LAHENDONG GEOTHERMAL EDUCATION PARK:

A proposed geothermal public education facility in the eastern part of Indonesia

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ABSTRACT

The Lahendong geothermal field is located in Tomohon City, about 30 km south of Manado, the capital city of North Sulawesi Province. The field is situated in a beautiful, steep volcanic terrain at about 750 m above sea level, with vigorous thermal manifestations including fumaroles, gas discharges, steaming ground, hot springs, hot mud pools with mud volcanoes, and altered ground. Lahendong is the first geothermal system developed in the eastern part of the country. The electricity production began in August 2001, and to date the system is producing 60 MWe. A direct utilization plant for drying palm sugar has been operating since 2008 to make use of the heat of the waste brine. Nevertheless, utilization of geothermal steam by the locals began much earlier with the use of steam from boiling springs for sauna.

As well as being the hosts of renewable energy resource, the many geothermal sites in Indonesia, including Lahendong, are popular tourist destinations. However they can also act as natural laboratories which can provide everyone with an unlimited chance for learning – something that is often overlooked. Public awareness of research activity at geothermal sites is lacking. The development of a geothermal education park in Lahendong will make people aware of such geothermal resources. This will give added interest to geothermal resources in the eastern part of the country by: 1) strengthening public support, 2) increasing the number of the Eastern Indonesian young people who are interested in getting involved in geothermal research and development. Our paper describes an overview of the field setting, the cultural, scientific and technological significances of the Lahendong geothermal environment, our proposal of a park concept, and also, the mechanism of park development.

1. INTRODUCTION

In accordance with one of its Three Missions (Tri Dharma), namely to conduct community empowerment, and in line with its campaign of "Geothermal for Indonesia" Universitas Gadjah Mada (UGM) collaborates in public education sector with other geothermal stake holders in the country by means of development of geothermal education parks.

Utilization of geothermal energy in Indonesia for electricity generation started in the 1980's with the development of the Kamojang geothermal field. It is now timely for us to promote these geothermal parks. Tourist impact on such inspiring and educational geothermal parks will heighten awareness, knowledge, and appreciation for locals and visitors as to the wealth of geothermal treasures.

Since the intent of our proposal is to encourage learning, the expected target of this public education program is the growth of knowledge and interest, especially for young Indonesians. It is hoped that they will see their geothermal resources as clean, renewable and sustainable.

We propose three developed geothermal fields namely Kamojang, Dieng (both in Java) and Lahendong (North Sulawesi) as the sites of the early models of the parks (Utami et al, 2011). In this paper we highlight Lahendong, which is the first geothermal system developed for electricity generation in the eastern part of the country. Future involvement here, by our young people, is very much encouraged.

2. FIELD OVERVIEW

Lahendong field is situated at about 750 m above sea level, within the beautiful volcanic landscape of Minahasa. It is located between two active volcanoes, namely Lokon (9 km to the North) and Soputan (20 km to the South). Lake Tondano, the remnant of one of the world's largest calderas (Newhall and Dzurisin, 1988) is situated 10 km to the East of field (Figure 1).

The situation map of the field is given in Figure 2. The field hosts patches of thermal manifestation, including a large mud pool in Lahendong valley, fumaroles and steam-heated features around the Lake Linau, and hot springs and altered ground in Leilem, Pangolombian and Kasuratan villages. Several neutral-pH, alkali chloride hot springs emerge at Tempang village (12 km south of Lahendong). However, their hydrologic relation to the Lahendong system is subject of further investigation. The thermal manifestations at Lahendong and Linau have been more popular tourist destinations in comparison to those in other villages.

The first known published description of the thermal manifestations in North Sulawesi was made by a British naturalist, Alfred Russel Wallace who visited Sulawesi in 1859 (Wallace, 1890), the year Charles Darwin published "On the Origin of Species". These include mud pools,

steaming ground, and hot springs emerged in several spots between Tompaso and Langowan villages.

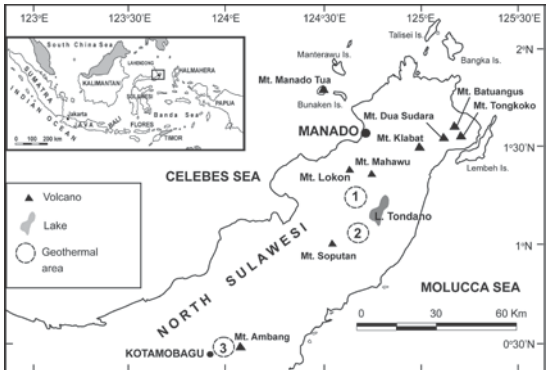

Figure 1: Location of the Lahendong geothermal system (1) and the Tompaso (2) and Kotamobagu (3) prospects with respect to major Quaternary volcanoes in North Sulawesi (Minahasa).

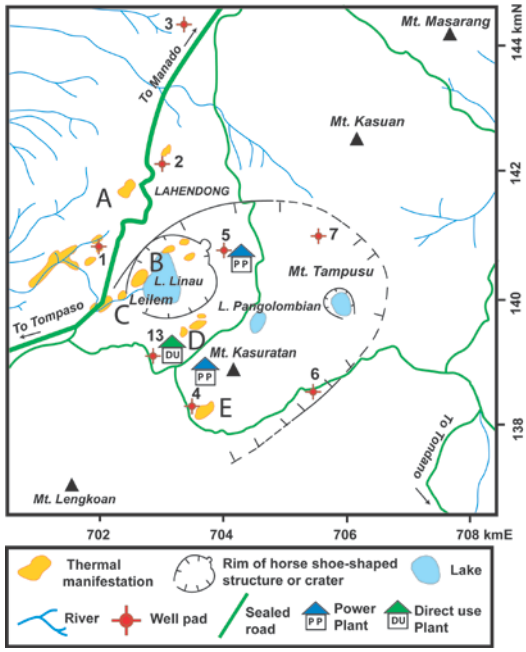

Figure 2: Situation map of the Lahendong geothermal field.

The field is currently producing 60 MWe. The steam field is managed by PT. Pertamina Geothermal Energy (PGE) and the electricity generation by State Electricity Company (PLN). An increase of electricity production up to 100 MWe is now being prepared.

Direct utilization of geothermal waste brine (supplied by PT. PGE) in the drying process of palm sugar has been carried out since 2008 by a local private company. As part of its Community Social Responsibility Programme, PT. PGE has also built a mini drying plant. This can be used at no cost by the locals to test their project of drying of agriculture products. In fact, direct utilization of geothermal steam began even earlier, i.e., for bathing. At Leilem village the locals set up wooden sauna rooms above a cluster of small hot springs on the bank of the Leilem River. Each room is equipped with a shower of cool water piped from a neutral-pH cold spring from the nearby hill.

The access roads to the thermal areas and the steam production and utilization are well developed. With the establishment of Tomohon as an Autonomous City in 2003 and its subsequent development, Lahendong becomes the only Indonesian geothermal field located in a city. Figure 3 shows several interesting spots in the field that can be utilized as the stop sites for geothermal learning.

About 10 km south, lies the equally beautiful Tompaso geothermal prospect (in Figure 1). This thermal area has been made popular by the development of Bukit Kasih recreational park. However, it has not so far been considered of educational significance. It is hoped that its current development by PT. PGE will lead to the development of a geothermal education park. Another geothermal prospect, Kotamobagu (90 km SW of Lahendong, in Figure 1), is now being re-evaluated by PT. PGE.

3. CULTURAL AND EDUCATIVE SIGNIFICANCE OF THE PARK

Indonesian culture is rich in story-telling tradition, so it is not a surprise that those living near thermal areas lovingly pass on the legends behind these thermal wonders to new generations and visitors. In North Sulawesi there is a legend of To'ar (The Sun) and Lumimu'ut (The Sweating Rock). The ancestors of Minahasan people believed that they began their life in a thermal area in Tompaso. The story of their life is depicted in Bukit Kasih recreational park in the Tompaso thermal area. It was believed that the occurrence of twin mud volcanoes at Lahendong thermal valley (10 km north of Tompaso, in Figure 3C) was proof of the couple's everlasting love. For this reason, they should not be disturbed by anyone. Mud volcano is a hydrothermal mud buildup around an ejecting vent. Mud volcanoes commonly develop in the relatively drier parts of the large mud pool at the Lahendong valley. When two vents are located side by side, the "twin" mud volcano is formed.

We perceive the legend of To'ar and Lumimu'ut (as well as many other legends behind the geothermal phenomena in Indonesia) as local wisdoms, reminding people to preserve the natural beauty. It is also a reminder that they should not be reckless but instead respect the beautiful yet hazard-prone active thermal areas. Nevertheless, it will be much more meaningful if the scientific explanations of the interesting thermal phenomena are readily available.

Development of a geothermal field brings high technology into the area. The view of the operating facilities in the steam field, the power plant, and other plant utilities is indeed captivating. However, lay people (locals and visitors alike) may wonder: What is going on? How can the hot fluid from a great depth turn into electricity? Will the exploitation of geothermal resource harm our environment? Can we utilize the hot steam and hot water for other purposes? A public learning facility such as geothermal education park is necessary in order to satisfy such curiosity.

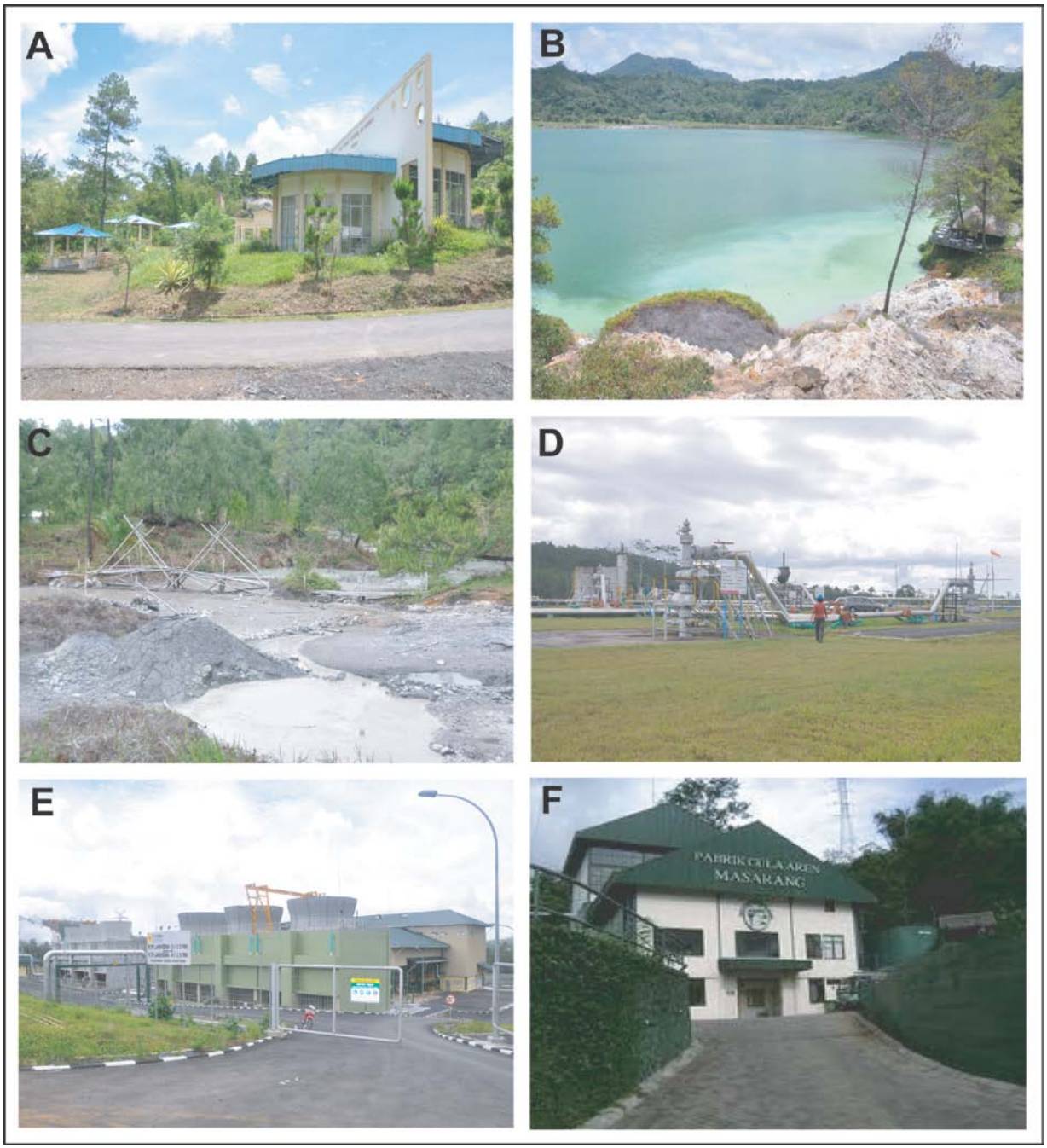

Figure 2: Some of the sites proposed as the learning points in the Lahendong geothermal park. (A) Visitor information center at Linau village. (B) Thermal manifestations at Lake Linau. (C) Lahendong thermal valley. (D) Production wells and steam gathering system in well pad-4. (E) Unit 2 and 3 power plants and well pad-5. (F) The Masarang palm sugar factory that utilizes the heat of the geothermal waste brine. Photographs by Wayan Warmada.

4. PARK CONCEPT

Thermal areas possess physical challenge. Most of them are located in remote areas and care must be taken when entering them. On the other hand they provide visual and cultural attractions (e.g. Efurt-Cooper, 2010). The discharged thermal fluids, which have certain compositions and temperatures, are claimed to have healing power (e.g., Lund, 2000). In New Zealand, Maori myths and legends give cultural appeal to some famous thermal areas (Nielsen et al, 2010). Most of the geothermal areas in New Zealand however, have been well equipped with scientific explanations as to their formation process. In Italy, a geothermal museum and an open-air educational display in miniature, explain the geothermal fluid production and utilization processes. This model has been built as an integral part of the Larderello geothermal field.

We propose a geothermal education park concept that allows visitors to enjoy the atmosphere of a geothermal area, but at the same time:

a) Learn about the science of geothermal phenomena and appreciate the indigenous folklores and wisdom behind

them. In this way the park encourages people, especially the young, to learn the science of the natural thermal heritage without ignoring its cultural significance.

b) Learn and appreciate the role of geothermal energy in fulfilling humanity's need of clean, renewable and sustainable energy. The park will show that the development of indigenous energy can help increase the prosperity of the community, and hence help eliminate resistance to the process of geothermal resource development.

We recommend that, in a developed geothermal field such as Lahendong, that park coverage includes both thermal manifestation and the geothermal production and utilization areas. The following are the suggested park elements.

1) A starting point with a billboard map. There should also be a brief explanation of the existence of natural geothermal activities in the region and their significance to human's life.

2) A visitor information center which would include a geothermal museum or gallery to allow brief but comprehensive interest in the geothermal surroundings. It should be erected at the entrance to the park. Collections such as geologic specimens from the field, miniatures of the steam field facilities and power station, photographs, sketches, and/or video to explain the history of development of the resource, could well be displayed here. Health and safety procedures for visiting the thermal area could be introduced here as well.

3) Safe and clear trails in the field which allow the visitor to follow the flow of explanations from "upstream" (the science of geothermal) to "downstream" (the technology of its thermal energy extraction and utilization).

4) Stop sites at thermal interest points with billboards displaying educational diagram of both scientific and legendary interest.

5) Signs to warn visitors of geothermal hazard, with clear instructions, in order that they avoid unnecessary accidents and risk.

6) Stop sites near the selected fluid production facilities, power plant and/or other utilization facility with billboards showing simple explanations about them (components, function, operating condition, etc). These stop sites must be located in a safe distance from the facilities so that they do not obstruct the operation of the field.

7) Lookouts, which should be positioned in strategic places so that visitors are able to enjoy the picturesque views and take a brief rest.

8) Muster points that allow visitors to gather safely in the event of geo-hazard or other disaster.

9) Other necessary public facilities.

We suggest the concept of a "growing park" where the park elements would be made available step by step depending on the availability of such issues as funding, space, the field development. Further explanation and displays could be added as the field development progresses. Simple, cheap, and "easy to make" items such as explanation billboards, and also trails should be prioritized. As a starter, by simply implementing these two basic steps, the park would be in a position to readily function and progressively find its shape.

The above concept of park development is readily applicable for Lahendong since several park elements are already available, and the existing roads connecting the trails from the thermal areas to the area of steam production and utilization are in a relatively good condition. As well, there is already public participation in the management and maintenance of the eco-tourism objects. These include the thermal wonders.

In 2009 a building intended as a tourism information center was erected by the Regional Development Planning Board of the North Sulawesi Province at Linau village overlooking the Lake Linau. Unfortunately the building remains unused until now. With minor repair it would be a perfect gallery and geothermal information center. Items and collections as in paragraph 3, number 2 can be displayed here. Lake Linau with its fumaroles, altered ground, mud pots, and gas discharge on its banks would be an ideal first site for public educational interest. The development of Lake Linau as an eco-tourism spot by a local private company since 2009 is beneficial for the proposed geothermal education park as it provides well maintained public facilities including a café, parking ground, rest rooms, and walking tracks (currently limited on the Eastern bank of the lake). The Lahendong thermal valley (about 2 km North of Linau thermal area), although less developed compared to the Linau thermal area, is regularly maintained by a family who live nearby. The proposed public learning facility will undoubtedly give added value to the eco-tourism in the area.

5. TRANSFORMING PLANS TO ACTIONS

Good will and consistency in support from all geothermal stakeholders in Indonesia are the keys for the success of the development of geothermal education parks in the country. As the park continues to develop, different areas of support could include:

a) Corporate Social Responsibility programme of the geothermal and/or electricity companies.

b) Local government's development agenda for both education and tourism sectors.

c) Academic institutions' community empowerment programme.

d) Community participation for promoting the natural and cultural heritages of the area.

UGM, PT. PGE, the Regional Development Planning Board of North Sulawesi Province and the Indigenous Community Groups in Tomohon City will work together to transform the development plan of this proposed geothermal public education facility into action. UGM has initiated the action by doing the preliminary field survey in September 2011, working on the park design. Together with other stake holders UGM will then communicate the mission to the local communities and conduct a feasibility study. Applying the concept of "growing park" we will then embark on the park development as soon as the non-technical issues which may arise are resolved. UGM has proposed a development scheme through a Student Thematic Community Empowerment Programme. This would involve groups of

students from different discipline in each stage of park development. In this way, their thoughts, ingenuity and technical capabilities would be pooled.

6. CLOSING REMARKS

Development of a geothermal education park in Indonesia is relevant to the campaign for the development of geothermal resources in the country. The presence of such a park would be of multi-beneficial significance:

a) The park would entice people, especially the young people, to learn about this clean, renewable and sustainable type of energy resource.

b) The positive understanding of geothermal energy gained through enjoyable learning in the actual park, would strengthen public support for the promotion of geothermal resource development in the country.

c) Well planned geothermal education parks will help increase the quality of the existing eco-tourism as well as increase the popularity of many of our thermal areas previously perceived as less preferred destinations.

The well-developed Lahendong geothermal field with its quality infrastructures is a favorable site for the first geothermal education park in the eastern part of Indonesia. It will inspire and motivate the local young people to participate in the future development of geothermal energy, as part of their own future.

Nevertheless, a geothermal education park can be built at any of the geothermal sites in the country, regardless of site development stage. Each geothermal site is scientifically unique. The development scheme and the technology applied to tap and utilize the resource are also site-specific. It follows that there are always different things to learn in parks of the different sites.

7. DEDICATION TO ARIE FREDERIK LASUT

The first author proposes a name for the Lahendong geothermal education park “Arie Frederik Lasut” after the 30-year old Minahasan geologist who was killed in Yogyakarta on 17 May 1949 by the Dutch colonial army. This was because he refused to hand over his work on the inventory of the mineral resources. The late Arie Lasut was acknowledged as a National Hero by the Government of Indonesia in 1969 for his sacrifice in the independence war and for pioneering the advancement of geological mapping of mineral resources of the country. “Sako mangema nan tana jao” (May peace be with you in the far away land).

8. ACKNOWLEDGEMENTS

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