Preliminary ecotourism and Edu-Techno park prospect of Cangar volcano hosted geothermal area, Arjuno-Welirang complex, East Java, Indonesia

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1. Introduction

The term ecotourism was first introduced by Hector Ceballos-Lascurain in 1983. It became generally accepted as a concept in the early 1990s through a series of workshops and meetings among academics and practitioner developers. Nowadays, ecotourism is applied and understood as a development concept, a social movement, a philosophy, a market segment, and industry or business[1]. Ecotourism based on the term introduced by Lascurain is a part of tourism related to the environment and local culture[2]. Due to its relation with environment, ecotourism usually associated with protected areas such as national parks, geoparks, or world heritage sites [3], which one of them includes volcanic and geothermal landforms. Protected areas here are characterized as regions that have predetermined boundaries and managed by an identifiable entity or individually such as government agency or institution designated by government to managed those protected areas [4]. Ecotourism is different from traditional tourism since it allows the traveler or people besides traveling, they also get environment education both in terms of physical scenery and local culture [5]. Some of the ecotourism in the world that have been known are Manuel Antonio, Monteverde, and Tortuguero at Costa Rica [6], Galapagos Island National Park [7], Antarctica, Iceland, and Amazon Rainforest.

Ecotourism has the main concepts of conservation, supporting local culture and economy, and environmental education for the surrounding community and tourists [8]. In addition, Blamey also mentioned that ecotourism is a nature-based, environmentally educated, and sustainably managed tourism[9]. In Indonesia, the concept related to ecotourism began in 2002 and successfully arranged 5 basic principles of ecotourism development; conservation, education, tourism, economy, and participation of local communities [10]. Minister of Home Affairs Regulation No. 33 of 2009 concerning about Guidelines for the Development of Ecotourism in Regions adds the suitability between types and characteristics of ecotourism, ecotourism provides satisfaction and experience to visitors, and accommodating local wisdom.

Since a long time ago, the Cangar Hot Spring (CHS) has been known by the local community as a hot spring tourism area. It located at the flank of the Welirang volcano and included as the part of geothermal system outflow zone in Arjuno-Welirang complex, Batu, East Java, Indonesia. The region around CHS is a conservation area managed by the R. Soerjo Forest Park, Malang, East Java. Some of
the waterfalls have found around CHS, such as Coban Rondo [11], Coban Talun[12], Coban Rais, Etc [13]. This area also has a variety of historical tourist sites such as temples and Japanese relic caves [13]. Based on the things mentioned above, the prospect of ecotourism in this area is very potential due to having the two terms introduced by Lascurain, a good environment, and local culture. Due to its location in a volcanic area with complex geological structures, CHS has become ecotourism that has the potential to be developed as an Edu Techno Park. Based on the research of Budiyanto [14], the development of the CHS has not been maximized. Budiyanto used a qualitative approach to explain the concept of Cangar potential as an area that can be used as a learning resource based on The International Ecotourism Society. The problem that arises in Budiyanto’s research is the absence of an ecotourism-based learning resource development format in the Cangar area. Therefore, the development of sustainable ecotourism in the CHS area become the priority issues of concern in our study. In this study, we will discuss the concept of preliminary development of the ecotourism prospect in Cangar Hot Spring, East Java, Indonesia, to continue in more detail than what has been discussed by Budiyanto especially related to the potential of educational tourism in the Cangar area. Our focus is on how to develop the prospect of ecotourism in CHS related to the main basic concepts and environmental education principles, in the form of Edu-Techno Park and justification that CHS is indeed worth developing based on geophysical data.

2. Methods

This study was conducted in Batu, East Java, Indonesia, especially in Cangar Agro Techno Park, located in Sumber Brantas village, Bumiaji District, Batu, East Java, Indonesia (Figure 1). The method used in this study is a literature review recommended by Torraco in Cabral & Dhar based on the results of research that have been done and a specific case study that focuses on Edu Techno Park in Cangar. This literature review takes the form of conceptual frameworks. After analyzing the data, the authors then provide alternative models or concepts that can be developed from educational-based ecotourism (Edu-Techno Park) in Cangar [15, 16].

![Figure 1. Location of Agro Techno Park complex that very closed to Cangar Hot Spring](image-url)
Some reasons why CHS has potential and developed as sustainable ecotourism will be explained based on the results of the analysis using seismic and nonseismic geophysical data. Nonseismic geophysical data consists of gravity, magnetic, Self-potential and Geolectric data, while seismic data is in the form of the Peak Ground Acceleration (PGA) results in Cangar and visual data of Welirang Mountain. We also include the Welirang Volcano Hazard map from the Center of Volcanology and Geological Hazard Mitigation [17] to identify the hazard potential at Cangar area. It will also be explained related to strategies in developing Education-based ecotourism in the Cangar area. Not only the strategy in the development of ecotourism, but also this study also analyzes hazards potential around the Cangar area and how the hazards potential can also be used as an education-based ecotourism material.

3. Results and Discussion
Various types of geophysical research have been carried out in the CHS area. The geothermal potential in Cangar is shown by the surface manifestations in the form of Cangar hot springs in the outflow zone, solfatara, and fumarole above the crater of Welirang volcano. Figure 2 shows the subsurface model of the existing geothermal system in the Cangar area based on gravity anomaly data analysis. The geothermal system in Arjuno-Welirang consists of 3 layers, topsoil (top), caprock (second layer) and reservoir (third layer), where the reservoir is indicated as the top reservoir due to the lack deep of the research area. Gravity analysis also correlates with the hypocenter of seismicity around the Cangar hot springs and shows that the appearance of these hot springs is influenced by the geological structures around the study area especially Cangar fault and its secondary structure. Similar to the analysis of gravity anomaly, Self Potential investigation shows that the hot fluid flow around the CHS spread from Southeast to Northwest. These results can be used to consider a high potential for ecotourism of the CHS especially related to the utilization of hot springs and community education related to volcano hosted geothermal.

Figure 2. Subsurface model based on gravity anomaly analysis correlated with seismicity in Cangar area

Besides the focus on the development of ecotourism in the CHS area, we also concentrate on the Edu Techno Park development in this area. Edu Techno Park is the entity of the forum that connected us, as higher education institutions, with the industry in a particular location that enables the flow of information and technology more efficiently and quickly [18]. In addition to tourism, integration with hazard mitigation is also needed for sustainable harmonic between community and nature. Currently, in
addition to establishing Agro Techno Park Cangar in the form of research facilities and field laboratories, training in the application of technology and consulting services that produce products such as agricultural cultivation technology for highland commodity and production technology for subtropical commodity, Universitas Brawijaya also has a Brawijaya Volcano and Geothermal Research Center (BRAVO GRC) Laboratory which focuses on research about volcano and geothermal exploration and monitoring in Cangar. This laboratory faces directly towards the emergence of solfatara and fumarole in the Welirang crater which aims to monitor the activity of that volcano. To monitor the Welirang activity, we applied the geophysical method as well as the seismic instrumentation system integrated with visual observation (Figure 3).

Figure 3. Planned of integrated observatory of volcano hosted geothermal as part of Edu Techno Park and Ecotourism development effort that can be used to visual monitoring of Arjuno-Welirang eruption directly. (a) visual observation, (b) seismic observation (c) seismicity recorded at Welirang volcano, (d) Peak Ground Acceleration map in Cangar based on the seismicity analysis.

The visual observation shows the occurrence of solfatara and fumaroles with magmatic gasses indicated the existence of a volcanic geothermal system in the subsurface around Arjuno-Welirang volcano hosted geothermal complex [19] (see Figure 3a). The visual observation developed in BRAVO GRC Laboratory is a part of integrated ecotourism concept and idea to community education for geothermal prospecting area. This visual observation also related to the seismic activity in Arjuno-Welirang volcano complex. Thus, the development of real time seismic monitoring also done by installing the seismometer in BRAVO GRC Laboratory, Cangar Techno Park (Figure 3b-3c).

The level of tectonic earthquake hazard in the Cangar region was analyzed using Peak Ground Acceleration (PGA) (see Figure 3d) [20, 21, 22]. The average PGA value in Cangar less than 25 gals.
The soil conditions in the area are loose and suitable for agriculture. However, the bedrocks are mostly composed of igneous rocks, thus it is good enough to build facilities here. In addition, whenever a tectonic earthquake occurs in this region, the possibility of damage is small. Based on the Meteorology, Climatology and Geophysics Agency, the PGA value less than 167 is included in the MMI scale I - VI where it could be small damage when a tectonic earthquake shakes in this area.

For the hazard due to the Welirang volcanic eruption, Welirang Volcano Hazard map is shown in Figure 4. There are 3 disaster-prone areas around the Arjuno-Welirang volcano where the safest areas are disaster-prone areas I, and subsequently II and III. Disaster-prone areas III has the potential to be affected by direct eruptive volcanic material such as lava, poisonous gas, and pyroclastic flows. This area is in the West to Northwest and Northeast part of the Arjuno-Welirang volcano. As for the Cangar, it is a relatively safe area due to it located outside the three disaster-prone areas.

![Welirang Volcano hazard map](image)

**Figure 4.** Welirang Volcano hazard map, modified from Center of Volcanology and Geological Hazard Mitigation [17].

At the beginning of this study, we identify the current status of ecotourism in the CHS area at the field level, followed by a SWOT analysis to understand the collective views of the diverse base of regional-wide stakeholders and identify the major issues classified by the development components. In addition, an empirical study was conducted in the form of pilot projects. Our ongoing pilots project is the development of instrumentation system and application of geophysical method (seismic and nonseismic) to explore the geothermal prospect and hazard mitigation in Cangar, Arjun-Welirang complex. The key points for development identified based on the major issues. Furthermore, the ecotourism vision was proposed to depict the ideal state of national ecotourism in the future following the analysis.
The ecotourism development strategies were proposed to attain the ecotourism vision and in consideration of the feasibility of short-term and long-term strategies for the development of the CHS area. These strategies based on the study from the Regional Development Planning Agency Tulungagung in cooperation with the Research and Community Service Institute of Universitas Brawijaya about the prospect of the Karst area in Tulungagung [23]. In the case of CHS, it consists of the determination about what areas will be included as Edu Techno Park and what are the developments that will be prioritized. Strategies related to the protection of the Edu Techno Park area and restrictions on incoming tourists also need to be considered because Edu Techno Park has a different structure from ordinary tourism[5]. The development of the Edu Techno Park was also carried out in order to encourage economic growth in the CHS area through the distribution of growth centers in the context of equity. Edu Techno Park is designed for the development of new innovations in the integrated area enhancing the superiority of the CHS area.

Based on the perspective and the results from the published or ongoing research, this study assesses how much this applies to Ecotourism and Edu Techno Park of geothermal ecosystems in the CHS area. We develop a concept and observed some aspects to improve the development of the CHS area as Ecotourism and Edu Techno Park. In the previous studies, Ecotourism consists of three factors: (a) tourism resources and environment, (b) communities and local residents, and (c) tourists and economy [24]. From these factors, we must integrate the tourism development of communities, thus the benefits of tourism are more widespread. On the other hand, we must expand all kinds of infrastructure necessary for the consolidation of the different sides and have proper land use planning.

4. Conclusion
Based on the geophysical method approach (seismic and nonseismic), Agro Techno Park Cangar University of Brawijaya could be developed as integrated of Ecotourism and Edu Techno Park that can be used as multi purposes observatory of volcano hosted geothermal. It can be used to monitor and to educate the community regarding the volcano eruption as well as to educate the geothermal exploration. The strategies to develop the Cangar Edu Techno Park consists of the determination about what areas will be included as Edu Techno Park and what are the developments that will be prioritized. Strategies related to the protection of the Edu Techno Park area and restrictions on incoming tourists also need to be considered because Edu Techno Park has a different structure from ordinary tourism.

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