Assessment of Agricultural Production in Dry Season in Nganjuk District, East Java, Indonesia

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1. Introduction

Grain production in dry season is still important for regional sustainable development in Indonesia. Java is the main production area for grain in Indonesia, where 53 percent of paddy and 55 percent of corn from each total production are produced [3]. In the long term from environmental perspective, agriculture in Java must be conserved for sustainable food security in Indonesia. For that purpose, improvements in land use and water management are needed.

Nganjuk District lies in Brantas basin at Widas sub-basin. In Nganjuk area, there are 3 planting season, wet season (WS, November-February), first dry season (DS1, March-June), and second dry season (DS2, July-October). Paddy fields are cultivated in WS and DS1. Sugar cane cultivated in WS, DS1, and DS2. Secondary crops (corn, soybean, red onion, chilies, melons and vegetables) are cultivated in DS1 and DS2.

An objectives of this paper is spatial assessment of agricultural production in second dry season. Especially, land use and irrigation wells density was analyzed by GIS to get spatial distribution.

2. Methods

2.1 Land Use Analysis

The classification was concern to the irrigated area which was cultivated in DS2. NDVI analysis was conducted for LANDSAT series data from 1972 to 2009 in DS2.

2.2 Irrigation Wells Density Analysis

Irrigation well density (IWD) was generated from number of wells at agricultural field areas in each village. Criteria of IWD based on the radius influent of well in the research area. Radius influent of well in these research areas are varied at 118-348 m [4].

2.3 Irrigation Data

Irrigation intake was obtained from surface irrigation data in 2009. Average irrigation intake data was collected from four blocks in Nganjuk District. Water supply in DS2 (September 2009) was analyzed to confirm conjunctive use of groundwater.

2.4 Overlay Analysis

Overlay analysis was used to get the actual utilization of irrigation well in DS2. Irrigation well density (IWD) map was overlay with land use map to get the actual utilization of irrigation well or pumps to support agricultural production in DS2

3. Results and Discussions

3.1 Land Use

Vegetation NDVI typically ranges from 0.1 up to 0.7 [5], with higher index values associated with greater density and greenness of the plant canopy. Based on NDVI values, cultivated area in DS2 was increasing around 12% from 26.8% in 1972 to 38.8% in 1982. In the last decade, cultivated area was increasing around 30-40%, varied 71.0-86.3% area was cultivated. Widas, Ketandan-Tretes, and Kuncir-Bodor blocks were increased more than 10, 6, and 5 times, respectively. Mrican-Kiri block was increased around 1.6 times (Figure 1).

Cultivated area was stable in WS and DS1 in whole irrigation blocks. 100% of irrigation blocks area was cultivated in WS and DS1 (Table 1). Paddy was predominant in WS (86-95% cultivated area). Paddy and secondary crop was predominant DS1, 38-69% and 28-58% cultivated area was paddy and secondary crop, respectively. Secondary crop was cultivated in almost cultivated area in DS2 (63-95% cultivated area). Paddy was cultivated 1-6% cultivated area in Widas and Kuncir-Bodor blocks. Sugar cane was cultivated 3-14% cultivated area in all irrigation blocks. Based on LANDSAT data 1999-2009, cropping intensity in DS2 is around 0.71-0.85 crop per season.

Agricultural production has same meaning with cropping intensity. The agricultural production was dramatically increased during 20 years. In 1991, average cropping intensity was 2.31 crops per years [1], and in the last 10 years was increased and stable at 2.8 crops per years.

Rice production was 414 metric ton per year with productivity around 5.8 ton per hectare and harvested

Table1. Percentage of cultivated area per season

Irrigation Block		Widas	Ketandan-Tretes	Kuncir-Bodor	Mrican-Kiri
Paddy	WS	90	86	95	95
	DS1	38	44	69	64
	DS2	6	0	1	0
Sugar Cane	WS	3	14	3	5
	DS1	3	14	3	5
	DS2	3	14	3	5
Secondary Crop	WS	6	0	3	0
	DS1	58	42	28	30
	DS2	64	63	74	95

Source: RTTG 2006/2007, Nganjuk Irrigation service

area was 71,893 hectare. Corn production was 204 metric ton per year with productivity around 5.8 ton per hectare and harvested area was 35,144 hectare. Soybean production was 17 metric ton per year with productivity around 1.7 ton per hectare and harvested area was 10,091

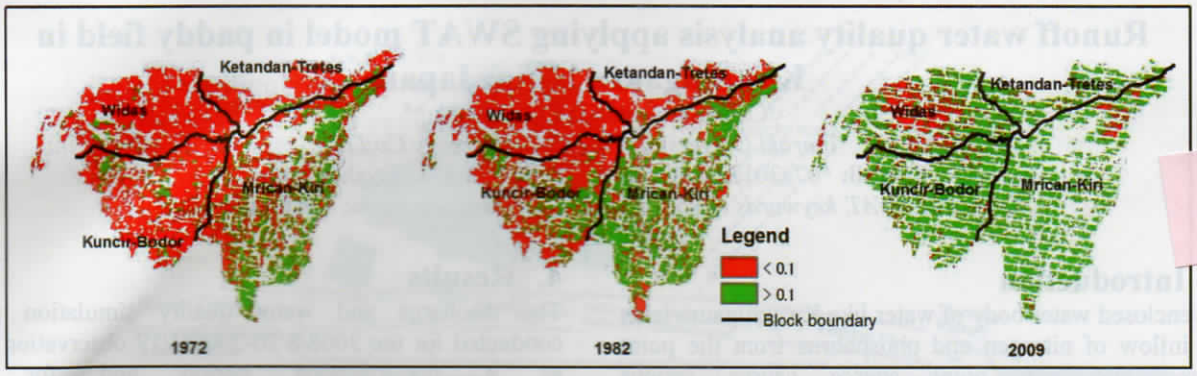

Fig. 1. NDVI of irrigation block area in DS2 in 1972, 1982, and 2009

hectare [2].

3.2 Irrigation Well Density Analysis

The number of well were varied from 0 to 606 wells per village and total number of well in Nganjuk is 15,475 wells. The IWD was varied 0-3 wells/ha. High exploitation (IWD >0.5 well/ha) has conducted in 79 villages. These villages are mostly located at Kuncir-Bodor block (Figure 2). Medium exploitation (0.05 < IWD ≤ 0.5 well/ha) has conducted in 120 villages and mostly located at Widas and Mrican-Kiri blocks. Low exploitation (IWD < 0.05 well/ha) has conducted in 47 villages.

The number of well in Kuncir-Bodor block was highest (7,677 wells) and in Ketandan-Tretes block was lowest (346 wells) with average IWD 0.76 and 0.08 well/ha, respectively. The IWD has correlation with groundwater exploit, however, depend on the surface water supply in DS2.

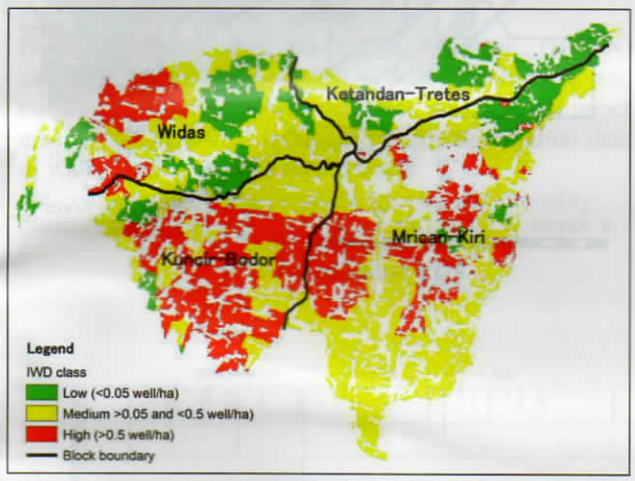

Fig. 2. Map of distribution of irrigation well density (IWD)

3.3 Groundwater Utilization to Increase Agricultural Production

Based on data 2009 and LANDSAT 2009, Mrican-Kiri, Widas, Kuncir-Bodor, and Ketandan-Tretes blocks was supply surface irrigation water around4.7, 1.1, 0.3, and 0 mm/d, respectively. Mrican-Kiri block was supply enough surface water in DS2. Widas block was supply little bit surface water and not enough for normally plant growth. Kuncir-Bodor was supply very small surface water and Ketandan-Tretes was not supply surface water in DS2.

Based on overlay of IWD and land use in dry season, cultivated and IWD >0.05 well/ha has 63% of farm field area. 86% of Mrican-Kiri block and 88% of Kuncir-Bodor block was cultivated with IWD >0.05 well/ha. These blocks have highest agricultural production. Mrican-Kiri block was enough surface water, so the IWD was not related with agricultural production in this block. However, IWD in Kuncir-Bodor block was related with agricultural production because need more water supply from groundwater in DS2. Agricultural productivity in both blocks was almost same in WS, DS1, and DS2.

Water shortage was potentially occur in cultivated area with low IWD, especially in Ketandan-Tretes block caused no water supply in this area in DS2. 25% of Widas block was uncultivated and has IWD >0.05 well/ha. This area was already harvested in August and red onion was predominant. Agricultural productivity in DS2 in these blocks was lower than another blocks caused by water shortage.

4. Conclusions

Land use and well density analysis is needed to get spatial evident in wide area to know actual cultivated area in DS2 within irrigation wells. Agricultural production in Mrican-Kiri block was supported by water supply from surface irrigation. Agricultural production in other blocks was supported by conjunctive use of groundwater with surface irrigation, where Kuncir-Bodor block was enough water supply; Widas block was enough water supply but potentially water shortage was occur; and Ketandan-Tretes block was occurring of water shortage.

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