REGIONALITY OF KARST AND THE HUMAN ACTIVITY IN GUNUNG SEWU, JAVA ISLAND

URUSHIBARA-YOSHINO Kazuko

ABSTRACT

In Gunung Sewu, Java Island, there exist 4 marine terraces and hill areas with cone karst. Areas having high cones show a high cone density which is in contrast to areas on the younger terraces in which there are only small cones.

In Miocene marly limestone areas (Wonosari polje), the population density was 936/km² in 1991. But in the typical cone karst areas of pure Miocene limestones the density is quite low (277-359/km²) due to the poor condition for agriculture land use.

During strong El Nino years like 1982-83, when Java Island suffered from drought, the population and number of families in the cone karst areas decreased intensively. On the other hand, in marly limestone areas, the population and number of families have been not so greatly affected by the drought caused by El Nino. Because of the relatively high productivity in this area and the progressed urbanization, such as in Wonosari, people from the surrounding low productivity areas of cone karst flowed to these region.

INTRODUCTION

In the humid tropical area, solution of limestone occurs effectively. When the limestone area is covered by vegetation and heavy clay, solution ratio of limestone is extremely high under the condition of high precipitation during long rainy season. Lithological and tectonical conditions, acidity of soils, CO_2 contents in soil, the properties of litter and topography relate to karstification very much. In the humid tropical areas, the connection of these factors can form cone karst.

The cone karst develops independently to the of geological ages of limestone. We can observe such a phenomenon in the Tertiary limestone areas in some countries in Southeast Asia and Central America. Furthermore, Verstappen (1960) reported cone karst in the Quaternary uplifted coral areas in Malaysia.

In the Gunung Sewu in Java Island, where the present study is carrying on, cone karst develops well in the Tertiary limestone areas. Cones and cockpits are distributed in the areas along the geotectonical lines and lineaments of limestone (Waltham et al., 1983, 85). In these areas, the human activities have been very strong, since the stone age. Nowadays, density of population in these areas have been kept very high, even peoples

have problems to find enough water for agriculture and living. In order to clarify, the relationship between the precipitation fluctuation and population change, was examined by a study in the Gunung Sewu in Java Island.

TOPOGRAPHY AND CLIMATE IN GUNUNG SEWU

In Gunung Sewu, the cone karst was studied by LEHMANN (1936), BALÁZS (1968), VERSTAPPEN (1977) and WALTHAM et al. (1983,85). They reported cave systems and underground systems. Miocene limestone distributes along the Indian ocean. *Fig. 1.* shows the volcanic areas in central Java and the limestone areas. Gunung Sewu, which means thousand mountains, locates in 50-150 km southeast from Yogyakarta. The number of cones is estimated as about 40000 in an area of 1300 km^2. The Gunung Sewu area has been uplifted might accelerate more solution. These area might be uplifted actively during the Quaternary period, which several marine terraces with well developed clearly demonstrate. Around the mouth of Kladen river, shown on *Fig. 2.*, 4 marine terraces developed very well along the coast in the limestone areas and in the sandstone areas, which are covered by layers of limestone. Big cones developed very well, particularly on the higher terraces composed of limestone.

On the lowest terraces (15-20 m a.s.l.), the cones are very small in size. In contrast, on the oldest terraces (80 m a.s.l.), deep dolines and high, big sized cones developed. As we can see on *Fig. 2*, the distribution pattern of cones seems to be controlled strongly by tectonical lines as lineaments and fault lines. People use deep dolines like Telaga as reservoirs. Especially in the mountain areas, density of Telaga increases.

In the Gunung Sewu, which is located at about 8°S, rainy season occurs from November to March under the influence of westerly winds. On the other hand, dry season is from May to October under the influence of easterly winds. But the fluctuation in length of rainy season and precipitation amounts are very large. EGUCHI (1988) reported that rainfall controlled by westerly from the Indian-ocean instead of under the ITCZ. But position of ITCZ is a distribution boundary of rainfall and clouds. Therefore, it should be pointed out that Java Island is a very sensitive area for rainfall

HUMAN ACTIVITY AND MICRO-TOPOGRAPHY OF KARST

(1) Micro-topography and agriculture

In Gunung Sewu, population density is extremely high. Since the areas have been used for agriculture, there exist no original or secondary forests. The cones covered shallow soils are using for terraced farm lands, if cones are lower than about 50 m. When the cones are too much high or large for making farm land, they are afforested with teak and acacia. *Photo. 1* shows the land use of cone karst. Main agricultural lands are located in the bottom of dolines, cockpits and at the bottom of dry valleys. *Fig. 3* shows the farm lands in the bottom of dolines and dry valley near Sadeng. The boundary of rice fields are

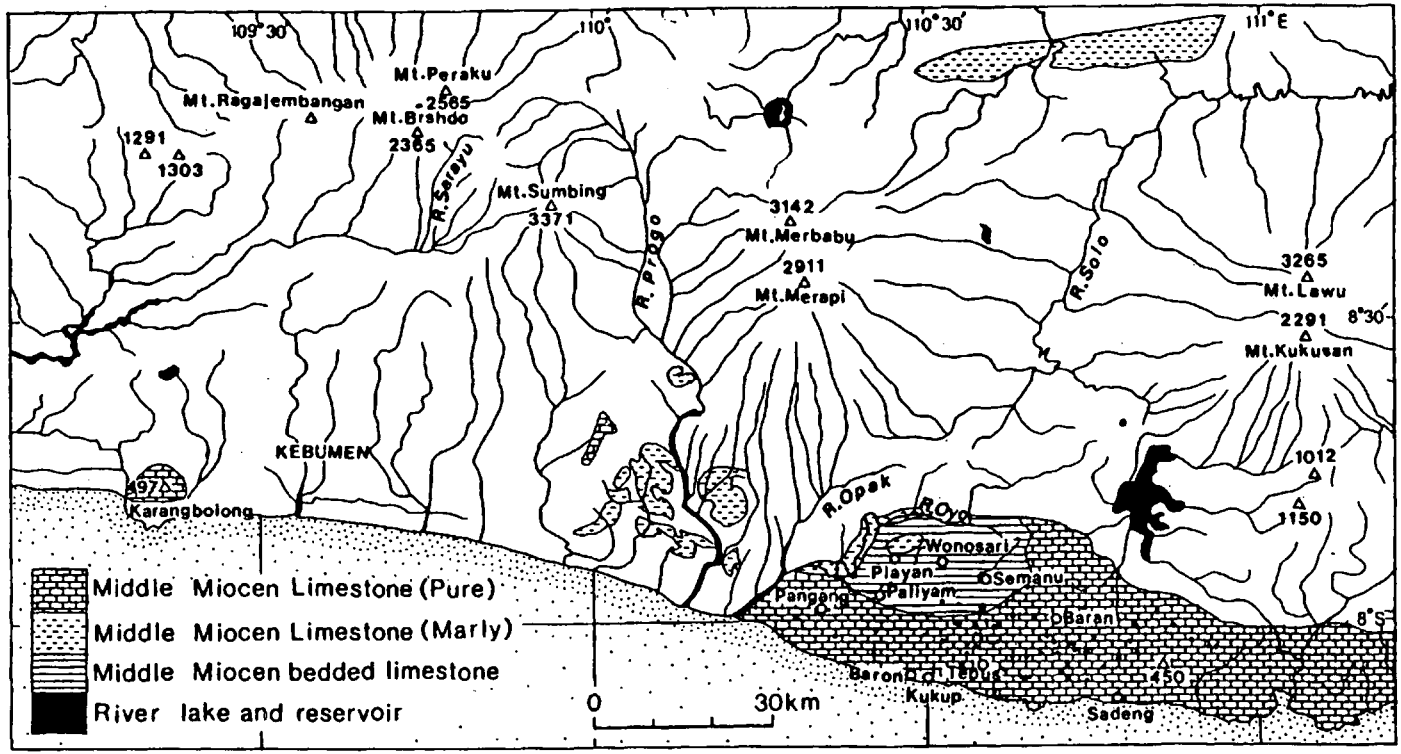

Figure 1 *Distribution map of Miocene limestone and calcareous marl, Tertiary in Southeastern part of Java Island*

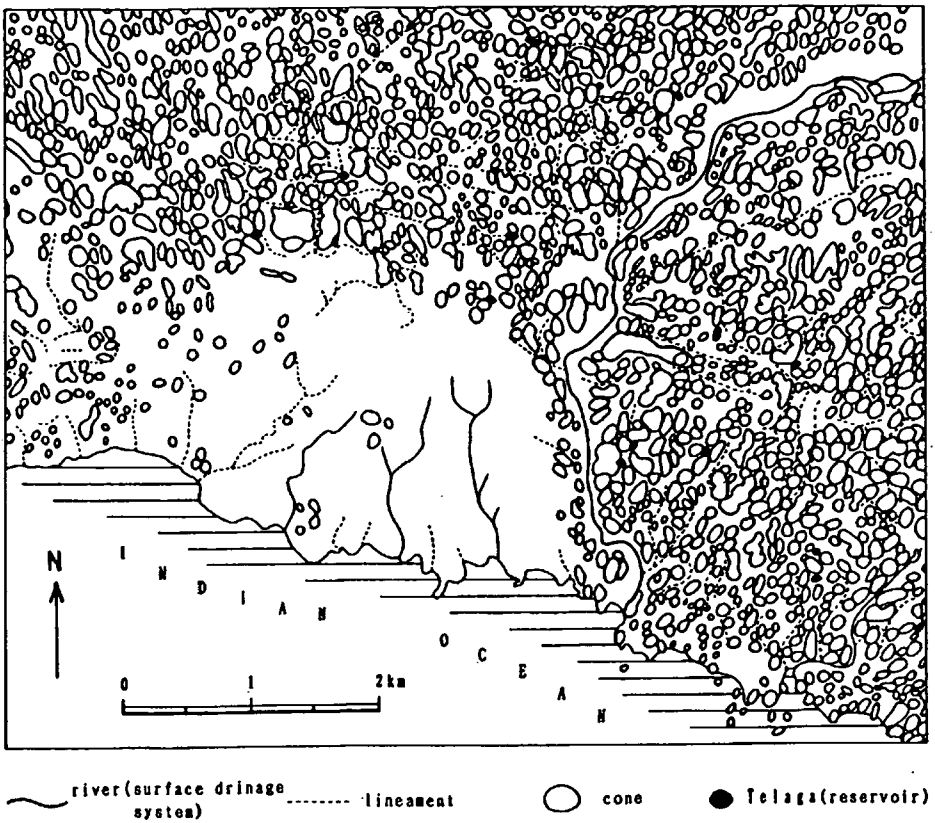

Figure 2 *Topography and drainage systems in limestone and sandstone areas at the river mouth of Kladen river*

controlled by the condition of micro-topography. The farm lands in the bottom of doline or depression areas are used as fields. But the slopes of cones are used only for poor fields during all seasons. The deep soil filled depression, which have springs, are used as Telaga. The model of land use by season are shown on *Fig. 4* (Urushiba-Yoshino, 1991). In the most poor areas for cultivation, only cassava is seen.

(2) Population density and soils

In part of the inland area of Gunung Sewu, geology is composed by Tertiary Miocene marl. This area is a karst polje with Grumusol, which is very fertile for agriculture, because of containing montmorillonite. Areas outside of limestone are composed by andesite or sandstone.

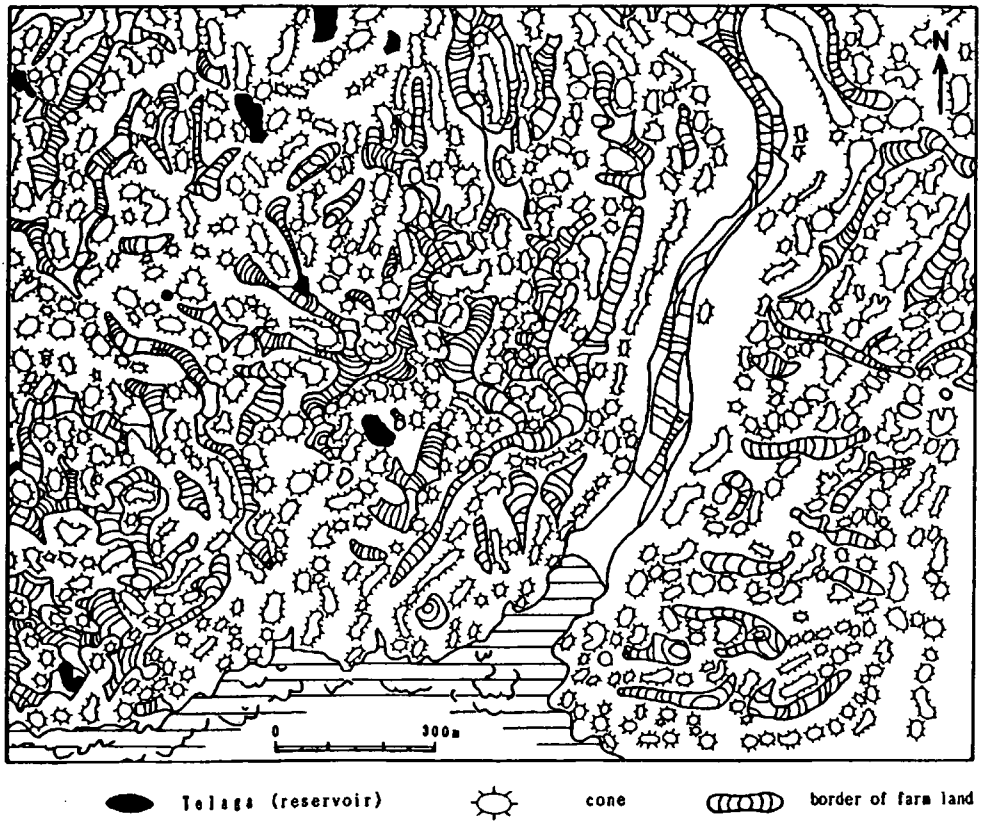

Figure 3 *The border of farm land controlled by micro-topography in cone karst and Sadeng dry valley*

These areas are covered by thick Latosol. The distribution map of soils is shown on *Fig. 5*. The population density of subdistricts is related to soil type. Especially, it is noteworthy that Wonosari subdistrict having Grumusol keeps 936/km² (1991). This population density is almost equal to the paddy cultivation area in a rich alluvial plain. The pure limestone are Paliyan, Rongkop and Tepus. The population of Tepus 359/km² has the highest value. It seems to be that the cone karst areas have reached their limit of population density. Latosol areas in other geological conditions can keep higher densities than in the Red soil areas in one karst area.

(3) Population in karst areas

It is well known that El Nino is one of the causes of abnormal climate in the Monsoon area. Especially strong El Nino 1982-83, weak one 1987 and weak one 1991-93 are well known.

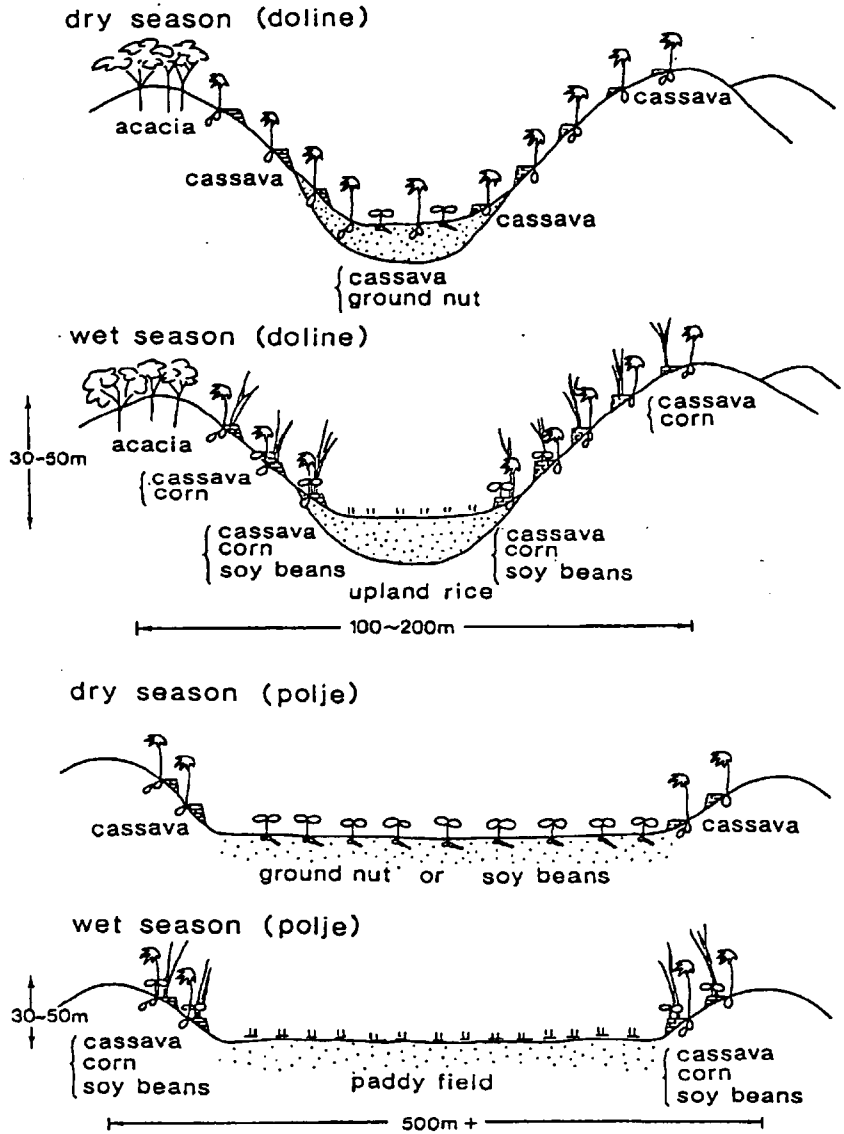

Figure 4 *Agricultural crops in the dry season and wet season in the polje and doline in Gunung Sewu*

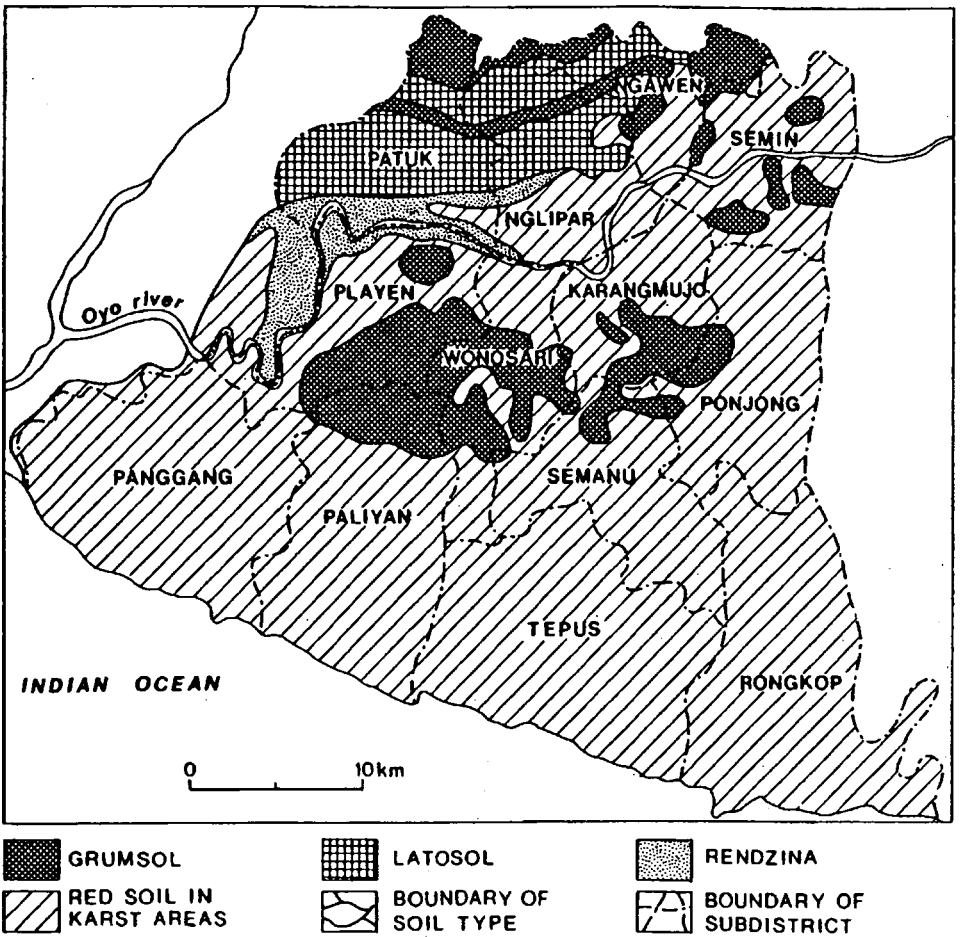

Figure 5 *Soil distribution and the subdistrict of Gunung Kidul*

The relation between El Nino and precipitation in Java Island is shown on *Fig. 6*. The precipitation from 1980 to 1991 and the anomaly of sea surface temperature at 120° W show clearly the effect of El Nino which caused particular as long dry season without rainfall in 1982 and less rainfall in the wet season of 1982/83.

In 1987 El Nino year, it appeared that the dry season of 1987 was longer than in a normal year. Since 1980, the population and family number of subdistricts we got from the Statistical Office in Yogyakarta. *Fig. 7* shows the comparison of population and families in the red soil areas (Panggang, Rongkop) and Grumusol areas (Wonosari). Population and family numbers of 1983 decreased in Pangang and Rongkop dramatically. In 1987, the population in Panggang and Rongkop decreased. But; in both El Nino years, population

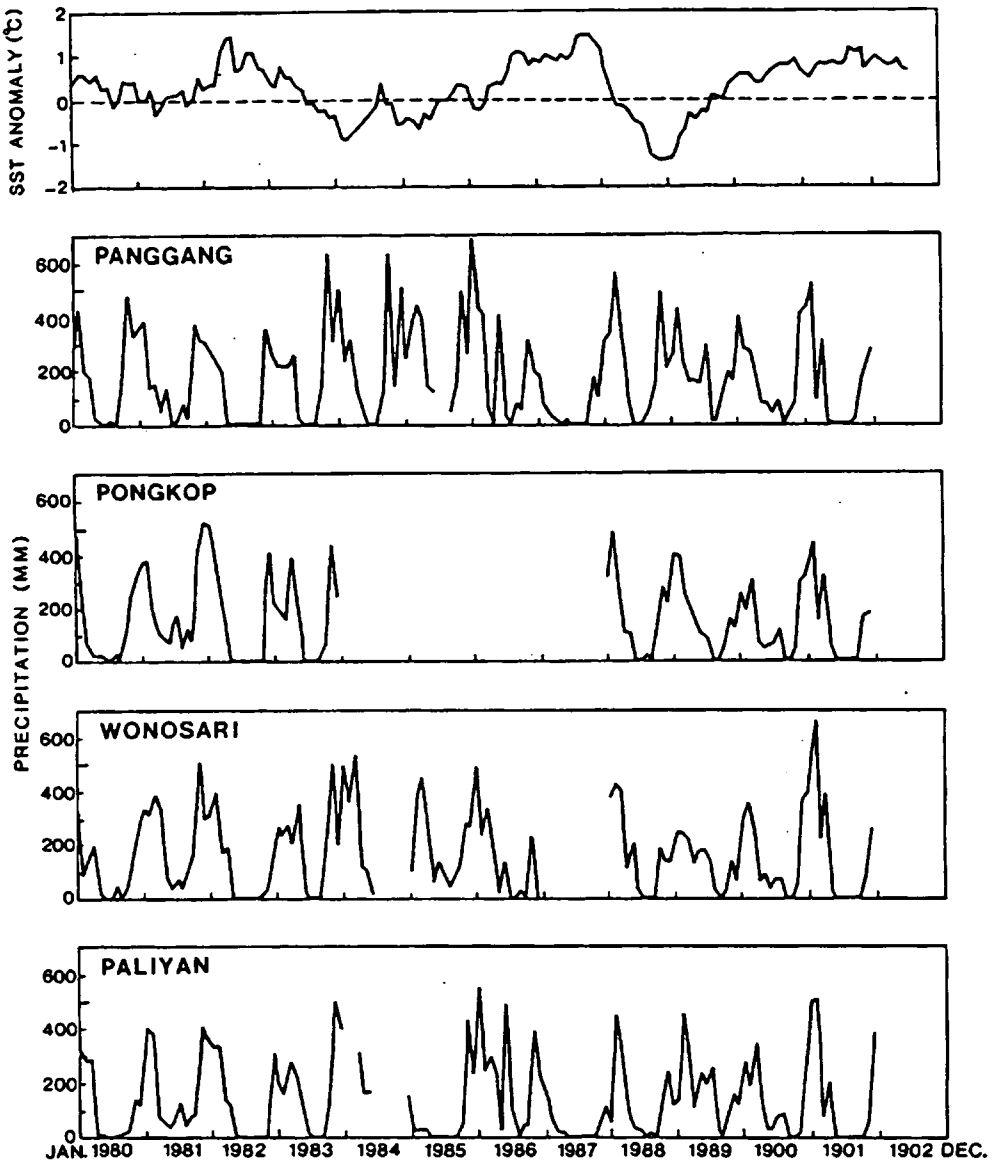

Figure 6 *Fluctuation of SST annomaly in the sea area os El Nino 4 and precipitation at 4 stations in Gunung Kidul 1980-1991*

and family number is steadily increased in Wonosari. It seems the Wonosari was not so strongly effected by El Nino, and people moved from the cone karst areas to Wonosari or some other city urban areas under such anomalous weather conditions.

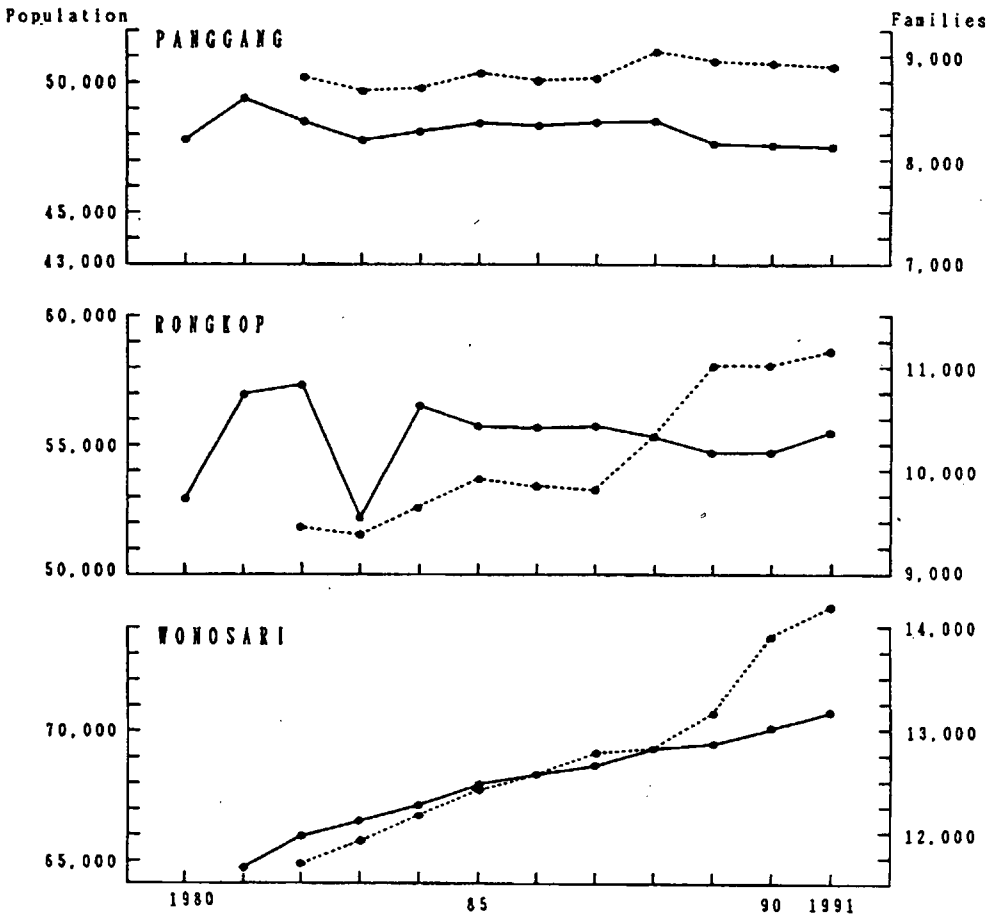

Figure 7 *Changes of population and number of families in Panggang, Rongkop, Wonosari in 1980-1991. Full lines show population and dotted line the number of families*

In 1983, they were sensitive for drought in cone karst area. Especially the polje areas of Grumusol and Red soils in limestone area with cone karst were affected seriously by anomalous weather conditions caused by El Nino. Some traditional Telaga were also dried up in the drought year in cone karst areas. So the government tried to find a way to supply constant water quantities for agriculture and living.

Since 1980's, the Government supported the building of tanks which collect rainfall through roves of houses. After that, the Government tried to pump up underground water with one set for each 5 families (*Photo 2*). Since 1991, each of the families must pay for water supply by the measured amount used. This means that the farmers had to change the

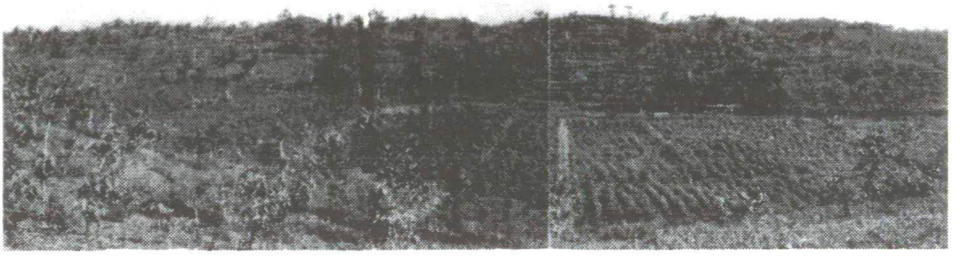

Photo 1 *Agricultural land use in the cone karst areas of Gunung Kidul and within the dolines (taken by URUSHIBA-YOSHINO on 04. Jan. 1994)*

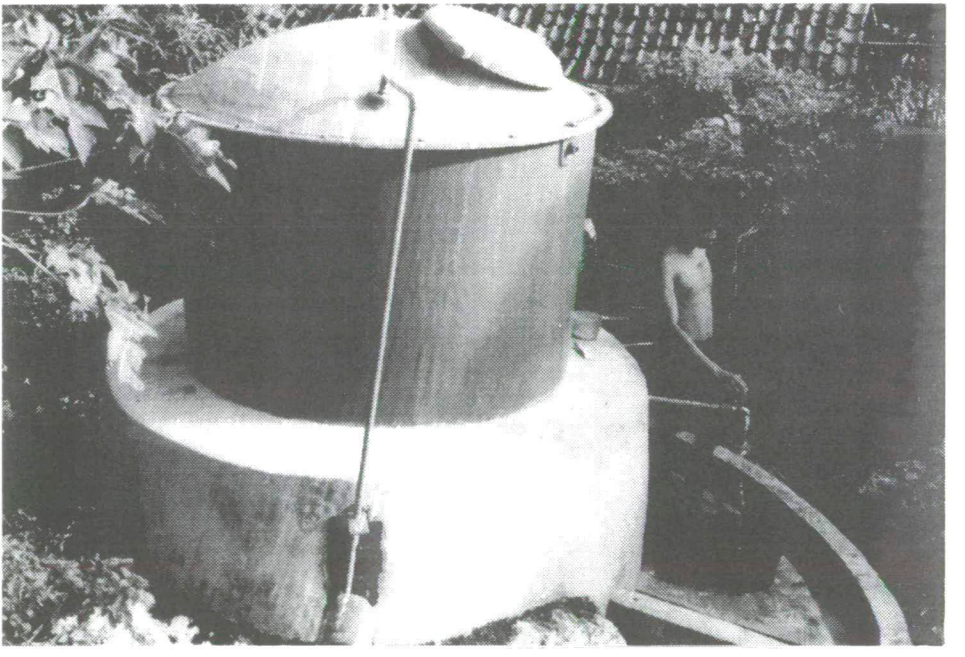

Photo 2 *A tank for water supply which is supplied since 1991 for 5 families each (taken by URUSHIBA-YOSHINO on 04. Jan. 1994)*

system of cost-free water to charged water. For the farmers, the water supply is a heavy economic burden. These areas are still restricted at present, but the water problem will become a more severe in the near future.

CONCLUSIONS

1, In cone karst areas, the population density is usually very low in the other countries like as Puerto Rico and Jamaica. But in Gunung Sewu, the population density is exceptionally high being about 395/km^2 (Tepus, 1991). therefore, agricultural land use is very intensive. On the other hand, the Grumusol area in a Polje has high productivities, but population density is also high, 936/km^2 (Wonosari, 1991).

2, During the El Nino years like 1982-83, population and family numbers decreased in the especially most dense cone karst of Panggang and Rongkop. But, in Wonosari, population and family numbers increased continuously showing no relation to El Nino years.

3, In weak El Nino year of 1987, Panggang and Rongkop had very abnormal weather conditions. El Nino caused a slight decrease of population and family numbers.

4, It is obvious that the drought caused by El Nino resulted in an out-flow of farmers from limestone areas to the productive areas such as Wonosari.

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Address of author: Kazuko URUSHIBARA-YOSHINO
Department of Natural Sciences
The Komazawa University
Komazawa 1-23-1 Setagaya-Ku
Tokyo, 154 Japan