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MAXIMIZE BENEFIT OF POTENTIAL GEOTHERMAL SOURCE FOR AGRICULTURE WITH AREA STUDY GEDONGSONGO TOURIST DESTINATION

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ABSTRACT

The Research has been done about the geothermal potential in prospect around Mt. Ungaran. In the Gedong Songo vacation area, there are some kind of geothermal system such as hot springs, fumaroles, mud pots, hot springs, steaming ground and Altered ground. Chemical content of these manifestation quite a lot, it is CO_2, H_2S, H_2, CH_4, and Ar. That Inorganic compound can be used in many ways especially in agricultural sector, for example of the manifestation in form of mud pot which rich H_2S, it is very useful for tubers plant and also for seeding growth's process.

The discussion of geothermal potential in Gedong Songo is considered from earth science research. the estimation for energy in geothermal reservoir have temperature about 230^{o}C. it is same with the energy for 11,25 MWe based on geothermometry comparative method. a source of heat like that not only can be used for electrical sector but also in agriculture as for sterilization in growing media and desiccation yielded crops, plantations, and fisheries. its outcome in agriculture areas can be processed using the heat energy for the geothermal potential area.

Keywords: *Geothermal, Gedongsongo, Agiculture*

Introduction

The gedongsongo temple area included in a southeastern area of Mount Ungaran which have the Hindu kind of temple. Located at height 1200 - 1400 meters above sea level, it is currently used in a tourist, culture, and the education sector. In the agricultural sector which is the main activity of community people produces various of vegetables and flowers. There is an idea for the development of the site which became an issue among local people, relating to the development of the area that the potential of the geothermal could disrupt the tourism, agriculture, and some others thing, is the reason for this issue. (Dhave, 2011).

The government currently seek the solution to maximize the geothermal energy, not only on the organize of the construction in geothermal power plants but also the optimize of its utilization, especially in the agricultural sector. Judging from the appearance in the geothermal field, Gedongsongo have the manifestations as if fumaroles, hot springs, and gaseous of soil. The chemical compound and physical properties contained naturally and produced continuously made it be needed for integrating processes in order to create more optimal result and help the agricultural sector.

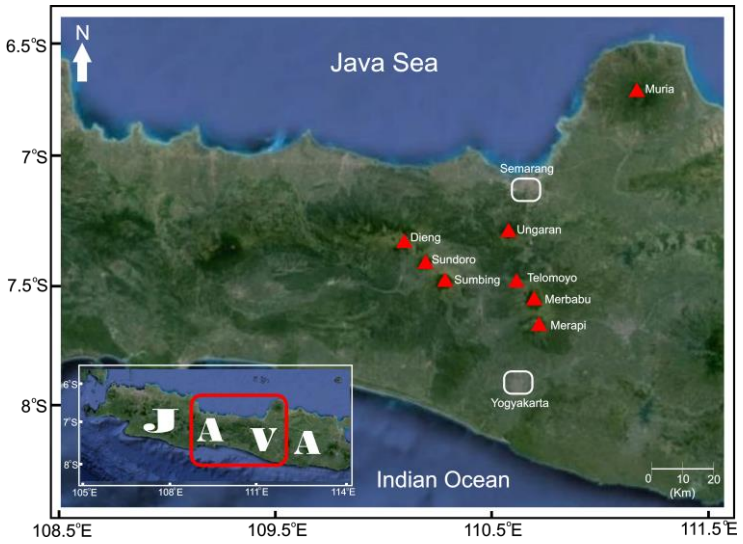

Figure 1 : The Location of Ungaran Volcano

The use of the chemical compound on geothermal for agricultural sector

Based on the data from previous studies that have been done by taking water samples for the local manifestation of western Gedongsongo, which is taken from fumaroles in the western gulf and hot springs that located a few meters to the east of the fumaroles location. The content of both samples has been studied in the laboratory (UGM) to analyze the chemical content, and for the isotopic content was measured by GNS Lower Hutt (New Zeland).

Table 1 : chemical and isotopic constituents (unit: o/oo) of gedongsongo manifestation, ungaran geothermal prospect, central java, indonesia.(nukman, 2011).

Location	West Ung-01	East Ung-02
pH	2	6.7
Li	0.1	-
Na	91.8	17.6
K	54.3	6.2
Ca	1.1	10.9
Mg	40.4	3.7
Cl	753.3	790.9
SO_4	3008.3	5.7
HCO_3	-	-
SiO_2	411	189.6
$\delta^{18}O$	2.68	-8.19
δD	-9.2	-4.94

From the results of that water samples which have been examined before, knowledge of the lithology and the geochemistry gedongsongo area could be determined which it could be useful in agricultural sector:

a. pH value

The value that is influenced ions H^+ concentration used in the soil parameter which affecting rapid or slow on the growth of the various plants. However the nutrients which are the kind of elements that should be absorbed by plants as its requirement, yet if the pH that it contained is not normal then plants itself unable to absorb this nutrient because they have not desire to absorb all of the nutrients which present in the soil. In the agricultural sector, influence on soil pH have a very important role to determine whether the nutrients conveniently are absorbed by plants or vice versa. Generally, the nutrients will be easily absorbed by plants at pH 6-7, it is because at that point most of the nutrients will be readily soluble in the water. The conditions of the soil pH also determine the micro-organism develop in the soil, from pH 5,5 - 7 is the point when decomposition of organic material fungal and bacterial will be growth well, likewise the useful micro-organism for the plant roots will also well developed.

In this case, at the research site has a normal pH for plants which located around former steaming ground manifestation, because the content tends to be on the neutral pH.

b. Natrium (Na)

The function of the Natrium nutrient for plants have a role in stomata opening and could replace K compound which have a role in tuber formation, prevents the rotting potatoes on its middle part (hartrot). This element derived from feldspar and amphibole.

c. Potassium (K)

As a levelling on the physiological processes as if photosynthesis, accumulation, translocation, carbohydrate transport, opening and closing of stomata and regulate the water distribution in the cell. Potassium contributes to the formation of the proteins and carbohydrates which strengthens the plants, solidified straw and wood of the plants so that the leaves and flowers are not convenient to fall. It also assists on the resistance of plants to drought and bug. In addition to the elements which is found in the water samples obtained from the fumaroles is calcium (Ca). Calcium plays a role in the growth cell, strengthen and levelling permeability, as well as taking care of the cell wall. It is obtained from the mineral called silica.

d. Calsium (Ca)

It is absorbed by plants in the form of Ca^{2+}, and it has a function for plants as a stimulate the formation of root hair, role in the proteins generation or the active part of plants, concreted plant stems and stimulate the formation of seeds all at once, neutralize organic acids which produced during metabolism. The calcium present in the stem and leaf could neutralize the compound or the acidity of the soil.

e. Magnesium (mg)

It has a role in the transport energy for several enzymes within plants. Magnesium is very dominant on leaves, especially for the availability of chlorophyll. It is also prominent compound in the formation of chlorophyll and enzymes to various process of protein synthesis. Element source is from $MgCO_3$ and $Mg_3SiO_2(OH)_4$.

f. Chloride (Cl)

The chloride content is generally useful to improve and elevate the results of the dried plants as if tobacco, cotton, potatoes and vegetable plants. It has functioned on the transfer transferring in plants, improving osmose cells, preventing the loss of water that not balanced, repairing the absorption of other ions.

g. Sulfur (s)

Element Sulphate as known sulfur absorbsed by plants in the form of sulfate ions (SO_4^{2-}). This substance is part of a protein that is present in the form of cysteine, methionin, thiamine. Element Sulphate serves to help the formation of the grain so that the green color of leaf more green. It adding protein and vitamins in crops, increase the number of tillers, play an important role in produce sugars, also provide the color, scent, and spasticity in tobacco.

h. Iron (Fe)

It is absorbed by plants in the form of Fe^{2+}, Function of nutrient iron (Fe) for the plant is important for the formation of leaf green (chlorophyll), the formation of carbohydrates, lipid and proteins, found in the enzyme Catalase, Peroxidase, and Cytohrom hidroginase Prinodic oxidase. The iron compounds derived from the mineral (Mg, Fe) 2SiO, pyrite, siderite ($FeCO_3$), goethite (FeOOH), magnetite (Fe_3O_4), hematite (Fe_2O_3) and ilmenite ($FeTiO_3$).

i. Silikon (Si)

Silicon have very important role in the growth of certain plants such as rice (Oryza sativa), maize (Zea mays), and sugarcane (Saccharum officinarum). It make the soil increase element p and reduce toxic metals activity such as Al, fe and mn. Beside that it also increase resistance of plants to pests and diseases. SiO2 compound found almost in all rocks. Availability Si in the soil is affected by the absorption reaction, temperature, irrigation water, and soil pH. Element Si help leaves be more upright under the influence of nitrogen fertilization, thus improving the photosynthesis process..

j. Mangan (Mn)

Mangan is absorbed by plants in the form of Mn^{2+}. Functions of element nutrient manganese (Mn) for the plant is forming of protein and vitamins, especially vitamin C, play an important role in maintaining the condition of the green leaf on old leaf, act as enzymes feroksidase and as activator wide-enzymes, acts as an important component for the smooth assimilation process. This element is obtained from pyrolusit (MnO_2), manganit (MnO(OH)), rhodochrosit ($MnCO_3$) and rhodoinit ($MnSiO_3$)

k. Boron (Bo)

Boron is absorbed by plants in the form of BoO^{3-}. Functions of element nutrient boron (Bo) for the plant is served as transport carbohydrates in the trunk, improve the quality of vegetables and fruits, play a role in the formation/cell culture, especially in the growing point of shoots, also in the formation of pollen, flowers and roots, boron is closely related to the metabolism of potassium (K) and calcium (Ca), element bo nutrients can reproduce nodule branches to give a lot of bacteria and prevent bacterial parasites. Boron is often found in soil minerals such as tourmaline ($(H_2\,MgNa\,Al(BO)_2.\ Si_4O_2)O_{20}$ containing 3% -4% boron. Other minerals containing boron kernit ($Na_2B_4O_7.\ 4H_2O$), kolamit ($Ca_2B_6O_{11}.\ 5H_2O$), uleksit ($NaCaB_5O_9.\ 8H_2O$) and aksinat.

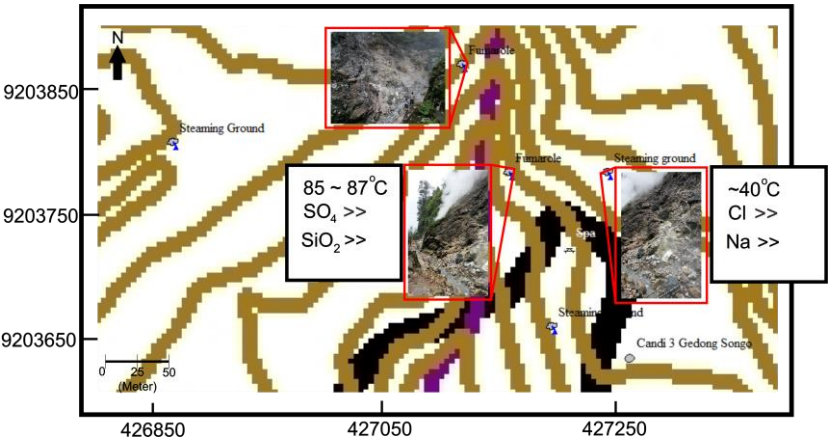

Figure 2: Location manifestations and matter content

The direct use of geothermal resources

Heat fluid generated by the manifestation above the Gedong Songo temple complex have been utilized by the public and modified piped apply the height difference between the manifestation with the local community then naturally flowing stream. Here is the benefit of the fluid in the agricultural sector:

a. The heat energy for drying agricultural products.

Geothermal energy can be used directly with simple technology in the drying process of agricultural products. Fluid heat coming from the hot springs or manifestations that have high temperatures and heats the room accommodated dryers are designed specifically for drying agricultural products

Some of the agricultural products that use this place categorize the main products are peanuts, rice, and tomatoes. The advantage of the use of this space is to provide results faster and better than natural drying of the sun. The temperature used in this place is not too high, it has temperature of about ~ 80° C and the tendency to be not too far from the manifestation. Future utilization of this space could be used in larger numbers and are not only used for the agricultural sector.

b. Heat energy in sterilized growing media.

Gedong Songo tourist areas in the future can be developed in agro-industry. It have high land, fertile soil, and wide land produces mainly vegetables and fruit crops like tomato, cabbage, peppers, and onions. The plants can grow well here, so there are ideas to build greenhouses at this location.

The purpose of the soil to kill pests in the early planting require the place of plants growing media be sterilized. Sterilization of growing media can be done by heating the media on certain temperature (the average ~120^{o}C) so that the pests die and cannot thrive. Heating is assisted by geothermal energy due to the output temperature is not hot enough. In accordance with the purpose of raising the temperature of the heat coming from geothermal wells is passed to a heat exchanger before being used. From the heat exchanger is then created network of water pipes around the surrounding area heated by crop the pipes. The heat from the pipes then heats the soil medium after heating at a certain time. Heated soil was allowed to cool for the next planting. Other uses of the plumbing system in the greenhouse to keep the temperature of the cold greenhouse in certain seasons with the flow pipe laying open area.

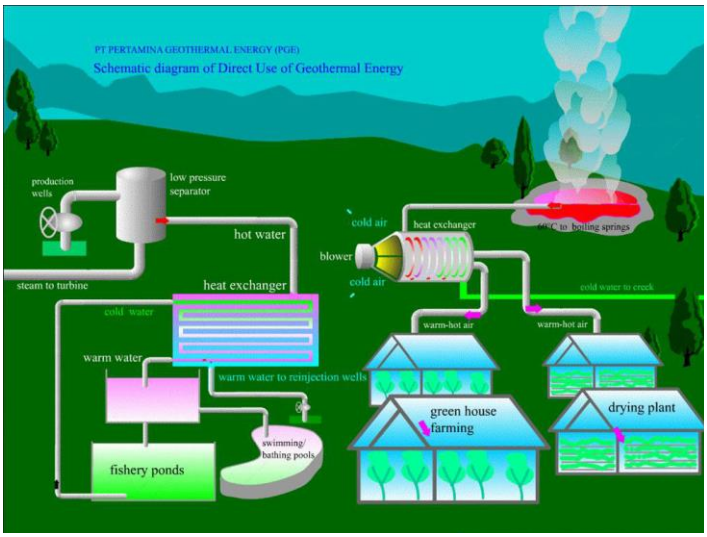

Figure 3: Schematic temperature geothermal utilization in agriculture and fisheries (PT Pertamiana PGE, 2011)

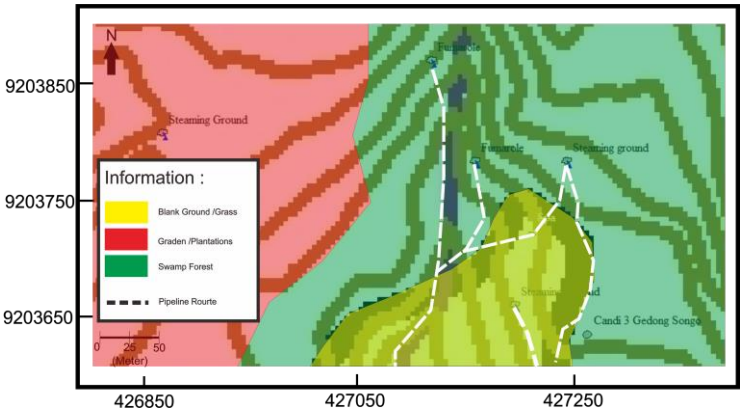

Figure 4: Map land use and pipe route

Result and Discussion

Gedong Songo tourist area have prospect as geothermal field, on the other hand the area produces a wide variety of agricultural products such as peanuts, onions, potatoes, cabbage, and tomatoes. From the manifestations results obtained of chemical compounds are processed and taken according to the needs of agriculture.

Basically there are 16 essential elements that absolutely necessary to growth a plant. Three of the available lot in nature such as carbon, hydrogen, and oxygen. Nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium needed plants in large amounts, or so-called macro needs. Micro needs such as iron, chlorine, manganese, copper, zinc, and barons which the plants need very little amount. All of these needs are available and able to be produced from geothermal manifestations. Primary needs such as sulfur, magnesium, potassium, and nitrogen has been taken from rock extraction/fluid around the area manifestation.

In its use of the chemical element as fertilizer then mixed with the soil where it's planting. Crops such as tomatoes, onions, cabbage, and potatoes are the main agricultural commodities in Gedong Songo have been already used the mixture. In the real field case the processing number is still very small and it has not used special chemical composed in separating chemical

compounds from its primary source. People still take direct rock/fluid mixed land without knowing its chemical composition. Urgent follow-up to help people in the separating element chemical compounds which needed by the plants.

Based on estimates of reservoir temperatures are expected reach temperature of 230^{o} C. The use of temperature in the agricultural sector in Gedong Songo is not fully utilized. Reason it comes from the surface manifestations temperature in range ~ 80°C. To get the maximum temperature then it require straight drilling the point of reservoir and flow the fluid directly from the subsurface.

Figure 5: the use of pipes on the manifestation

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