understanding on the complexity effects of fragmentation on individual species (Purvis et al., 2005) through ecological specialization (Davidson et al., 2009), habitat use or food sources (Bregman et al., 2014; Sekercioglu, 2011), as well as ecological roles such as predator and prey (Ryall et al., 2006), body size (Cardillo et al., 2005) and population density (Boonratana, 2019) are needed for development conservation planning.

## 6. CONCLUSIONS

Amungme, Damal, Moni and Dani (Lani) tribes in the Pegunungan Tengah of Papua have local knowledge in the form of traditional conservation principles to protect the existence of NGSD. This knowledge has been passed down from generation to generation for hundreds of years. The perspective of local tribes includes the belief of ancestral relationship, ability of the dog to have sensitivity on water and food quality have emerged into respect and limiting information for outsiders. However, with the current condition where outsiders actively in the upper area of the mountain to work, the information spreading cannot be limited except for local beliefs. Limiting human and dogs' direct interaction probably can reduce the negative impact of the interaction, particularly reducing activity which caused noise, maintain a certain radius from their home range or habitat, especially nesting, feeding, and drinking places. An NGSD conservation program based on the principles of ethno-conservation can be used as a manifestation of collaborative action based on a multidisciplinary approach.

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