

GEO-TOURISM OPPORTUNITY DEVELOPMENT ON KAMOJANG FOREST IN WEST JAVA

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Received : 16/12/2022, Revised : 20/05/2023, Approved : 23/07/2023

ABSTRACT

The landscape of volcanic and geothermal energy which has an attractive object and unique ecotourism is very important for geo-tourism destination. Nevertheless the use of geothermal so far in Indonesia including Kawah Kamojang only for electricity production which is still not optimal, but it has the potential of tourism in the form of craters geothermal and other potential tourist activity. Therefore, the research is needed to discuss the spectrum of tourism opportunities in Kawah Kamojang forest. The method for this study is Recreation Opportunity Spectrum (ROS), which was developed by the U.S. Forest Service. The result is a spectrum of geothermal potential ecotourism developed in integrated 6 ecotourism sites such as Geothermal Installation, Kawah Kamojang Nature Park, Situ Ciharus, Situ Cibeureum, Tourism Village, and Eagle Conservation Center. Some programs and tourism activities may be able to be potentially developed such as camping, jungle trekking, hiking, swimming, fishing, flora and fauna sighting, hot water bath, educational, culinary and cultural tourism. The constraints on developing geotourism are facilities and services, management, social and collision with applicable regulations. Therefore, there should be a joint effort and collective work between central government, local government, private sector, NGOs, educational institutions/ universities, and local communities towards this plan.

Keywords: Activities opportunities; ecotourism; geotourism; Kawah Kamojang

INTRODUCTION

The volcanic landscape and geothermal energy contains object and unique eco-tourism attraction that is incredibly significant for Geotourism destination. A large number of volcanic regions over the world which combined with geodiversity offer various outdoor activities including education about geoheritage, insight of local cultural values, religion and history.

The Importance of volcanic and geothermal environment for the tourism sector has been recognized linked to the development of active volcanoes based national parks and geothermal landscape which was promoted as a tourism site. According to the evolution popularity of volcanic destination and geothermal destination site, it is important for the stakeholders to establish a Geotourism management visits like in volcanic mountain environment as good as possible. Geotourism's purpose is to inform the public about the earth, to preserve and maintain natural resources and environment for future generations, and preserve the environment through volunteer efforts or monetary donations.

National Geographic's Center for Sustainable Destinations [2010] defines "Geotourism" as "travel" that sustain or enhance the geographical character of its environment area, culture, aesthetics, heritage, and population welfare." According to Dowling and Newsome (2006), Geotourism is a sustainable tourism which primarily focused on the geological features of the earth through enhancing the appreciation and environmental conservation, cultural understanding which lead to beneficial economic local communities. Geotourism is a form of tourism that highlights earthly aspects and has tourist attractions (Escorihuela, 2017; Hermawan, 2017; Hermawan, 2018).

Previous research related to the development of geotourism has been carried out by Giovanni et al., (2019) who studied the development of environmental carrying capacity in the tourist attraction of Mount Masigit through the geopark concept; Haerani et al. (2019) who analyzed the role of human resources who tend to support conservation ideas through geotourism in the Citatah mining area; Wulung et al. (2021) conducted a study on the development of geotourism attractiveness in West Bandung Regency in supporting the realization of the Aspiring Citatah-Saguling Geopark; Lutfianti & Pratiwi (2017) studied geotourism route planning in the Cimenyan area, Bandung Regency

Geothermal energy is heat energy which stored in rocks below the earth's surface and the fluid contained within. Since then, a geothermal power plant has been built in many countries including New Zealand, Japan, the United States, Indonesia and Kenya. The increasing demand for energy and oil prices, particularly in 1973 and 1979, has spurred other countries, including the United States, to reduce their dependence on oil by harnessing geothermal energy. Currently geothermal energy has been used for electricity generation in 24 countries, including Indonesia. Besides, the geothermal fluid is also used for non-electricity sector in 72 countries, among others, for space heating, water heating, greenhouse heating, drying agricultural products, soil heating, drying wood, paper and others.

In Indonesia, the exploration of geothermal energy was first performed in the area of Kamojang crater in 1918 by the Dutch. In addition, Indonesia managed to build the first commercial geothermal power plant which located in Kamojang, West Java in 1983 with a grant from New Zealand (Setiawan, 2012).

In the case of geothermal utilization in Kamojang Carter Forest area, the area were legitimated by the Director of Pertamina's Exploration and Production in January 29th 1983 become Kamojang Geothermal Field as the first geothermal production field and the beginning of geothermal utilization era in Indonesia. Kamojang Geothermal field managed by Pertamina Geothermal Area Inc. as a business unit from Pertamina Upper Department which produce and distribute steam to the consumer; Indonesian Power as a single buyer.

The utilization of geothermal in Indonesia including Kamojang crater is still limited in the electricity production. On the other hand, the use in Geotourism in the form of geothermal tourism not implemented yet. Potential area in Kamojang geothermal reached approximately 21 km² which includes the nature reserve area and Nature Park Kamojang crater. Kamojang Crater Nature Park (KCNP) offers attractions such as geothermal craters but the management still not optimal. Management of KCNP conducted by the Natural Resources Conservation Center (BBKSDA), West Java which tend to be separated with the tourism potency and destinations around it. Also, it may potentially become new attraction,

If it could merge with the surrounding tourism which could increase tourist visits to Crater Kamojang. Besides, geothermal at Crater Kamojang which conducted by Pertamina Geothermal Energy (PGE) Inc. still lack of effort the gheothermal installation to evolve educational tourism destination as geotourism sites in Kamojang Crater. Even though, if the installation opened for Geotourism purposes, it's potentialy give positive impact in introducing issues and potency of

geothermal to huge mass of Indonesia communities. It is stated in Law Number 21 Year 2014 about Geothermal, article 9 that the direct use of geothermal energy in protected areas can only used for nature tourism activities.

Furthermore, through this research, the prospects of geothermal as one of Geotourism destinations and tourism specs nearby the area will be discussed. These results were expected to be material for planning purposes by related stakeholders. It may lead more optimal utilization of the Kamojang Crater Forest Area.

METHOD

Research Location and Period

The study was conducted around Kamojang crater forest areas which consisted of production and protection forest managed by Perum Perhutani Unit III West Java Garut-South Bandung and Nature Reserves and Nature Park which is managed by the Natural Resources Conservation Center (BBKSDA), West Java. The utilization effort on geothermal was situated in those forest functions. This research conducted on May to August, 2018.

Data Collection Procedures and Processing

Inventory procedure were used within Recreation Opportunity Spectrum (ROS), which was developed by the U.S. Forest Service (1998) as a device to regulate the management of forest recreation on forest land and integrate a recreation area with other land uses. ROS capable to help managers in providing guidelines to analyze the effects of other recreational activities, analyze the consequences of management decisions on recreational opportunities, connect user requests to the available opportunities, identify complementary role for recreational suppliers area and establish standards and guidelines for recreational arrangement.

In addition, ROS inventory purposes to identify, describe and classify the area into a class of recreation opportunities based on occasion recreation, natural conditions and social experience. Furthermore, ROS inventory also could provide information about the recreational opportunities that exist for land use and land planning and to assist managers in producing decisions about suits land use, the aims of resources development and the management pattern.

The implementation of inventory concerns with measurable, systematic and objective way to collect data about the potency of geotourism activity. The identification based on the incidence of geological and geomorphologic features that significant for the destination. The mapping proceed based on research site to determine the location of all the features and geological conditions. While for description of these geosites, concern to scientific or aesthetic value of the area as a geotourism site is required.

RESULTS AND DISCUSSION

The principle of geotourism should be able to promote conservation of culture and history. Geotourism contains the sustainability principles that emphasize local peculiarities and satisfies upon visitors and local people. Geotourism should be synergistic in which all the elements of geographical character working together to compose a travel experience that more interesting and attractive to visitors with diverse interests.

Referring to geotourism activity that should involve community, the local business and civic groups are merged to provide a distinctive sense upon visitor's experience. Communities find their own heritage by learning things that can allow interest to visitor. Local communities

should be able to develop pride and skill in showing off their local character. Therefore, visitor will get diverse experience during their visits.

When members of the society understand the benefits of geotourism, then they will be responsible for this geotourism destination. In returns, the local stakeholders will also receive economic benefits which could create a willingness to respect and preserve the asset value of this tourism site. Travelers will respect local culture and tradition and also learn local ethics. Local communities learn to deal with travelers expectations that possibly dissimilar with their own. Later on, enthusiastic visitor will take home new knowledge which potentially could encourage friends and relatives to experience the same thing.

The measurement of success in ecotourism not only based on visitors number, but also period of stay, how they spend their money, and the quality of their experience. Related to that, in Kamojang crater Geotourism there are some purposes or tourism potency that can be used as a Geotourism sites for tourism development in Kamojang crater forest areas which could support the utilization optimality.

The installation of Geothermal Utilization in Kamojang Carter

Geothermal energy is an environmentally friendly energy because after heat energy converted into electrical energy, the fluid returned to the base surface (reservoir) through the injection wells. The injection of water into the reservoir is a necessity to maintain mass sustainability, aiming to slow down of reservoir pressure and to discontinue subsidence. The fluidal reinjection geothermal energy just after the fluidal get employ for turbine electricity power, then again the ensue water recharge on its surface, results the geothermal energy as sustainable energy.

The use of geothermal energy relatively eco-friendly, mainly because its un contributed to green house on its effect, so that just outcoming the urge of its formed; the use of geothermal energy will incarnate need toward fuel on its lessing on that conserve the earth fuel. On because the low level of its emission, geothermal energy consider to be used by Clean Development Mechanism (CDM) on Protokol Kyoto product. This mechanism consented that the developing countries have to take away those green houses on its emission as much as 5.2% on 1990, clean energy on its purchase by the developing countries above year 2000. That clean energy is geothermal energy.

Based on that reason, geothermal energy power become important to developed because the needs of energy gradually increased, it leads to the limit and down of fossil energy (gas fuel and charcoal). The potency of geothermal energy get wide (27,000 MW), but the utilization is still not optimal which only 3%. Besides, of the benefit of geothermal energy is it is renewable, eco-friendly (poor gas emission, the absence of fluid desecrate) and the development of geothermal energy about to less the obedience to the use of fossilized energy sources.

The first person who triggered the ideas was J.Z van Dijk. On monthly magazine Koloniale Studiën (1918) as he said " Krachtbronnen in Italie". That a HBS teaching person in Bandung concern about geothermal energy potential based from volcano by the record which has done in Italy. Nevertheless, the early record about geothermal source had showed its review before Van Dijk did. As the evidence, Franz Wilhelm Junghuhn wrote his review about the 23 geothermal spots which consider to be earth heated water in Java, Deszelfs Gedaante, Bekleeding en Inwendige Structuur (1854).

Further, Berend George Escher had criticized his colleague van Dijk once in his writing, "Over de Mogelijkheid van Dienstbaarmaking van Vulkaan Gassen" (published on De Mijningenieur, 1920), by declaring that most of the solfatara in Hindia Belanda on a certain height,

which considered as the less flated area, in a row of its process drilling on the volcano landscape consider as a hard thing to do based on corrosiveness of the solfatar. However, N.J.M. Taverne (in "Omzetting van Vulkanische in Electricische Energie," De Mijningenieur, Jg. 6, 1925) had showed the success of Italian about conducting geothermal energy in Larderello. Therefore, on Februari 1926, Volcanologische Onderzoek was once doing the drill on fumarola field in Crater Kamojang. That was the first try of the drilling geothermal spot on Hindia Belanda. This is supported by research review of geological survey center Hindia Belanda that held mapping the geographic of volcano and solfatar field to fumarol at the same time between 1900-1914 (Hochstein and Sudarman, 2008).

In time of exploration on 1926, some of the holes in Kamojang Crater was producing geofluida, which is the steam and heated water. Until 1928, it had already done five geothermal spots exploration. But the drilling hole which could steamed is only KMJ-3 labeled with depth 66 m. Up to present, KMJ-3 well operated nicely natured steam which temperatured on 1400°C and pressured to 2,5 at. Those bay be able to build attractive tourism landscape on Nature Park Kamojang Crater well known as Kereta Api Crater.

On year 1928 R.W. van Bemmelen visited Larderello who has written "Over de toekomst an een met vulkanisches stroom gedreven centrale in Nederlandsch Indie" in De Mijningenieur Jg. 9, 1928). Over the review, van Bemmelen showed his optimism and support to idea exploration on geothermal spots in Kamojang. Once Ch. E Stehn wrote "Kamodjang Crater" which dedicated as discipline to excursion on the Fourth Passific Science Congress in Batavia and Bandung. On that article, Stehn counted the capacity of earth heat that produced by Kamojang Crater.

There was also geothermals exploration which done by UNESCO Volcanological Mission to Indonesia which begun on 1964, continued until January 1965. The exploration was held only in Java and Bali, such as Kamojang and Dieng Mountains. The mission ended on January 1965 because Indonesia discharged from UNO (Geothermal: Current and Future Energy, 2004).

Volcanological association in Indonesia then held observation over potential geothermal spots in Java, Bali and Lampung on 1968. The geothermal spots exploration which include foreign volunteer began with Eurafrep mission again. On that time, the scientists were from Vulkanologi, ITB, PLN, dan Eurafrep. They investigated on geothermal spots, such as Kamojang, Dieng, Bayah-Sukabumi (Cisolok-Cisukarame), Tampomas Mountain (Sumedang), Karang Mountain (Banten), Kromong Mountain (Cirebon), and Bali. On the year 1971, Geothermal Energy Ltd (GENZL) ambassador from New Zealand visited some of the geothermal landscapes which had been observed and determined before. The result was project of bilateral assistance from Colombo Plan. Between period 1971-1974, the earlier exploration was done in Kamojang.

Geothermal Kamojang landscapes is in Garut Regency, West Java. The area was around + 17 km, Northwest from Garut or + 42 km Southeast of Bandung, and located on 1640 – 1750 m above sea level. Geographically, Kamojang field located on $107^{\circ}37,5' - 107^{\circ}48'E$ dan $7^{\circ}5,5' - 7^{\circ}16,5'S$.

Significant improvement has been occurred in Kamojang on 1974. At that time, Pertamina ventured with PLN to developing electricity turbine sized 30 MW. An exploration well depth 600 meter was built. The well produce steam which able to explore electricity energy. The development was done in the year of 1977.

Besides that, Pertamina also create a monoblock with the total capacity of 0,25 MW at Lamojang landscape, which inaugurated by Mentamben Subroto on 27 November 1978. The turbine powered 250 kW was pulled to retrieved the electricity with the steam derived from KMJ-

6 well. On 1997, there was a delay of Kamojang development Project just after the Keppres No. 39/1997 published.

The enterprise of geothermal spots was adjusted in UU No. 27/2003 about geothermal. PT Pertamina was not gaining monopolitical right in over Indonesia. Then, through the Government regulations (PP) No. 31/2003, Pertamina was oblige to shift geothermal business into its subordinate. On that reason, PT Pertamina put up PT Pertamina Geothermal Energy (PT PGE) as its subordinate which has been adjusted business about geothermal since year 2006. Kamojang also was not be parted from PT PGE, so then well known as PT Pertamina Geothermal energy Energy Area Kamojang (PGE-AK).

At this time, electricity power enterprise of PLTP Kamojang was undertake by PT Indonesia Power, the subordinate of PLN. The company which found on 3 October 1995 was originally named PT Pembangkitan Jawa Bali I (PT PJB I) changed to PT Indonesia Power on 3 October 2000. The Kamojang PLTP under PT Indonesia Power is known as the Kamojang Generating Business Unit (UBP), which has three Business Sub Units, namely Kamojang (140 MW), Darajat (55 MW), and Salak Mountain (180 MW)

Kamojang Crater Nature Park (KCNP)

The uniqueness of the resources in KCNP is separate craters where the names of each crater are adjusted to the characteristics, location and events that have occurred in the crater. Variations in appearance of heat manifestations that appear in KCNP in the form of craters (Berecek Crater and Manuk Crater), hot mud (Sakarot Crater and Leutak Crater), steam bursts (Railway Crater, Stick Gas Crater and New Crater), sulfur gas smell (Kamojang Crater, Gendang Crater and Saar Crater), fumaroles (Rain Crater) and hot springs (Cibuliran Crater and Beureum Crater). As for some of the manifestations of heat found in the 5 main craters at KCNP, that are:

Kamojang Inactive Crater.

This crater was once a dead crater, which is located in the Southeast of the Berecek Crater. This site used to be an active crater, but now it's freezing. The uniqueness of this location is the presence of sulfur which crystallizes and forms like flower petals. Soil conditions have a fairly hot temperature, indicating the bottom of the frozen layer of soil which there is hydrothermal activity that continues until now. Steaming ground measurements show soil temperatures around 70-60 °C.

Train Crater

The train crater is a geothermal well that was drilled during the Dutch colonial era. From this well, steam is spraying with very high pressure and making loud sounds like the sound of trains.

Rain Crater

The observation at this location is the hot steam that appears from the cavity between the rocks. However, a cold spring was found in the east of this location. This cold water comes from shallow aquifers, which is not related to hydrothermal activity. The results of the pH calculation show that water is close to neutral acidity. Many people use this water for saunas.

Mud Pond

Mud ponds are a manifestation of hot air that forms a mud puddle that emits gas. This mud pool is located between the rain crater and Cibuliran crater. It has air bubbles on the surface of the air, but it has a low height. This comes from shallow aquifers, and arises as a result of high pressure of gases from the Earth's crust. Adjacent to the location of the manifestation, it was

discovered that a crater was off and began to freeze. Argillic alteration is found, which is dominated by mineral white-coated talc. The dried mud looks broken and cracked on several sides.

Cibuliran Crater

In Cibuliran crater, it appears drilling wells that are no longer productive at this time. In the north of the drill location, there are hot springs which still flowing. This spring flows from the east to west, and emits a fairly high gas content with strong odor.

Accessibility

The distance between Kamojang Crater Nature Park (KCNP) to the provincial capital \pm 43 km with good road conditions. The distance from KCNP to the national / international air gate in Jakarta is \pm 163 km. Travel time from the city center to the tourist attraction KCNP is about 2 hours. Kamojang Crater can be reached from Garut with good road conditions (asphalt) while access through the city of Bandung must go through winding roads and it tends to be bad.

Places and Overall Potential Geothermal Recreations

Situ (Lake) Ciharus

Situ Ciharus is a natural basin or natural water reservoir that has been used for irrigation water in the area below, especially in the dry season. It has potential spring that can be developed for the surrounding area or the area below to support the conservation of water resources. Based on geographical location, it is located at $107^{\circ} 22' - 108^{\circ} 50'$ East Longitude and $6^{\circ} 41' - 7^{\circ} 19'$ South Latitude. Administratively, Situ Ciharus is located in Dukuh Village, Ibun District, Bandung Regency in a valley between Mount Dona, Mount Sangser, Mount Beling, Mount Java, and Mount Cibatuipis which are included in the Kamojang Crater Nature Reserve.

Situ Situ Ciharus Has a watershed area it is about 163.50 ha or 1,635 km² and an area of situ is 10.1 ha. Situ Ciharus has an average discharge of 16.50 m³ / sec with a TDS value of 58 ppm and a temperature of 24 ° C. Situ Ciharus is expected to be able to fulfill the raw water needs in Ibun Subdistrict which consists of twelve villages including: Ibun Village, Laksana Village, Mekarwangi Village, Sudi Village, Talun Village, Tanggulun Village, Lampegan Village, Cibegan Village, Cibeet Village, Karyalaksana Village, Pangguh Village, Dukuh Village, Neglasari Village.

The trip to Situ Ciharus through the Kamojang Geothermal area can be reached by car through the following paths: Bandung - Majalaya - Kamojang \pm 44 km distance by \pm 1 hour. Situ Ciharus can be reached by three main tracks, first through the crossing of Mount Rakutak - Situ

Ciharus, the second path is through the Kamojang Geothermal area, and the third is through the Samarang District, Garut Regency. The first path is through Mount Rakutak that located in Pacet District. Normal climbing to reach the 'Top of Rakutak' takes about 4 hours with the condition of open fields, fairly loose soil, and field tracks.

If the journey continues towards Situ Ciharus, the path that must be taken is at the top of Rakutak. The terrain is quite extreme, the soil is loose and it will be more dominated by derivatives there. The path from the Peak of Rakutak to the Ciharus River flow (the usual designation given because there is no data on the official name of the river) is quite narrow, slippery by loose soil and dry leaves. The path from the end of the river to approaching Situ Ciharus will be slightly sloping even though there will still be climbs and derivatives. In this path, at least the path taken must cross the river, even along the river flow until it meets again with the dirt track. If it is on rainy season, it will be quite difficult because the water discharge will rise, the field will be filled with mud, and more leeches will be found.

Normally, the estimated time from the Peak of Rakutak to Situ Ciharus is about four hours. The fastest route is the second line through the Kamojang geothermal area by going along the Kamojang PLTU pipeline from the 204 - 304 and 404 pipelines for ± 3 km with a travel time of ± 15 minutes. From the Kamojang PLTU pipeline 404 pipe to the study site continued by walking for ± 3 km with a time of ± 2 hours passing through the protected forest clearing the bush, down the valley.

The third path is through the City of Garut then District Samarang, the same direction that goes to Kampung Sampireun Resort in Samarang District. Follow the Samarang-Kamojang main road, pass the T-junction towards Kampung Sampireun. After Kampung Sampireun, the terrain will continue to uphill, but the road conditions are good. However, the village / settlement will not be found until the gate.

Along the path of this geothermal area there is no street lighting. Most of residents in Kamojang Village suggest to taking the Kamojang-Majalaya route when riding motorbikes with a small number of groups in late evening. The path to Lake Ciharus from the Kamojang Nature Reserve gate is clear enough, because of the existence of a motorbike trail that already crosses the path is quite often. The climbs and derivatives are not too severe as the path from Mount Rakutak. Around Lake Ciharus still has fairly dense vegetation, but most of the the soil condition and path to Lake Ciharus, have been damaged because it is used as a motor trail. There is only one small gazebo that is sometimes used as residents.

The forest around Lake Ciharus belongs to the Kamojang Nature Reserve conservation area. Conservation forest is a forest area with certain characteristics that have the main function of preserving the diversity of plants and animals with their ecosystems. In addition, conservation forests also have a number of environmental services, especially water environmental services in Lake Ciharus area. These environmental services contribute to the social and economic life of the community continuously. Although there are still many users of environmental services of forests conservation who are not realize and appreciate the contribution of it.

Forest environmental services which is not appreciated led to an increase the rate of forest ecosystems degradation, whereas the higher the rate of forest ecosystems degradation, the value of environmental services declined. In this case environmental services can be considered as an output of the quality of forest ecosystem performance. One of the most important environmental services of a conservation forest is water. The water that flows from the forest ecosystem affects the consumption and economic activities, although many users are not aware of or consider about it.

Ciharus Lake has the potency to be developed as a Micro Hydro Power Plant according to research methods about rainfall, water availability, water requirements, water supply balance, and storage capacity. One analysis of the research method is the microhydro profit analysis. The low attitude of the community about utilization at Situ Ciharus for PLTM, lead challenges for developing the Situ Ciharus going forward, for this reason, information is needed to the community that Situ Ciharus development is required to overcome the electricity shortage crisis in the future if the Kamojang hydropower plant suffers from a deficit that caued from an rise in electricity due to population development and other economic activities. With the magnitude of the community's response to aspects of community empowerment, this provides a positive indicator that give information about the importance of developing Situ Ciharus for PLTM through socialization. Wukir and Purnamawati (2021), If a geological object is considered feasible to be used as geo-education-based geotourism, then the next thing that needs to be considered is the risk of its degradation.

One of the problems currently faced by Situ Ciharus is sedimentation. Sedimentation which occurs in lakes is commonly known as limnis sediment. Usually these deposits are deltas, layers of gravel, sand and mud. Precipitation that occurs in Situ Ciharus, caused by the existence of deltas and mud, especially on the edge of the lake to the river flow (*inflow*) right at the mouth of the lake. The area around the spring that has become an inflow is sufficiently shallow and deteriorating.

Other analysis results about sedimentation obtained potential sediment about 0.4 tons / year. To prevent the reduced potential of Situ Ciharus as a micro hydro power plant, the condition of the catchment area should always be preserved so that quality and quantity are maintained, for example by reforestation. Reforestation is intended to expand the rain catchment area. However, Situ Ciharus's latest problem is not the lack of a catchment area (catchment area) but the erosion of land that caused by eroded of vehicles (motorbikes, bicycles) and the accumulation of rubbish around the lake's bank. Land which is eroded by vehicles around Lake Ciharus contribute to sediment transportation during the rainy season.

Sediment material that is carried by rain surround bank area of Lake Ciharus caused by sediment transportation from the area around Kamojang Nature Reserve forest which is located higher than the surface of Lake Ciharus. The most severe sediment transportation occurs around the bank due to soil scouring, so that when the discharge rises or even in the rainy season, mud from the ground that has been eroded will become sediment in the expansion of the bank area, which will cause siltation and narrowing of the area Lake Ciharus.

Situ Cibereum

Situ Cibereum is one of the springs which directly adjacent to the KCNP area. Geographically this situ located at coordinates 7 ° 9 '42.6 "latitude and 107 ° 48' 23.8" east longitude. Infiltration that comes out from Situ Cibereum is in the Kamojang TWA area. The average water discharge from Situ Cibereum based on the results of direct measurements in the field using a current meter, it is about 1.85 m³ / sec with a temperature of 24 ° C. Total dissolve solid (TDS) value as an indicator of water quality is 52 ppm.

Accessibility to the area already supported by adequate road infrastructure. Only about 20 km from the downtown of Garut Regency. Visitors can reach this area for about 40 minutes. Situ Cibereum is located at an altitude of 2,124 meters above sea level (masl) and the maximum air temperature in the summer only reaches 18 degrees Celsius. Situ Cibereum is the main water supplier for one of the biggest rivers in Garut, Cimanuk River. The water discharge reaches 1,500 liters per seconds, it can irrigate paddy fields at least in four villages covering more than 900 hectares.

There are two travel objects in Situ Cibereum, object *camping ground* and clear lake water. Camping ground objects is located about 500 meters from the entrance gate. Tourists can do camping, outbound, and many more. Situ Cibereum lake is located about 1.5 km from the entrance gate, tourists can relax with family friends, also they can fishing carp. Previously, this situ was known as Situ Pa Enti, which was taken from the name of someone who was believed by some residents as the figure maker of that situ in the past.

According to the story, this situ was once forgotten by the communities. Until one day on 2001, drought occurred in Sukakarya Village. It caused sought water sources. Then, Situ was found, which it already covered with weeds and tall trees also buried by mud because it was so long unknown. Even though after being traced, it is clearly stated in the map of a village on 1946 from Dutch heritage, On 2005, the village government of Sukakarya was involved in the management process. This situ officially known as Situ Cibereum.

Since then, not only Perhutani managed it, but also villagers in Sukakarya. Some facilities such as MCK, musala, and a number of gazebo or hall were built by the government here. On 2010, a 200-meter road was paved from the public road to the entrance gate and the road after the gate to Situ Cibeureum, it was approximately 1.5 km.

Since this site has been discovered, residents began to fix the situation independently. They drained the clean water and overcome the drought for the first time. Camping area was built and started in 2005. Situ began to get the attention of Garut residents, although it was not as famous as Situ Bagendit or Situ Cangkuang. Some local residents also get a profit by opening a stall in the Situ area.

Situ Cibeureum area is included in the Garut Perhutani Forest. According to Perhutani's plan, rest area will be built that is integrated with the existing campsite at Situ Cibeureum. Also there will be some supporting facilities such as tree houses, tent *lots* , camp fires, *downhill tracks* , ATV tracks, *flying fox* and tourist huts that can be used as tourist accommodation. However, until 2014, there are still no signs of the construction of this tourism facility.

Tourism Village Activity

Community based Mushroom Cultivation developed by Geothermal Energy Utilization

Innovations are always developed by PGE Area Kamojang to improve the quality of CSR programs. By utilizing sustainable geothermal potential, PGE Kamojang Area has succeeded in substituting the fuel for the sterilization process of mushroom growth media in the form of gas and firewood that with geothermal steam. On the side of community institutional aspects development, PGE Kamojang Area has trained mushroom cultivators in Kamojang Hamlet by forming the Sauyunan Mushroom Cultivation Group. The member of that group mostly from young unemployed that identified in social mapping as vulnerable groups. While from the economic aspect, only from 30% of the total production capacity developed by PGE .

The group income in Kamojang significantly increased. This program is a concrete commitment by PGE Area Kamojang's to empowering the community. The geothermal steam which is the company's main business commodity, has donated for the community to achieve harmony between the company, the nature, and the community around it. The results of research by Riswanto and Andriani (2018) report that Kampung Batu Malakasari has criteria for forming potential tourist attractions in the form of natural beauty, education-based tourism, and geotourism-based tourism from the results of traditional exploration by the local community and carried out reclamation so as to form a geological format that is beautiful as a geotourism area in Bandung Regency, this proves that what causes an increase in tourist visits is to maximize the potential possessed by tourist objects.

Table 1. Comparison of Sterilization Mushrooms with LPG and Geothermal

Description	Type of Fuel	
	LPG fuel	Conventional Geothermal
Fuel Needs (1 month)	144 kg of LPG	No fee (Using exhaust steam from Steam Trap)
Production capacity	240 bag logs	800 log bags

Pollution aspects	Polluting the air	not polluted
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Source: PT. PGE, 2014

According to Inskip (2010), a tourist village is a rural area that has several special characteristics to become a tourist destination. Meanwhile, according to (Kirchner & Kubalíková, 2014) a tourist village area must also have various facilities to support the area as a tourist destination (Ernawati et al., 2019; Permadi et al., 2016; Wijaya & Widodo, 2015). These various facilities will make it easier for visitors to tourist villages to carry out tourism activities (Prihastha & Suswanta, 2020). Facilities owned by the tourist village area include accommodation facilities, namely providing lodging facilities in the form of tourist huts (homestays) so that visitors can enjoy a village atmosphere that is still typical (Sidik, 2015).

Women Empowerment Through The Cultivation of Herbal Plants

The targets of the women's empowerment program are housewives around the company area. This program is carried out with an ongoing basis to monitoring the progress.

Institutional strengthening is implementation through organizational management training activities. Currently the Women's Herbal Cultivation group is able to get a significant additional income from the development of the herbal agro-tourism center, the development of product innovations, and the development of partnership activities with surrounding communities through the distribution of herbal plant seeds.

Development of "Borondong" Traditional Snack Business -

Community empowerment based on brondong business culinary tradition that assisted by PGE Kamojang Area received an award from the Ministry of Women's Empowerment for the success of empowering housewives. The "Madu Rasa" group already get permit from the Bandung District Health Office and has also received halal certification from the Indonesian Theologian Council. The number of workers involved in the production of "Madu Rasa" is 12 people who are all housewives. They are able to absorb 2 tons of raw materials obtained from farmers around Laksana Village. Economic success, the PGE Area Kamojang Borondong business group managed to increase revenue by $\pm 200\%$.

Integrated Sheep Farmer Empowerment

The number of fostered partner farmers in this program is 70 breeders (initial number of breeders is 20 people) who live around the company's operational area. Institutional strengthening is done through training to improve organizational skills and development of livestock-derived products such as solid and liquid fertilizers from processed animal dung. These derived products can be used by people who grow vegetables and herbal plants. Within a period of 3 years, this sheep farming program succeeded in raising turnover significantly.

Culture Tour

Laksana Village has been designated as a tourism village by Bandung district government through the Decree of the Regent of Bandung Regency No. 556.42 / Kop.71-Dispopor / 2011 concerning on the Establishment of a Tourism Village in the Regency of Bandung. The village is famous for its cultural attractions such as the art of dance culture for example Merak Dance, Jaipong Dance and music culture, or example terbang, calung and karinding.

Raptor Sanctuary

The purpose of this program is to build a Java eagle conservation center as an effort to save and rehabilitate Java eagles through research and preservation activities in their habitat, by

involving the buffer zone communities around Kamojang Nature Park (KNP) . The existence of the Eagle Conservation Center (*Raptor Sanctuary*) in the mountains of Kamojang, Kampung Legok Pulus, Sukakarya Village, Samarang District, raises hopes of uplifting the population of endangered species such as eagle that are currently increasingly threatened.

The conservation center was built as a species recovery and habitat for eagle animals to realize the continuity between eagle and its habitat in Indonesia. It includes a collaborative program of planning management and evaluation monitoring, construction of information centers and raptor-based conservation education, construction of rescue centers, and raptor rehabilitation. Conservation Kamojang Eagles Centre currently have 14 eagle population, that are Java hawk-eagle (*Spizaetus bartelsi*), seven eagle snake (*Spilornis Cheela*), and six brontok hawk-eagle (*Nisaetus Cirrlatus*). Those eagles come from the results of the confiscation and voluntary surrender operations by the people who keep them.

The large of conservation center area is around six hectares, which consist of a rescue center about one hectare, a rehabilitation center 3 hectares , a training center 1 hectare , and a special animal park covering about 1 hectare area. Besides that, there is a release cage as a training tool for the eagle before being released in its natural habitat. Although the population has not known yet, the Javanese Hawk-eagle in Garut Regency is suspected to still exist. Generally, the potential habitat is in the mountainous areas of the Papandayan volcano, Kamojang, and Talaga Bodas.

Value and Geotourism Development in Kamojang Crater

Kamojang Crater tourism value

Based on data obtained from West Java BBKSDA which holds the West Java TWA region, the average of PNBP (non-tax state) tourists visiting TWA on 2012 - August 2014 gradually uplifted. This can be seen in the Figure 1.

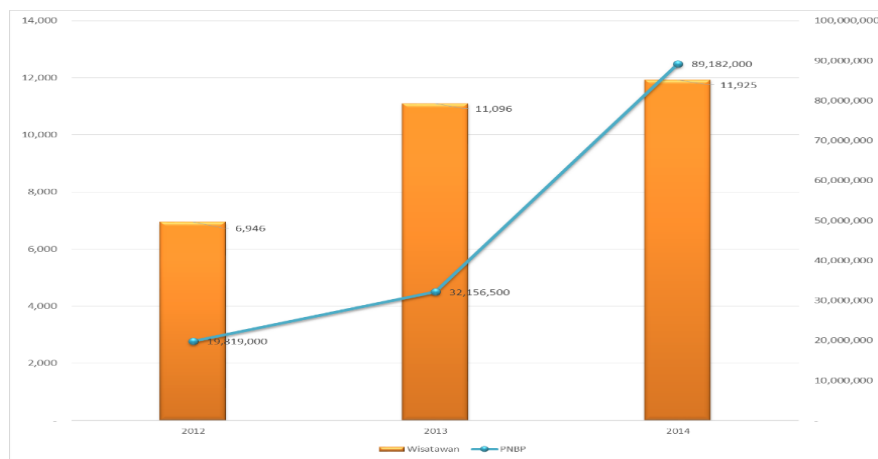


Figure 1. Number of Tourists in Kamojang Crater from 2011 to August 2014

Source: West Java BBKSDA

On the other hand, as can be seen from figure 2 provides information on the growth of tourists on 2013 during the first year, it shows that the highest visitors is about 1509 people on

August of and then followed by the the visitors on August 1,281 people. This indicates that the biggest visit occurred during the holidays.

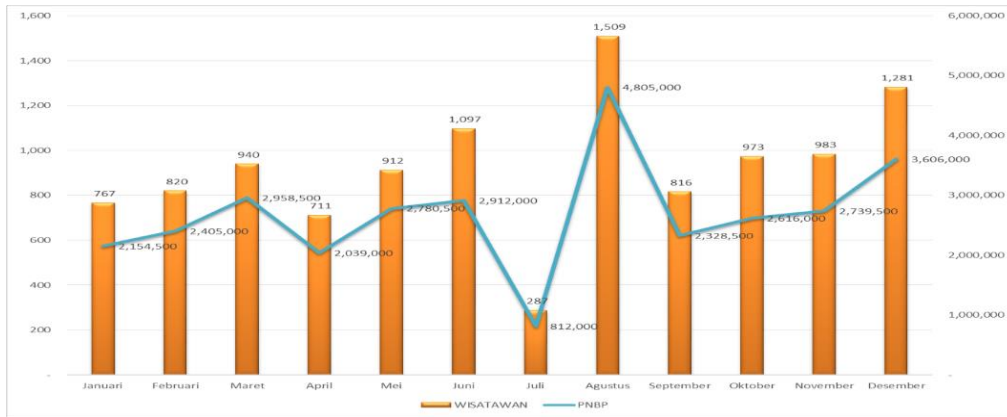


Figure 2 . Number of Travelers in Crater Kamojang T ear 2013

Source: West Java BBKSDA

If it is compared with the number of tourists in Garut (Table 2) , the percentage of travelers / tourists in Garut on 2011 was only 0.34%, and on 2013 was only 0.49%. This indicates that the amount of visitors in Nature Park (NP) is smaller than visitors in Garut. It may be caused by the lack of publications on travel in the crater Kamojang and sectoral ego between the parties who manage this area .

This condition must be considered and taken seriously by the management because the potential of the Kamojang Crater forest is very diverse and attractive. It should be a management improvement which involve of other parties that can support tourism activities in the Kamojang Crater forest and the harmony between parties to look up the tourism in terms of tourists, innovation activities and, facilities.

Table 2 . Percentage of tourist between TWA and Garut Regency

Year	2 012	2 013
Tourist KCNP	6,946	11,096
Garut Tourist	2,014,766	2,254,283
Percentage of NP tourists / Garut tourists	0.34	0.49

Source: West Java BBKSDA and Garut Regency Tourism and Culture Office (2014)

Developing of Geotourism in Kamojang Crater

There are six geotourism sites in Kamojang crater forest according to the description and geotourism. The management of those places should working well together for the effective and success improvement on Kamojang forest. Table 3 provides the information on values of several geotourism from 6 potential sites in Kamojang Crater.

As can be seen from the table, those sites are potential to be developed, according to its beauty, education value, tourism, and culture. The problems are the lack of tourism facilities and

the management that only involves one party, West Java BBKSDA for TWA / CA Kamojang Crater. This leads to poor program innovation and activities also political support and funding from other parties

Table 3 . Geotourism Values of 6 Potential Tourism Sites in Kamojang Crater

No.	Site Potential Geotourism	Values Education (Scientific value)	The beauty value (Aesthetical value)	Travel Value (Recreational value)	Values Culture (Cultural value)	Tourist Level
1	Geothermal Installation	+	+	+	-	National / International
2	Kamojang Crater NP	+	+	+	+	Local / Province
3	Situ Ciharus	+	+	+	+	Local / Province
4	Situ Cibeureum	+	+	+	+	Local / Province
5	Desa Wisata Laksana	+	+	+	+	Local / Province
6	Eagle Conservation Center	+	+	+	-	National / International

Note : + : available, – : not available

Table 4 shows the information on the potency programs and activities in each geotourism sites in Kamojang Crater. Some of programs and activities in Kamojang Crater are hot water bath, gold panning, jungle trekking, hiking, swimming, fishing, observation on flora and fauna, culinary and cultural travel. Geotourism development must also pay attention to information aspects, diversity aspects, cross-country adventures and the availability of natural ecosystems (Agustiyar, 2021).

Most of the potential geotourism sites in Kamojang Crater face several problems, such as low levels of accessibility, lack of facilities and infrastructure, and management, maintenance, and cleanliness problems.

Table 4. Spectrum of Potential Geotourism in Kamojang Crater

No.	Potential Sites of Geotourism	Program and Activites									
		Camp ing Landscape	Hot Stea m Bathing	Jungl e trekki ng	Hi kin g	Swi mmi ng	Fish ing	Obse rvatio n of flora and fauna	Educ ation Touri sm	Culin ary Touri sm	Cultur e Touri sm
1.	Geothermal Installation	-	-	-	-	-	-	-	√	-	-
2.	Kamojang Nature Park	√	√	√	√	-	-	√	√	-	-
3.	Situ Ciharus	√	-	√	√	√	√	√	√	-	-
4.	Situ Cibeureum	√	-	√	√	√	√	√	√	-	-
5.	Laksana Village Tourism	-	-	-	-	-	-	-	√	√	√
6.	Eagle Conservation Centre	-	-	-	-	-	-	√	√	-	-

As can be seen from Table 5, every site has different constraints in developing process, where facility constraints, management, social clash with the prevailing regulations. There is should be a collaboration between the central government, local government, private sector, NGOs, educational institutions / universities, and local communities on this plan. Geotourism programs and activities may contribute the conservation and development of these geotourism sites . Geotourism is also expected to encourage and empower local

communities to improve the welfare of the community following by preserving and developing their territory.

Table 5. Location and Potential Tourism Site Manager in Kamojang Crater

No.	Geotourism Potential Site	Location	Manager	Main Constraints to Development
1	Geothermal Installation	Protected forest, TWA and CA Kamojang Crater	PT. PGE	There is no special facilities for educational visits so safety level for tourists is still vulnerable
2	Kamojang Crater NP	KCNP	West Java BBKSDA	Management is carried out only by West Java BBKSDA
3	Situ Ciharus	Kamojang Crater Nature Reserve	West Java BBKSDA	The location is under the auspices of Kamojang Crater NP so it may be difficult to develop because of regulation clashing in forestry sector
4	Situ Cibeureum	Protected forest	Perhutani Unit III	Management is run by Perhutani and Sukakarya community group. There is only horizontal conflicts at the community level
5	Laksana village tourism	-	Village Laksana	Innovation and funding are still poor
6	Eagle Conservation Center	Kamojang Crater NP	West Java BBKSDA and PT. PGE	Development is still new

CONCLUSION

Geothermal travel spectrum in Kamojang crater forest has been inventoried and can be uplifted to 6 travel sites potential to be evolved among other Geothermal Installation, such as Kamojang Crater Nature Park, Ciharus Situ, Situ Cibeureum, Laksana village tourism and Eagle Conservation Center. Tourism sites in Kamojang Crater forest can support the development of geotourism in Kamojang Crater through several programs and activities such as camping, hot water bath, *jungle trekking*, *hiking*, swimming, fishing, sighting on flora and fauna, educational, culinary and cultural tourism.

To achieve this goal, it is necessary to have joint efforts and collective work between the central government, regional governments, private sector, NGOs, educational institutions / universities, and local community towards this plan. In addition, geotourism programs and activities should contribute to the sustainability development which is in harmony with environmental preservation, business certainty and local community welfare.

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