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Analysis of the Impact of Reservoir Development on the Availability of Water for Paddy Farming in Sanjai Village, East Sinjai District, Sinjai Regency

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Water supply which is a resource that must be sufficient in paddy farming. Reservoirs are civil construction buildings in the field of hydrology that are used to hold water so that it does not go straight to the sea, so that it can be used to improve the availability of water supply to paddy fields that cannot be reached by technical irrigation. The purpose of this study was to differentiating between the effects on water availability, farmer productivity, and economic impacts of the construction of the reservoir on the community. This study was conducted in Sanjai Village, East Sinjai District, Sinjai Regency. A total of 55 respondents of this study were farmers whose paddy fields used water from the reservoir and planted paddy as the main commodity of their farming. The method used to analyse the data was descriptive analysis and paired sample mean different test. The results of the study showed that the effect of reservoirs on water availability in addition to increasing farmer productivity can also reduce the risk of agricultural business due to drought and increase opportunities for farming, especially during the dry season. In addition, the construction of the reservoir has affected the availability of water in Sanjai Village, which was experienced by farmers after the construction of the reservoir, as well as a decrease in the intensity of floods and droughts, the smooth supply of water for the needs of farmers in farming in paddy fields so that the availability of water for farming in paddy fields is more sufficient after the construction of the reservoir and the impact after the development of the reservoir, from an economic point of view, the community was increasing production and productivity. It can be concluded that the construction of the reservoir has been achieved and the function of the reservoir for farmers was very useful and can also change cropping patterns as well as improve crop cultivation.
Keywords*:* Water supply, hydrology, farmer productivity, cropping patterns, economic benefits.

INTRODUCTION

Water is an important part of life, without water there will be no life, agriculture is no exception. Water scarcity due to climate change and environmental damage has hit various regions in Indonesia. Reservoir (Embung) is a civil construction building in the field of hydrology, in which has the ability to retain water (suprihati et al., 2018). The concept of a reservoir basically provides a solution as a water reserve, which means that during the rainy season water is stored in the reservoir, and during the dry season the water in the reservoir can be used as needed. Small reservoirs function as raw water storage structures (Guerra et al., 1990) to serve one or several hamlets in one village. Reservoirs are water management (Kudo et al., 2015) and effective in overcoming water shortage areas, both raw water and irrigation. The purpose of developing the reservoir is to create a standard water supply system to supply water for the needs of some villagers and for irrigation purposes.

Irrigation is a field of development of water, water sources, including the animal natural resources contained therein, both natural and cultivated by humans. Rainfed land is agricultural land that does not get a supply of irrigation water, so that the water needs of plants are met only from rainfall. This situation causes frequent crop failures or crop yields that are not optimal due to a lack of water. The success rate of the construction of a reservoir can be assessed by analyzing its performance, namely by carrying out a system approach that refers to 3 aspects; physical, utilization, and operational aspects as well as maintenance (Meluk, 2015). Agricultural reservoir infrastructure is used as an irrigation supplement to irrigate agricultural land during the dry season, both for food crop commodities (paddy, crops) and for horticultural commodities (vegetables). This is due to the limited volume

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of water available in the reservoir, so that the use of water must be carried out efficiently.

The need for water for drinking, cooking, bathing, washing clothes as well as for larger needs, namely irrigating paddy fields and others. This is often felt by the people in the East Sinjai Regency. As an area that has an area of rainfed paddy fields of about 7000 ha. The existence of the reservoir is expected to meet the water needs for local paddy fields. The work system for improving and maintaining the network for the construction of reservoirs according to standards is very much needed in an effort to increase paddy production, especially to fulfill the logistics of the people of Sinjai Regency. The increase in paddy production is expected to be directly proportional to the income of farmers in this region. Therefore, the purpose of this study was to differentiating between the effects on water availability, farmer productivity, and economic impacts of the construction of the reservoir on the farmers in Sanjai Village.

MATERIALS AND METHODS

***Population and sample*:** The total population of farmers in the village of Sanjai is 515 people who work as farmers. The reservoir in Sanjai Village involved in the present study was the Bisokeng Embung which is flanked by two rivers; the Santung and the Batusantung Rivers. The samples of the study were farmers who are members of farmer groups who are affected by the construction of this reservoir; the Takalala Farmer Group and the Bisokeng III Farmer Group. The Takalala Farmer Group has a total of 30 members and the Bisokeng III Farmer Group has 25 members and all of them take advantage of the available water in the reservoir construction.

Respondents in this study were farmers whose paddy fields used water from the reservoir building in Sanjai Village and planted paddy as the main commodity of their farming, so that the respondents in the study were members of the both farmer groups (55 farmers in total). According to Arikunto (2002), if the population is less than 100 then all are taken. However, if the population is greater than 100, 10-15% or 20-25% or more can be taken. Apart from that, we also took or interviewed village officials and local officials related to the building of the reservoir and its impact on the community, from an economic, social and environmental perspective.

Data collection: Data collection was carried out by means of literature and interviews using the help of a questionnaire. The data collection was using a list of questions that are arranged systematically, then answered by the respondent. In addition, open and/or closed questionnaire answer forms were also carried out. Open questions were questions that were made by completely giving the respondent the freedom to answer without any alternative answers being provided. Closed questions were carried out using a questionnaire to be answered by respondents.

The personal experience data of the respondents themselves with the alternative answers provided were listed in the questionnaire. With the questionnaire, data on the characteristics of the respondents were obtained, such as how long they had lived in the village or study location, the area of origin if previously they came from another area, the main occupation of the respondent and the data was in the form of characteristics (Prasetyo and Jannah, 2006). Then in addition to using a questionnaire, the interview method was also used in this study. An interview was an act of collecting data by asking questions directly face to face with the respondent with or without using an interview guide. The purpose of using this interview method was to get more in-depth answers about the impact of the construction of the reservoir in the area.

Data analyses: The data that has been obtained through the questionnaire was tabulated by grouping the questions into several groups. Furthermore, the data was explored in more depth using interview data. The answers from the informants were presented in the form of a concise and clear matrix so that it was very helpful in interpreting large amounts of data and makes it easier to draw conclusions. Data analysis was carried out using the constant comparative method or what is often known as grounded research.

The main principle of this analysis is to process and analyze the collected data into systematic, orderly, structured and meaningful data. While for the second objective, the data obtained through questionnaires was entered into the SPSS data processing tool. The aim was to test whether there was an impact of the construction of the reservoir on the local community's economy, or in statistical terms to test. Therefore, t-test was used to compared paddy production and farmers' income before and after the construction of the reservoir.

RESULTS AND DISCUSSION

***Effect of reservoir development on water availability*:** The development of reservoir, besides being aimed at providing water availability, is also aimed at overcoming floods caused by river water. In Figure 1, it can be seen that of the 55 respondents interviewed, 89% of respondents stated that floods had never occurred again after the reservoir was built, but 11% of respondents stated that floods had occurred. So that the effect of the construction of the reservoir in overcoming flooding is that when there is an overflow of water in the river, the reservoir can accommodate water and run off (Guerra et al., 1990) in the surrounding area as well as other possible water sources such as springs, ditches, and small rivers.

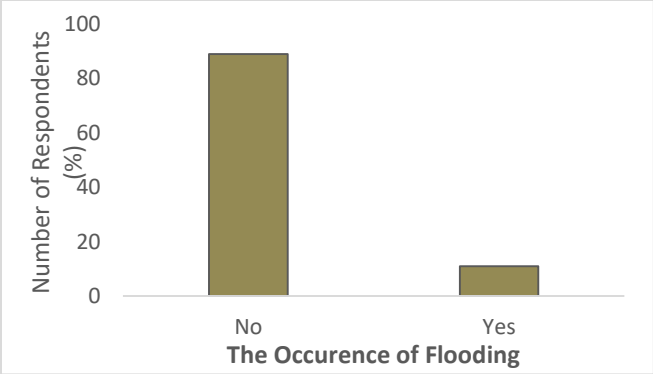

Figure 1. The effect of reservoir construction on the occurrence of flooding.

The construction of the reservoir plays an important role to the farmers, in which bringing water security (Pinhati et al., 2020) and is able to overcome flooding during the rainy season because it is accommodated in this reservoir as artificial water stores due to decreasing water availability (Thomas et al., 2011). In addition to storing excess water, reservoirs are also used as channels for draining excess water into rivers. Besides being able to overcome floods, the construction of reservoirs can also overcome drought because the reservoirs can provide a source of water as irrigation supplementation in the dry season for crops, horticultural seasonal crops, seasonal plantation crops and livestock. Of the 55 respondents interviewed, 13% of respondents stated that there had been a drought after the construction of the reservoir and 87% of respondents said that there had never been a drought again after the construction of the reservoir. So it can be stated that the construction of reservoirs greatly affects the continuity of paddy farming in this area because reservoirs can have a major influence on the availability of water which can increase paddy production and also the risk of experiencing crop failure is very small. The thing that is felt to be the most profitable for the farmers is the availability of sufficient water for them to manage their farming business as reliable source of water for irrigation (Pinhati et al., 2020). Farmers' opinions about water availability in detail can be seen in Figure 2.

Lack of water availability in the dry season is a vital problem in dryland regions (Zhang et al., 2016) and this area is included in it. Prior to the construction of the reservoir (2019), there was 45% of respondents stated that water supply was lacking. This means that before development of a reservoir, the supply of water for farming was very lacking. In 2022, 84% of respondents stated that the water supply from the reservoir is sufficient. This means that after the construction of the reservoir, water supply for farming is quite good. Furthermore, there were no farmers who lack water for their farming after the construction of the reservoir, which was very helpful for the farmers in irrigating their fields.

From the data above, it can be seen that the adequacy of water for paddy fields is getting better, so that with the availability of sufficient water it can give hope for farmers to be able to increase paddy productivity. Reservoir construction is very useful, especially during the dry season. The existence of a reservoir makes farmers no longer experience water shortages. This is in accordance with the objectives of building a reservoir as stated by the Directorate of Water Management, 2020 in the Technical Guidelines for Rehabilitation of Farm Level Networks or Development of Village Reservoir, Directorate General of Land and Water Management that the construction of a reservoir is required for water regulation which includes supply, distribution, administration, use and disposal of reservoir water.

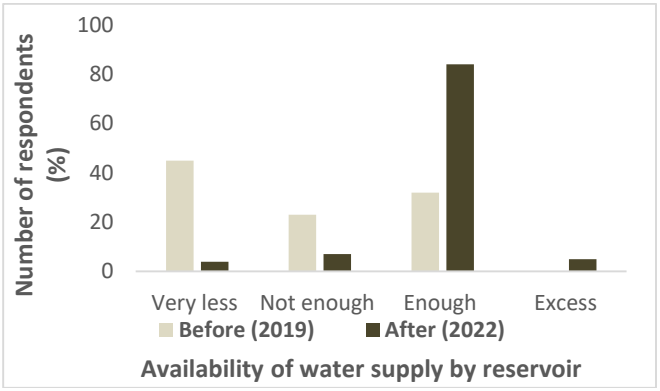

Figure 2. The effect of reservoir construction on the availability of water.

Another impact of the construction of this reservoir is that the frequency of carrying out mutual cooperation in cleaning the river has decreased. Prior to the construction of the reservoir, it was still common practice to clean the river together. This indicates that farmers still hope for the river to get water availability. After the construction of the reservoir, mutual cooperation in cleaning the river is rarely done. They assume that after the construction of the reservoir, the related agency prepares a budget for the maintenance of the reservoir, even though the farmers should be aware that togetherness in maintaining the reservoir between farmers and related agencies can be profitable and also maintain the continuity of the function of the reservoir. According to Mardjuki (2001), an increase in financial relations will be followed by an increase in strong social relations between water users. Especially for regions with very strong leadership, reservoir maintenance is carried out through payment of reservoir maintenance fees and accompanied by mutual cooperation activities. Contributions are used to purchase equipment to be used for maintenance of the reservoir, while the work will be carried out by farmers through mutual cooperation. In reality what happened in this area, reservoir maintenance fees were used to pay for labor to maintain the reservoir, so the intensity

of mutual cooperation has decreased. Maintenance fees for reservoir are budgeted by the Food Crops, Horticulture and Plantation Service and the amount depends on the age of the reservoir.

***Effect of reservoir development on the economic condition of village communities*:** In general, the construction of reservoirs in this area has an impact on improving the community's economy. This increase was due to increased paddy productivity which in turn increased farmers' income. The increase in the amount of paddy production may be due to the availability of water which is quite good as a result of the building of the reservoir. Besides that, with this reservoir, it is also possible to increase soil fertility which may be caused by ecosystem restoration which in turn can affect soil conditions (Pinmongkhonkul *et al.,* 2023).

***The Impact of Reservoir Development on Paddy Productivity in Sanjai Village*:** The thing that is felt to be the most beneficial for farmers is the increased productivity of paddy production which is the impact after the construction of the reservoir. Paddy production before and after the construction of the reservoir in detail are shown in Figure 3. Before the construction of the reservoir, paddy production in this area was around 7 tons/ha, and increased to 8.52 tons/ha after that. This means that there is a significant increase in paddy production (P<0.001) after the construction of the reservoir.

Figure 3. The average of paddy production before and after the construction of the reservoir.

Table 1. Paddy production before and after the construction of the reservoir.

Paddy production (Tons/Ha)	Construction of the reservoir	
	Before	After
	Number of farmers (%)	
< 5	34.6	10.9
5 – 10	52.7	60.0
> 10	12.7	29.1

Specifically, Table 1 shows that before the construction of the reservoir, paddy production greater than 10 tons/ha was only 12.7% and increased to 29.1% after the construction. Likewise, paddy production between 5 to 10 tons/Ha, increasing from 52.7% to 60.0% after the construction. On the other hand, paddy production of less than 5 tonnes/ha was decreased from 34.6% to 10.9%. This means that after the construction of the reservoir, the farmers' paddy production has increased significantly.

Increased paddy productivity in this village might be caused by several things 1) the existence of a reservoir encourages farmers to make better use of production inputs such as fertilizers and pesticides. The existence of a reservoir also encourages farmers to apply better farming techniques. This led to an increase in the average productivity of farmers; 2) the existence of a reservoir has made it possible for farmers to increase cropping intensity. Reservoir allows farmers to plant all year round. Increasing cropping intensity will increase total production per year; 3) there is a change in farmers' paddy cropping pattern due to the availability of water from the reservoir which is sufficient so that they can do farming without fear of no water supply.

***Impact of Reservoir Development on the Income of Farmers in Sanjai Village*:** As described in the previous section, the construction of the reservoir has increased paddy production and productivity in Sanjai Village. The increase in production and productivity also led to an increase in farmer's income. The different test showed that the average nominal income after the construction of the reservoir significantly higher (P<0.001) in comparison to before construction (Figure 4). The average income of farmers before the construction of the reservoir was IDR 18,955,281 per year while the average income of farmers after the construction was IDR 28,054,931 per year. This suggests that there is an increase in average about IDR 9,099,650 per farmer.

Farmers' income from paddy fields is very important for this area. This is because only this job can be relied upon to support his family. Therefore, the construction of ponds is very important for farmers as part of the government's political economy impact (Kurosaki., 2008).

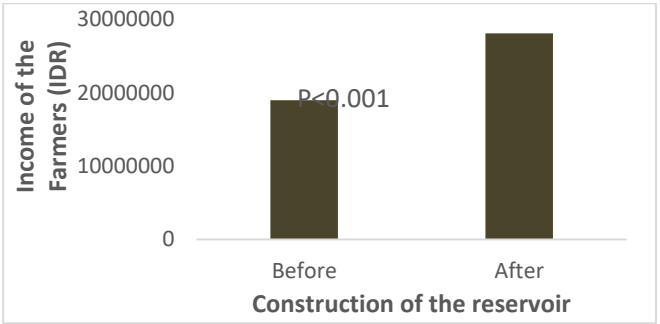

Figure 4. The average of farmers' income before and after the construction of the reservoir.

***Conclusions*:** Based on the description in the present study, it can be concluded that 1) The effect of reservoirs on water supply in addition to increasing farmer productivity can also reduce the risk of agricultural businesses due to drought and increase opportunities for farming, especially during the dry season. In addition, the construction of the reservoir on the availability of water in Sanjai Village experienced by farmers after the construction of the reservoir can also be seen from the decrease in the intensity of floods and droughts, the smooth supply of water for the needs of farmers in farming in paddy fields so that the availability of water for farming in paddy fields is increasingly sufficient after the construction of the reservoir; 2) The impact after the construction of the reservoir from the economic point of view of farmers is increased production and productivity, so that the goal of building a reservoir is achieved and also the function of the reservoir is very beneficial for farmers and can also change cropping patterns as well as improve crop cultivation. However, since this finding is a local problem of the paddy farmers, it might not be applied in the other areas. Nonetheless, it is necessary future research are needed based on the problem in certain area.

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***Conflict of Interest Statement*:** The authors declare that there is no conflict of interest in performing this study.

***Informed consent*:** Written informed consent was obtained from all participants regarding publishing their data.

Author's Contribution*:** *La Sumange,** Drafting and planning the study, collecting and analyzing data, writing the manuscript. Jamal, Collecting and analyzing data, writing the manuscript.

***SDG's Addressed*:** Zero Hunger, Climate Action, Life on Land.

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