

Influence of the 2016 Kumamoto Earthquake to the Flooding Project conducted in the Middle Shira-river Area

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The central area of Kumamoto prefecture, which consists of eleven municipalities (hereinafter referred to as Kumamoto area) with a population of about one million people, has the biggest use of groundwater in Japan. The main recharging area of groundwater in the Kumamoto area is rice paddy fields that are located along the Middle Shira-river that runs from east to west, from the Aso caldera through the Kumamoto city. The first paddy field reclamation in this area was done at the beginning of the Edo period; Kiyomasa Kato who ruled Higo province (former name of the Kumamoto prefecture) back then planned to build seven weirs along the Middle Shira-river in order to develop local rice farming culture. By the Meiji period, this region became one of the major paddy rice production area of the prefecture which had reached 1500 ha and these paddy fields had high seepage capacity of over 100 mm/day. As a result, both the amount of groundwater from the Kumamoto area and the discharge from the downstream of spring water areas in the mid Shira-river were increased substantially. However, after the rapid economic growth began in the 1970s recharge rates of groundwater decreased every year due to the urban development and shift in consumers' food preferences which caused reduction in rice planting rate in Japan. As a consequence, the amount of groundwater recharge in the Kumamoto area decreased for a long period of time because there were some farmers started to grow other crops instead of rice to suit the market demand. The Flooding Project kicked off in 2004, which is a countermeasure to increase the amount of groundwater recharge in the area by filling these farmlands.

There were not many local farmers supported this project at the beginning due to the lack of understanding of the project intention. However, the number of participants gradually increased every year, the Kumamoto city government and five companies fund this project which partly used as cooperation fees to compensate supportive farmers. 10 years after the launch of the project, the amount of groundwater recharge in the area exceeded 20,000,000 m³. The recharge amount of flooded paddy fields is calculated by multiplying the number of days that fields were filled with water, the water surface area and daily seepage rate of the fields. The daily seepage height was observed at more than 100 locations and a distribution map was created in order to calculate the seepage height of each paddy field. The amount of groundwater in the paddy fields was also calculated by the same method. The data collections of daily seepage rate from paddy fields were conducted before and after the season of drying-up the paddy fields which is at the end of every July. In 2013, the amount of the groundwater recharge became about 70,000,000 m³, which increased by 20,000,000 m³ from the outcome of 2004. The amount of groundwater recharge from flooded paddy fields had been maintained at about 20,000,000 m³ between 2007 and 2015. The groundwater level of the Kumamoto area was also able to recover from the long-term downward trend and was able to move towards a slight upward trend during this period.

Two large earthquakes with a seismic intensity of seven hit Kumamoto prefecture on April 14th and 16th in 2016. This is so called the 2016 Kumamoto Earthquake. The main shock happened at 1:26AM on the 16th, which involves both intense vertical swings and long lateral swings, occurred many cracks and landslides especially along fault belts. Furthermore, localized torrential rain in the following June generated further disasters. Rainwater loosens damaged grounds and occurred many more landslides. The paddy fields along the Middle Shira-river were also severely damaged by earthquakes and heavy rains. Many of their irrigation canals attached to seven weirs were blocked and unable to supply water for rice cultivation. The

Flooding Project was also forced to stop for a while. In 2017, damaged irrigation canals were restored and both rice cultivation and the project was mostly resumed, yet there are still some fields have not been entirely recovered.

In this paper, we will present the status of the Flooding Project conducted these past fourteen years, and impacts of the 2016 Kumamoto Earthquake on the project and local groundwater.

Keywords: The Flooding Project, Groundwater Recharge, 2016 Kumamoto Earthquake, Kumamoto Area