農業情報学会 2009 年度

オーガナイズセッション・個別発表　講演要旨集

テーマ：

「情報技術による農産物生産現場の革新」

（共催：日本農業工学会）

日時：2009 年 5 月 21 日（木）9：00 ～

会場：東京大学弥生講堂（農学部内）

（東京都文京区）

主催：農業情報学会

農業情報学会　2009 年度研究発表会　プログラム

開催日時　　2009 年 5 月 21 日（木）9 時開始
開催場所　　東京大学弥生講堂（東京大学農学部内）
（講演時間：研究発表 13 分，質疑 2 分）

<オーガナイズセッション>（弥生講堂 一条ホール）

テーマ：「情報技術による農産物生産現場の革新」（主催：農業情報学会　共催：日本農業工学会）

開会（09:00〜09:05）大会担当理事 中野和弘（新潟大学大学院）
学会長挨拶

セッションA：「農場リスク管理と情報通信技術ICT」

オーガナイザー　南石晃明（九州大学大学院農学研究院）

9:05-09:10 オーガナイザー挨拶

討論（10:40-10:50）総合討論

セッションB：「生産情報とユビキタス・マーケティング技術」

オーガナイザー　杉山純一（農研機構 食品総合研究所）

10:55-11:00 オーガナイザー挨拶

GIS Based Sustainable Groundwater Management Approach for Irrigation

-Case Study: Nganjuk District, East Java, Indonesia-

Liyantono*, 加藤亮**, 黒田久雄**

* *United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology*
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Abstract

This research was conducted in Nganjuk district, East Java province, Indonesia. GIS and remote sensing were used to analysis land use, digital elevation model and hydrological data. Water balance analysis was conducted to estimate annual recharge and withdrawal of groundwater. The spatial database for distribution of wells was developed. The exploitation of groundwater for irrigation in dry season was analyzed. The estimation groundwater recharge showed the irrigated area has surplus recharge shallow groundwater. The irrigation well density analysis showed that irrigation wells were used in DS2. A water management plan for sustainable groundwater use was developed based on spatial distribution wells and water balance.

Keywords

groundwater, GIS, irrigation well density, water balance

1. Introduction

In Indonesia, rice production in dry season is still important for regional sustainable development. This research was conducted in Nganjuk district, East Java province, Indonesia. Objectives of the research are to develop spatial database for distribution wells, to analyze water balance and to propose a water management plan for sustainable groundwater use.

The Approach of this research was conducted in three steps. First step was to analyze annual recharge and withdrawal of groundwater by estimation of water balance. Second step was to develop a spatial database for distribution wells and to analyze groundwater exploitation for irrigation in dry season. Third step was to evaluate scenarios to propose a water management plan for sustainable groundwater use.

2. Study Area

The Nganjuk District lies in a climatic regime characterized by the annual progress of rainy and dry seasons, and receives roughly 80% of precipitation within the 5 to 6 months of the rainy season (December-May). Nganjuk area has flat area in central and eastern of Nganjuk with altitude ranging from 30 to 100 m above sea level. Mountains area is located at southern and northern area.

In Nganjuk area, there are 3 planting season, wet season (WS), first dry season (DS1), and second dry season (DS2). Paddy fields are cultivated in WS and DS1. Secondary crops (corn, soybean, onions, chilies, melons and vegetables) are cultivated in DS1 and DS2. Cropping intensity in Nganjuk district is high varied 2-4 crops yr^{-1} with average 2.83 crops yr^{-1} (BPS Nganjuk, 2007).

There are three main sub-basins in Nganjuk area, Widas, Kuncir, and Bodor sub-basins. Kedungsoko River is for Kuncir and Bodor sub-basins, Widas River is for Widas sub-basin and those rivers were merged into Brantas River. In Nganjuk area, there are two surface irrigation systems, Widas block and Mrican-Kiri block. The Widas block has irrigation command area in north western area of Nganjuk. The Mrican-Kiri block has irrigation command area in south eastern area of Nganjuk. In Widas block a reservoir is constructed in west of Nganjuk, and in Mrican-Kiri block, irrigation water is uptake from Brantas River (Fig.1). The surface irrigation system in Nganjuk area can supply irrigation water in DS1, however, it is not enough to supply water in DS2. Therefore, groundwater is used for conjunction irrigation with surface irrigation in the DS2.

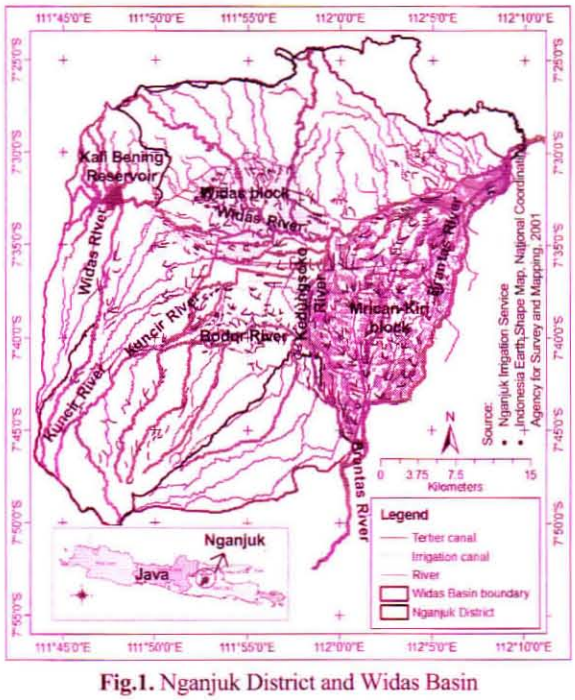

Fig.1. Nganjuk District and Widas Basin

3. Water Balance, GIS Database and Groundwater Management

In analysis of this research, GIS and remote sensing were used to analysis land use, digital elevation model (DEM) and hydrological data. And water balance analysis was used to analyze groundwater recharge and withdrawal.

First, water balance analysis was conducted in wet and dry seasons, respectively (Fig.2). Precipitation and irrigation data was supplied from local offices. Evapotranspiration was estimated using Penman Monteith method. Surface runoff was estimated using SCS-CN method. Subsurface flow and base flow were estimated from change of water storage (ΔS). ΔS' was replaced ΔS subtracted subsurface and base flows. Withdrawal was assumed same to ΔS'.

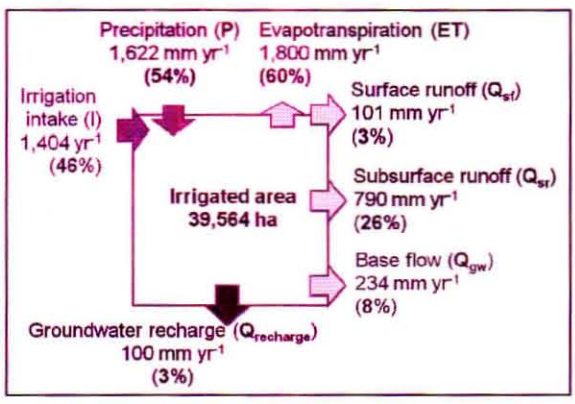

Fig.2. Flowchart of water balance in irrigated area

Second, irrigation well density (IWD) was estimated by cropping area and number of irrigation wells. The spatial distribution of groundwater withdrawal was analyzed using IWD. The IWD was varied 0-3 well ha^{-1} in Nganjuk in 2006. High exploitation (IWD >0.5 well ha^{-1}) has conducted in 79 villages. These villages are located at south and central of Nganjuk area (Fig.3). Based on land-use/land-cover 2004 classification in DS2 and IWD map, irrigated area with crop and IWD >0.05 well ha-1 has 82% of cultivated area.

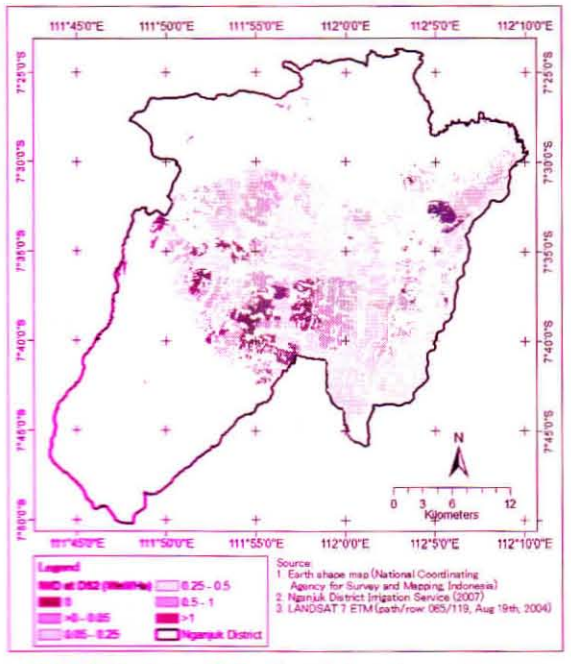

Fig.3. Irrigation well density at irrigated area with crop

Third, a water management plan was developed based on the spatial distribution of irrigation wells and water balance. Based on IWD and the estimation of groundwater withdrawal in each area, a water management plan for sustainable groundwater use was proposed. The area with high IWD (>0.5 well ha^{-1}) should be managed with integrated management of wells and pumps to reduce the exploitation and interference of pumping.

The cropping intensity in the area with surplus groundwater recharge can be increased. Five scenarios of cropping pattern were made, i.e., corn, soybean, onion, melon, and mixed crops for increasing cropping intensity at the second dry season. Based on five scenarios, corn and soybean scenario more be feasible because these scenario still have surplus recharge of shallow groundwater and cropping intensity can be increased till 0.6-0.7 crop yr^{-1}.

4. Conclusion

The research showed as following. The estimation groundwater recharge showed the irrigated area has surplus recharge shallow groundwater. The spatial database for distribution of wells was developed. The IWD analysis showed that irrigation wells were used in DS2. A water management plan for sustainable groundwater use was developed based on spatial distribution wells and water balance.

References

Allen, R.G, L.S. Pereira, D. Raes, D., and M. Smith (1998). *Crop evapotranspiration, guidelines for computing crop water requirements*. FAO Irrigation and Drainage. Paper 56, FAO, Rome, Italy.

Clyma, W (2002). Management Strategies for Sustainable Irrigated Agriculture With Organizational Change To Meet Urgent Needs. The CIGR Ejournal. Vol. IV. September, 2002.

Departemen Pekerjaan Umum (2006). Inventarisasi Data: Sumur, Jaringan Irigasi Air Tanah, Mesin, dan Pompa. Satuan Kerja Sementara Pengembangan dan Pengelolaan Air Tanah Jawa Timur. Surabaya.

Longley, P.A. et.al. (2005). Geographical Information Systems and Science. 2nd Edition. John Wiley and Sons, New York.

McCabe, G.J., and Markstrom, S.L. (2007). A monthly water-balance model driven by a graphical user interface: U.S. Geological Survey Open-File report 2007-1088, 6 p.

Prastowo, S. Hardjoamidjojo, B. Pramudya, K. Murtilaksono (2007). Performance of Shallow Groundwater Irrigation Schemes in Nganjuk-East Java, Indonesia. The CIGR Ejournal. Vol. IX. June, 2007.

Puspowardoyo, R.S. (1984). Peta Hidrogeologi Indonesia - Lembar Kediri. Direktorat Geologi Tata Lingkungan, Departemen Pertambangan dan Energi. Bandung.

Satti, S.R., J.M. Jacobs (2004). A GIS-based model to estimate the regionally distributed drought water demand. Agric. Water Manage. 66, 1–13.

Tsuji, K. 2004. Groundwater Development in the Mountain Skirts of Volcanic Massifs in East Java, Indonesia. The 2nd Asia Pacific Association of Hydrology and Water Resources Conference (APHW2004), Proceeding.