

Management of irrigation systems in padi growthusesin the context of climate change (panincong village case kec. Marioriawa kab. Soppeng)

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Abstract

This study aims to: (1) determine the impact of climate change on the availability of water for paddy rice farming in Panincong Village, Marioriawa District, Soppeng Regency; (2) determine the perception of farmers related to the management of irrigation systems for paddy rice farming in Panincong Village, Marioriawa District, Soppeng Regency; and (3) determine the perception of farmers related to changes in the management of irrigation systems for paddy rice farming in Panincong Village, Marioriawa District, Soppeng Regency as a result of climate change. This research was conducted from March to July 2024, in Panincong Village, Marioriawa District, Soppeng Regency. The population in this study were owner farmers in Panincong Village who had cultivated rice paddies for at least 15 years, as many as 50 rice paddy farmers. Determination of the sample is done by using a census or saturated sampling technique where all members of the population are used as research samples. Data analysis used is descriptive analysis by combining scoring and qualitative descriptive. The results showed that the impact of climate change on the availability of water for rice paddy farming in Panincong Village includes; water shortages on rice fields, changes in river water discharge and changes in groundwater availability. Farmers' perceptions related to the management of irrigation systems from various aspects are in the medium/good and high/good categories. Farmers' perceptions of irrigation infrastructure are in the high or good category, irrigation water is in the medium or good enough category, irrigation management is in the medium or good enough category, irrigation management institutions are in the high or good category and human resources are in the high or good category. Farmers' perceptions related to changes in the management of irrigation systems in wet-rice farming due to climate change from various aspects are in the category of low / poor and moderate / quite good. Farmers' perceptions of irrigation infrastructure are in the moderate or quite good category,

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irrigation water is in the low or poor category, irrigation management is in the moderate or quite good category, irrigation management institutions are in the moderate or quite good category and human resources are in the moderate or quite good category.

Keywords: Climate Change, Paddy Rice Farming, Perception, Irrigation System Management.

INTRODUCTION

Climate change is a serious problem that is being faced now. This climate change can be characterized by erratic rainfall and in the long term occurs continuously (Bappenas, 2021). There are 3 main factors in crop cultivation namely climate, soil and plants (Estiningtyas & Syakir, 2018). Climate change is closely related to the agricultural sector where agricultural activities are one of the factors that influence climate change, namely the agricultural sector contributes methane gas (CH₄) and nitrogen oxide gas (N₂O) which are greenhouse gases. However, climate change can also pose serious challenges for the agricultural sector.

An agricultural commodity that is particularly affected by climate change is paddy rice (Rusmawan *et al.*, 2018). At the beginning of the growing season, farmers usually rely on rainfall to replenish water in rice fields. If the rainy season does not provide sufficient rainfall, then the rice fields will lack water which can be a threat. When the dry season arrives, previously fertile rice fields can become dry land and cause plants to die. One of the efforts or strategies that can be done to overcome the problem of water availability caused by climate change, namely less or excessive rainfall on wet rice farming is by managing the irrigation system.

South Sulawesi Province is one of the producers of paddy rice in Indonesia. One of the rice producing districts in South Sulawesi is Soppeng Regency which has the seventh largest harvest area of all districts in South Sulawesi with a total harvest area of 51,274.80 ha and a total production of 280,911 tons. Of the 8 sub-districts in Soppeng Regency, Marioriawa Sub-district is the largest rice paddy producing sub-district with a rice harvest area of 11,579.90 ha and a total production of 64,357 tons (BPS South Sulawesi, 2021). Marioriawa sub-district is a sub-district where one of the types of irrigation for paddy fields comes from irrigation with an area of 5,408.00 ha (Agriculture Office of Soppeng Regency, 2020). Of the 10 villages in Marioriawa Sub-district, Panincong Village is one of the villages where most of the population earns a living as wet-rice farmers. The area of rice fields is approximately 800 ha, most of which are irrigated by a network or irrigation system from a river source connected to Panincong Village. . In Panincong Village, there are 2 irrigation areas, namely the labuleng irrigation area and the cempae irrigation area . Irrigation in Panincong Village is irrigation that has long been built by the government for the



needs of rice fields. The uncertain availability of water is influenced by seasonal factors or climate change which can be a major obstacle for rice farming. Based on data from the Agricultural Extension Center (BPP) of Marioriawa District, it is known that there are fluctuations in the amount of rainfall in the research area. The year 2010 was the year with the highest amount of rainfall which was 2,904 mm/year and for the lowest amount of rainfall was in 2015 which was 939 mm/year. The graph of the amount of rainfall in Panincong Village, Marioriawa District, Soppeng Regency can be seen in Figure 1.



Image 1 Graph of Total Rainfall in Panincong Village, Marioriawa District, Soppeng Regency 2009-2023 (Source: BPP Panincong Village, Marioriawa District)

Figure 1 shows that the amount of rainfall in Panincong Village, Marioriawa Sub-district, is not consistent every year. In addition to the data obtained from the Panincong Village Agricultural Extension Center (BPP) Rain Post per month, there are fluctuations in rainfall in certain months. That is, in months that are supposed to be wet months or the rainy season, sometimes there is a drought or dry season. For example, what happens in December, which should be a wet month, but there are several years of drought in that month. In December 2023, rainfall only reached 42 mm/month while in the previous year, the amount of rainfall reached 312 mm/month. This makes it difficult for farmers to delay the planting schedule. Saediman *et al.* (2021) argued that the amount and distribution of rain fluctuates every year, so farmers have to adjust their planting schedule which results in the planting schedule being often delayed.

In the dry season (prolonged heat) the availability of water will decrease, so that the need for water in rice fields cannot be met optimally and experience drought as well as during the rainy season excessive (high rainfall) will cause the availability of water to increase significantly so that it often causes flooding of rice fields. However, this can be overcome with regular and good management of the irrigation system.

Based on the description of the background, it is necessary to conduct research on "Management of Irrigation Systems in Rice Paddy Farming in the Context of Climate Change (Case of Panincong Village, Marioriawa District, Soppeng Regency)".

METHOD

The population in this study were all owner farmers who had cultivated paddy rice at least 15 years, totaling 50 people. In this study, samples taken from the population using a census or saturated sampling technique, namely the sampling technique when all members of the population are used as samples because the population is less than 100 or relatively small. Based on this description, it can be seen that the sample used was 50 people. Data collection techniques were carried out by observation, interviews, questionnaires, and documentation. The data analysis techniques used in this study are;

1. Analysis of the Impact of Climate Change on Water Availability. In this case, respondents' answers to questions were made on a three-level Likert scale as a basis for scoring which can be seen in Table 1.

Table 1 Three-level Likert Scale

No.	Symbol	Description	Assessment Score
1	S	Agree	3
2	N	Neutral	2
3	TS	Disagree	1

To see the category of respondents' answers by looking for intervals from the formula Likert scale according to Sugiyono (2012) as follows:

$$I = \frac{\text{Skor Tertinggi} - \text{Skor Terendah}}{K}$$

The categories obtained from the above formula are as follows:

- 1.00 - 1.67 Disagree
- 1.68- 2.35 Neutral / Undecided
- 2.36 - 3.00 Agree

2. Analysis of Irrigation System Management of Rice Paddy Farming , in this case, the question items will be given appropriate answers with a 5-level Likert Scale .
3. Analysis of Changes in Irrigation System Management of Paddy Rice Farming as a Result of Climate Change, the scale used to measure the level of assessment of respondents of

paddy rice farmers on irrigation management and changes in irrigation management due to climate change is a scale of 1 to 5 which can be seen in Table 2.

Table 2 Five-level Likert Scale

No.	Symbol	Description	Assessment Score	
			Statement +	Statement.
1	SS	Strongly Agree	5	1
2	S	Agree	4	2
3	N	Neutral	3	3
4	TS	Disagree	2	4
5	STS	Strongly Disagree	1	5

According to Sugiyono (2011: 105) the measurement scale is an agreement that is used as a reference to determine the length of the interval in the measuring instrument, so that the measuring instrument produces qualitative data.

Furthermore, categorizes the respondents' answers by finding intervals using the Likert scale formula according to Sugiyono (2012) as follows:

$$I = \frac{\text{Skor Tertinggi} - \text{Skor Terendah}}{K}$$

Based on the formula above, it can be seen that the score interpretation criteria are as follows:

1.00 - 2.33	Low / not good
2.34 - 3.67	Medium / sufficient
3.68 - 5.00	High/good

RESULTS AND DISCUSSION

Impact of Climate Change on Water Availability

1. Farmers' Perceptions of Climate Change

Farmers' perceptions of climate change can be seen in Table 3 below.

Table 3 Farmers' Perceptions of Climate Change in Panincong Village, Marioriawa District, Soppeng Regency in 2024

Variables	Average Score	Category
Increase in air temperature	2,78	Agree
The timing of the arrival of the rainy season	2,82	Agree

and dry season becomes erratic		
Rainfall frequency and intensity become erratic	2,62	Agree
More frequent droughts	2,90	Agree
More frequent flooding	1,30	Disagree

Source: data (processed), 2024

Rice paddy farmers in Soppeng District perceive changes in climate conditions compared to the last 15 years, such as rising temperatures, seasonal uncertainty, and erratic rainfall intensity. A total of 42 farmers (93%) agreed that the air temperature is getting hotter, with an average perception score of 2.78, supported by BPS data showing an increase in temperature from 26.89°C in 2020 to 28.45°C in 2021. The uncertainty of the rainy and dry seasons was also agreed by 82% of farmers, with an average score of 2.82, resulting in difficulties in determining planting times and irrigation instability. Data from the Panincong Village Agricultural Extension Center shows that the rainy and dry season patterns often shift, such as rains that usually start in October are now delayed until November or December. Erratic rainfall intensity is felt by 35 farmers, with an average score of 2.62, making it difficult to plan planting and harvesting times. In terms of drought, 90% of farmers agree that the increasing frequency of drought (score 2.90) is a cause of crop failure. In contrast, the frequency of flooding was in the disagree category (score 1.30), although flooding events had occurred in 2021, causing losses to some paddy fields. These climate impacts contributed to a decrease in rice paddy harvest area from 48,562 hectares in 2020 to 47,466 hectares in 2021 (2.26% decrease), which in turn reduced paddy rice production.

2. Impact of Climate Change on Water Availability on Farms

This difference in perception occurs due to different experiences and awareness of farmers. The impacts of climate change felt by farmers on the availability of water on their farms are as follows;

- Based on the results of interviews, farmers stated that the changes in rainfall had a major impact on the availability of water used for their rice fields. They admit that they often experience water shortages for their paddy fields, the main cause of which is due to the long dry season and erratic rainfall. Erratic rainfall and lack of intensity can result in a long dry season or drought that affects the water available for irrigation of paddy fields to be reduced. In line with the opinion of Surmaini and Syahbuddin (2016) that in rainfed rice fields and irrigated rice fields where the availability of water is uncertain, determining the



beginning of the planting season really requires and considers rainfall for the purposes of land processing to the growth process.

- Changes in River Water Discharge, based on the results of interviews with farmers said there were changes in river water discharge which tended to decrease, especially during the long dry season. With the decrease in river discharge, this has an impact on the supply of irrigation water used for rice fields to be reduced and has an impact on farmers' rice farming activities. This is in accordance with the opinion of (Ferijal. T *et al.*, 2016) that the main water source for irrigation water is surface water which is highly dependent on rainfall. With this change in rainfall will directly impact the availability of water, especially the availability in rivers, reservoirs and other water reservoirs used for irrigation.
- Changes in Groundwater Availability, based on the results of interviews most farmers in Panincong Village have implemented several strategies to overcome the shortage of irrigation water they experience, namely by making boreholes and water pumps with the aim of obtaining groundwater sources as an alternative. Water pumps are used to lift water from boreholes or prepared water sources such as reservoirs to their rice fields. Some farmers stated that the availability of groundwater has changed, which can be seen from the volume of water obtained by the borehole wells is small and difficult to obtain, even farmers once did not get groundwater for their rice fields which caused them not to carry out farming activities for some time until the required water supply was sufficient. Farmers also stated that they had to dig deeper wells or use more powerful water pumps in order to get sufficient water supply. In addition, air temperature also has an impact on groundwater availability, in line with the opinion of Subagiyo (2021) that an increase in earth's temperature will cause water reserves in the atmosphere to increase, thus reducing the availability of water in the ground, especially during the dry season.

Farmers' Perceptions of Irrigation System Management

To measure the perception of farmers is done using the scoring method or Likert scale in each question. In line with the Minister of PUPR Regulation No. 30/PRT/M/2015 on the Development and Management of Irrigation Systems, the irrigation system consists of 5 namely irrigation infrastructure, irrigation water, irrigation management, irrigation management institutions and human resources.



Table 4 Indicators of Farmers' Perceptions of Irrigation System Management

Indicator	Number of Statements	Average	Category
Irrigation Infrastructure	7	3,79	High
Irrigation Water	7	3,05	Medium
Irrigation Management	7	3,55	Medium
Institutionalization of Irrigation Management	7	3,90	High
Human Resources	7	3,79	High

Based on table 4 above, it can be explained as follows;

1. Table 4 shows that farmers' perceptions related to the management of irrigation systems in their paddy rice farming areas. Overall, the perception of wet-rice farmers related to the management of irrigation systems on irrigation infrastructure is at an average of 3.79 with a high or good category. This indicates that the management of irrigation systems on irrigation infrastructure in Panincong Village has been well managed. However, it still needs to be improved, especially on the resilience to natural disasters and the condition of the complementary buildings.
2. Table 4 shows the perception of wet-rice farmers related to the management of irrigation systems on irrigation water. The perception of wet-rice farmers related to the management of irrigation systems on irrigation water indicators as a whole is at an average of 3.05 which is categorized as moderate or quite good. This indicates that farmers have a fairly good view of the management of irrigation systems on irrigation water indicators, although there are still some aspects that require improvement, especially on the availability of water and the consistency of water supply provided to farmers' rice fields.
3. Table 4 shows that farmers' perceptions of irrigation system management on irrigation management. Overall, the perception of rice farmers related to the management of irrigation systems on irrigation management indicators is at an average score of 3.55 which is categorized as moderate or quite good. This shows that the management of irrigation systems on irrigation management indicators has been done quite well, but there are still some aspects that need to be improved such as the delivery of information and the need for planning and regulation of irrigation water in order to achieve better things.
4. Table 4 shows the perception of wetland rice farmers on the management of irrigation systems in irrigation management institutions. The average value of all statements is 3.90

in the high category. This indicates that the respondent farmers have a good perception of the management of irrigation systems by irrigation management institutions. These results reflect that irrigation management institutions have worked effectively in accordance with the views of farmers.

- Table 4 shows farmers' perceptions of the management of irrigation systems on human resources. Overall, the average score of answers obtained from farmers' perceptions related to the management of irrigation systems on human resources showed an average of 3.79 which is included in the high category. However, there are still some aspects that need to be considered and improved such as adaptation to new technologies and methods and although farmers are satisfied with irrigation management but there are still some farmers who are confused, so more adequate training and support is needed.

Farmers' Perceptions Related to Changes in Irrigation System Management in Rice Paddy Farming as a Result of Climate Change

The impact of climate change on human life is enormous. Therefore, it is necessary to make efforts to anticipate by all parties, especially farmers as subjects of agricultural implementers and irrigation management institutions. Wahyuni Setyo Lestari *et al.* (2014) showed that the vulnerability of irrigation systems can increase due to climate change. Climate change can affect the performance of irrigation systems that require changes in its management.

Table 5 Indicators of Farmers' Perceptions Related to Changes in Irrigation System Management in Rice Paddy Farming as a Result of Climate Change

Indicator	Number of Statements	Average	Category
Irrigation Infrastructure		3,54	Medium
Irrigation Water		2,19	Low
Irrigation Management		2,76	Medium
Institutionalization of Irrigation Management		2,51	Medium
Human Resources		2,87	Medium

Based on table 5 above, it can be explained as follows;

- Table 5 shows farmers' perceptions related to changes in the management of irrigation systems for rice paddy farming as a result of climate change in irrigation infrastructure.



Overall, the average score of all statements is 3.54 which is in the moderate category. This shows that the majority of farmers perceive improvements and changes in irrigation infrastructure such as main irrigation channels, irrigation infrastructure and drainage systems, but there is still a need for further improvement and improvement related to other irrigation infrastructure such as water buildings and water storage facilities (embung) to overcome the impact or consequences of climate change in the future.

2. Table 5 shows farmers' perceptions related to changes in irrigation system management of paddy rice farming as a result of climate change in irrigation water. Overall, the average score of all statements is 2.19 which is in the low category. Farmers feel that the availability and quality of irrigation water is affected by climate change. Although there are adaptation strategies that have been implemented, they are still considered insufficient by farmers. This shows that further improvement is needed in terms of adaptation strategies and technology to manage changes that occur due to climate change such as the quality and availability of irrigation water that is lacking and difficult to obtain.
3. Table 5 shows farmers' perceptions related to changes in irrigation system management of wetland rice farming as a result of climate change in irrigation management. The average value of all statements is 2.76 in the medium category. This indicates that the changes in irrigation system management on irrigation management have been quite good but still less than optimal. This means that farmers assess that the efforts made to manage and adapt irrigation management strategies are not enough or not well implemented to deal with the impacts that arise due to climate change. So it needs improvement related to policies, risk management that is more responsive to climate change and so on.
4. Table 5 shows farmers' perceptions related to changes in the management of irrigation systems for rice paddy farming as a result of climate change in irrigation management institutions in this case the water user farmers association (P3A). The average value of all statements is 2.51 in the medium category. This indicates that changes in the management of irrigation systems in irrigation management institutions in the face of climate change still need to be improved. This means that farmers assess that irrigation management institutions in the face of climate change are still not effective enough but there is already awareness of the importance of adaptation of irrigation system management by irrigation management institutions to the impacts of climate change that can occur.
5. Table 5 shows farmers' perceptions related to changes in the management of irrigation systems for paddy rice farming as a result of climate change in human resources. The average value of all statements is 2.87 in the medium category. Overall, it shows that there





is already high motivation by farmers to adapt to climate change and increased collaboration and communication between human resources involved in irrigation management, but there are still shortcomings and weaknesses in terms of capacity, readiness, training and adoption of new technologies and strategies/methods to face the challenges arising from climate change. In addition, knowledge on climate change is also adequate, but there is still a need to improve in terms of training, roles and responsibilities and adoption of new innovative strategies and technologies.

CONCLUSION

Based on the results of the discussion in the research on the management of irrigation systems in wet-rice farming in the context of climate change in Panincong Village, Marioria District, Soppeng Regency, it can be concluded that the impact of climate change on the availability of water in wet-rice farming has been felt by farmers, among others, often experiencing a shortage of irrigation water for wet-rice fields. In addition, river water discharge changes and groundwater availability also changes in the volume of groundwater becomes reduced and difficult to obtain. Lack of irrigation water causes farmers to change planting schedules, disrupted plant growth and poor yields and even crop failure.

Farmers' perceptions related to the management of irrigation systems from various aspects are in the category of moderate / quite good and high / good. Farmers' perceptions of irrigation infrastructure are in the high / good category, farmers' perceptions of irrigation water are in the category medium or good enough, farmers' perceptions of irrigation management are in the medium or good enough category, farmers' perceptions related to irrigation management institutions are in the high / good category and farmers' perceptions of human resources are in the high or good category.

Farmers' perceptions related to changes in the management of irrigation systems in wet-rice farming due to climate change from various aspects are in the category of low / poor and moderate / quite good. In irrigation infrastructure, farmers' perceptions are in the medium / good enough category, farmers' perceptions of irrigation water are in the low / poor category, farmers' perceptions of irrigation management are in the medium / good enough category, farmers' perceptions of irrigation management institutions are in the medium / good enough category. And farmers' perceptions of human resources are in the medium / good enough category.

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