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The potential loss of rice production due to wetland conversion in East Java

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Abstract. East Java is one of the biggest rice producers in Indonesia. This statement is supported by the availability of wetland resources which are relatively larger than the area of wetland in other provinces. However, over the past few years, East Java is experiencing a significant decline in the wetland area, which can lead to a potential loss of rice production. This research aim to know the aggregate amount of potential loss of rice production that occurred in East Java due to the conversion of wetland. The data used are secondary data from Indonesian Central Bureau of Statistics from 2006 to 2015, including the data of wetland area, rice production and productivity in East Java as well as paddy and rice conversion factors from Food Security and Extension Agency. The method used is descriptive method. The potential loss of rice production can be calculated by multiplying the area of wetlands that are converted with rice productivity, and then the data is adjusted to the available conversion factors. The analysis shows that during the last 10 years there has been a conversion of wetland area of 23.585 hectares in East Java. The loss of wetland area caused the potential loss of rice production is 81.025 tons. The potential for lost production is equivalent to rice consumption for 94.148 people per year in East Java with an average amount of rice consumption of 86 kg per capita per year.

1. Introduction

East Java is one of the biggest rice producers in Indonesia. The high production of rice in this province is supported by the extent of wetland which is the main input for rice farming activities. Based on the data from the Indonesian Central Bureau of Statistics, it is known that the province of East Java had an area of wetland of 1,091,752 hectares with paddy production of 13,154,967 tons in 2015 [1]. The area of the wetland was the widest area compared to other provinces in Indonesia in the same year. The wetland area is agricultural land that is patchy and limited by channels to hold or distribute water, which is usually planted with rice. The availability of wetland for rice farming activities is the main key to ensure the availability of rice for the community's food needs. However, over the past decade, namely the period of 2006 to 2015, East Java experienced an increase in economic activity from the non-agricultural sector.

The increasing economic activity of the non-agricultural sector which is very rapid and faster than the agricultural sector, leads to a shift in the economic structure from depending on the agricultural sector to depending on the non-agricultural sector [2, 3]. This shift in economic structure has led to an

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increase in land demand for activities in the non-agricultural sector [4]. Land is one of the resources that have a relatively fixed area, so that an increase in land demand in a particular economic sector can cause a reduction in the amount of land for activities in other economic sectors [5]. Wetlands are the most frequently used land to meet land needs from the non-agricultural sector. Millar and Jane stated that the area of agricultural land tends to be wider than the land for other activities, causing agricultural land is often converted to be used in the non-agricultural sector [6]. Increased activity in the non-agricultural sector, which is rapid and faster than the agricultural sector in East Java, caused the province to experience a significant conversion of wetland during the period of 2006 to 2015. This can affect the decline in rice production potential that can be produced in East Java and ultimately can reduce the availability of rice for residents in East Java. The loss of rice availability meant the loss of food that can be consumed by the residents and its can be threaten food security. Therefore, this study was conducted with the aim to determine the potential loss of rice production that occurred in East Java due to the conversion of wetland.

2. Materials and Methods

The type of data used in this study is secondary data collected from the Indonesian Central Bureau of Statistics and the Republic of Indonesia Food and Extension Agency (BKPP). These data include the area of wetland, data of production and productivity of rice, and data of conversion factor of paddy to rice. The time period used is the period of time from 2006 to 2015. Descriptive methods were used in this study. The data were analyzed by calculating the area of wetland that was converted by setting aside the current wetland area with the area of wetland in the previous year. Furthermore, the potential for gross paddy production loss due to wetland conversion can be calculated by multiplying the converted wetland area to paddy productivity in the same year. This potential loss was the loss of gross paddy production. The amount of paddy available losses (LAP) can be calculated using the following formula:

$$\text{Lost Available Paddy (LAP)} = \text{GPP} - \text{GPPL} \quad (1)$$

Gross Paddy Production (GPP) variable was the amount of gross paddy production and the GPPL (Gross Paddy Production Lost) variable was the amount of gross paddy production lost during the production process. GPPL can be calculated using the formula:

$$\text{GPPL} = (\%\ \text{PfSN} + \%\ \text{PfFN} + \%\ \text{PfSP} + \%\ \text{PfNFI}) * \text{GPP} \quad (2)$$

The gross amount of paddy production lost during the production process (GPPL) were 0.90% paddy for seed needs (PfSN), 0.44% paddy for feed needs (PfFN), 5.40% paddy for scattered paddy (PfSP), 0,56% paddy for non-food industries (PfNFI). After knowing the amount of paddy available, the amount of gross rice production can be calculated using the standard conversion of paddy to rice by 63.20% for the period 2006-2008 and 62.70% for the period 2009-2015 [7]. Furthermore, to find out the loss of available rice production (LRA), the formula used is:

$$\text{Lost Rice Availability (LRA)} = \text{GR} - \text{GRPL} \quad (3)$$

The Gross Rice (GR) variable was the amount of gross rice production and the GRPL (Gross Rice Production Lost) variable was the amount of gross rice production lost during the rice production process. GRPL can be calculated using the formula:

$$\text{GRPL} = (\%\ \text{RfFN} + \%\ \text{RfSR} + \%\ \text{RfNFI}) * \text{GR} \quad (4)$$

Gross rice production lost during the production process (GRPL) were 0.17% rice for feed needs (RfFN), 2.50% rice for scattered rice (RfSR), 0.66% rice for non-food industries (RfNFI) [7].

3. Results and Discussion

The area of wetland in East Java fluctuates every year. This happened due to land clearing for wetland and the conversion of wetland area to non-wetland. The area of wetland that are converted and the rate of depreciation of wetland in East Java can be seen in Table 1.

Table 1. Area and wetland conversion and land clearing of wetland rate in East Java.

Year	Wetland Area (ha)	Converted Wetland Area (ha)	Land Clearing Wetland Area (ha)	Rate of Wetland Depreciation (%)
2006	1,096,479	0.00	0.00	0.00
2007	1,096,605	0.00	126.00	0.01
2008	1,108,578	0.00	11,973.00	1.09
2009	1,100,517	-8,061.00	0.00	-0.73
2010	1,107,276	0.00	6,759.00	0.61
2011	1,106,449	-827.00	0.00	-0.07
2012	1,102,874	-3,575.00	0.00	-0.32
2013	1,102,863	-11.00	0.00	0.00
2014	1,101,765	-1,098.00	0.00	-0.10
2015	1,091,752	-10,013.00	0.00	-0.91
Total	11,015,158.00	-23,585.00	18,858.00	-0.42
Average	1,101,515.80	-2,358.50	1,885.80	-0.04

Source: Secondary Data Analysis

Based on the data in Table 1 the conversion of wetland in East Java is greater than the land clearing of wetland. The area of wetland converted from 2006 to 2015 amounted to 23,585 hectares, while the land clearing of wetland only reached 18,858 hectares. The high rate of land conversion in East Java can be caused by economic transformation [4, 8] and rapid population growth [9, 10]. Conversion of wetland was relatively larger than the ability to make up wetland area in East Java, which can provide a threat to a decline in rice production. The greater conversion of wetland has consequences for the greater potential of losing rice production that can be produced from converted wetland [11]. Potential loss of rice production is started from the loss of potential paddy production. Potential loss of paddy production due to wetland conversion in East Java can be seen in Table 2.

Table 2. Potential loss of gross paddy production results due to wetland conversion.

Year	Productivity (tons/ha)	Converted Wetland Area (ha)	Gross Paddy Production (tons)
2006	5.45	0.00	0.00
2007	5.53	0.00	0.00
2008	6.01	0.00	0.00
2009	6.02	8,061.00	48,519.16
2010	6.04	0.00	0.00
2011	5.55	827.00	4,589.02
2012	6.26	3,575.00	22,361.63
2013	6.00	11.00	66.01
2014	6.00	1,098.00	6,588.00
2015	6.20	10,013.00	62,080.60
Total	59.05	23,585.00	144,204.42
Average	5.90	2,358.50	14,420.44

Source: Secondary Data Analysis

Based on Table 2 the potential for paddy production lost due to the conversion of wetland in East Java is 14,420.44 tons per year. The loss of production will be even greater when the area of the

converted wetland is also getting bigger. In addition, higher productivity can lead to higher potential loss of rice production in East Java. The data in Table 2 is the amount of gross paddy lost due to the conversion of wetland area in East Java. Gross paddy production in Table 2 can be adjusted with the conversion factor of paddy availability so it can be seen the amount of available paddy lost due to wetland conversion. Adjustments are made by reducing the amount of gross paddy lost in Table 2 with available paddy conversion factors. The conversion factor of rice availability was obtained based on the BKPP report which showed that there was rice used for the needs of seeds, feed, scattered rice and rice for the non-food industry with a percentage of 0.90%, 0.44%, 5.40% and 0.56% respectively. Based on this adjustment, it will be known that the potential loss of rice is available due to the conversion of wetland. The available paddy lost due to the conversion of wetland area in East Java can be seen in Table 3.

Based on the data in Table 3 it can be seen that the amount of paddy availability lost due to wetland conversion in East Java in the period of 2006 to 2015 was 133,677.50 tons or an average of 13,367.75 tons per year. The production of paddy availability that is lost due to the conversion of wetland in East Java will be even greater when the area of converted wetland is also getting bigger. The production of paddy availability indicates the amount of paddy available which can be processed into rice that can be consumed by the community. The higher amount of available paddy that is lost, then it becomes a reflection of the less amount of rice that can be produced due to the conversion of wetland in East Java. The production of paddy availability can then be converted into gross rice production in East Java by using the paddy to rice conversion factor provided by BKPP. Gross rice production lost due to conversion of wetland in east Java can be seen in Table 4.

Table 3. Potential loss of paddy availability production due to wetland conversion.

Year	Gross Paddy Production (ton)	Conversion Factors of Paddy Availability				Paddy Availability (ton)
		Seed Needs (%)	Feed Needs (%)	Scattered Paddy (%)	Non-Food Industries (%)	
2006	0.00	0.90	0.44	5.40	0.56	0.00
2007	0.00	0.90	0.44	5.40	0.56	0.00
2008	0.00	0.90	0.44	5.40	0.56	0.00
2009	48,519.16	0.90	0.44	5.40	0.56	44,977.26
2010	0.00	0.90	0.44	5.40	0.56	0.00
2011	4,589.02	0.90	0.44	5.40	0.56	4,254.02
2012	22,361.63	0.90	0.44	5.40	0.56	20,729.23
2013	66.01	0.90	0.44	5.40	0.56	61.19
2014	6,588.00	0.90	0.44	5.40	0.56	6,107.08
2015	62,080.60	0.90	0.44	5.40	0.56	57,548.72
Total	144,204.42	9.00	4.40	54.00	5.60	133,677.50
Average	14,420.44	0.90	0.44	5.40	0.56	13,367.75

Source: Secondary Data Analysis

Table 4 shows that the gross rice production lost due to the conversion of wetland in East Java was 83,815.79 tons in the period 2006 to 2015. The production of gross rice was the result of conversion with a conversion factor of 63.20% from paddy to rice. The table above shows that the gross rice production lost will be even higher when the conversion of paddy fields in East Java is also higher. The data in Table 4 is gross rice production, so it needs to be adjusted by rice availability conversion factor. The conversion factor of rice availability was obtained from the BKPP report which showed that there were the number of rice used for feed needs by 0.17%, there was scattered rice at 2.5% and there was rice used for the non-food industry by 0.66%. After the adjustment, the amount of rice availability will be known. Available rice lost due to rice field conversion in East Java can be seen in Table 5.

Table 4. Potential loss of gross rice production due to wetland conversion.

Year	Paddy Availability (ton)	Paddy to Rice Conversion Factor (%)	Gross Rice Production (ton)
2006	0.00	63.20	0.00
2007	0.00	63.20	0.00
2008	0.00	63.20	0.00
2009	44,977.26	62.70	28,200.74
2010	0.00	62.70	0.00
2011	4,254.02	62.70	2,667.27
2012	20,729.23	62.70	12,997.22
2013	61.19	62.70	38.37
2014	6,107.08	62.70	3,829.14
2015	57,548.72	62.70	36,083.05
Total	133,677.50	628.50	83,815.79
Average	13,367.75	62.85	8,381.58

Source: Secondary Data Analysis

Table 5. Potential loss of rice availability production due to wetland conversion.

Year	Gross Rice Production (ton)	Conversion Factors of Rice Availability			Rice Availability (ton)
		Feed Needs (%)	Scattered Rice (%)	Non-Food Industries (%)	
2006	0.00	0.17	2.50	0.66	0.00
2007	0.00	0.17	2.50	0.66	0.00
2008	0.00	0.17	2.50	0.66	0.00
2009	28,200.74	0.17	2.50	0.66	27,261.66
2010	0.00	0.17	2.50	0.66	0.00
2011	2,667.27	0.17	2.50	0.66	2,578.45
2012	12,997.22	0.17	2.50	0.66	12,564.42
2013	38.37	0.17	2.50	0.66	37.09
2014	3,829.14	0.17	2.50	0.66	3,701.63
2015	36,083.05	0.17	2.50	0.66	34,881.48
Total	83,815.79	1.70	25.00	6.60	81,024.72
Average	8,381.58	0.17	2.50	0.66	8,102.47

Source: Secondary Data Analysis

Rice availability is defined as the rice production that is ready to be consumed directly by residents in East Java. Available rice production has been adjusted to the gross rice conversion factor into available rice. Available rice production is the difference between gross rice production and other uses, in addition to community consumption, namely the use of seeds, animal feed, and production that are scattered during processing [12]. Based on the data in Table 5 it can be seen that the potential loss of available rice production due to wetland conversion in East Java is 81,024.72 tons during the period 2006 to 2015 with the average loss of rice available production in each year amounting to 8,102.47 tons per year. The potential loss of available rice production is quite large, because the available lost rice production of 8,102.47 tons per year has the potential to be used for consumption in East Java as many as 94,148 inhabitants per year with an average consumption of rice of 86 kg per capita per year [1]. The significant potential loss of available rice production in East Java shows that the conversion of wetland has a negative impact on the reduced amount of rice availability in East Java. Available rice is important to note, because available rice is showing the amount of rice that can be consumed by the population. Conversion of wetland in East Java needs to be controlled, so the potential loss of available rice production can be minimized. Wetland conversion can be controlled by

implementing policies that able to provide incentives for farmers, so farmers are willing to maintain the wetland area. The policy can be in the form of price incentives, both input prices and output prices. In addition, the wetland tax relief policy can also be an incentive for farmers to maintain their wetland area.

4. Conclusion

Conversion of wetland to non-wetland area has a negative impact on rice production in East Java. The higher conversion of wetland area can lead to a greater potential loss of available rice production. Wetland conversion can be reduced by implementing policies that can provide incentives for farmers to maintain their wetland area. The policy can be in the form of a policy of input and output subsidies as well as alleviating wetland taxes managed by farmers.

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