Climate Changed Effect on Irrigated Water Supply at Segaran. Malang, Indonesia

Lily Montarcih Limantara *}
Djunaedi & Mochammad Ibrahim, ST **)

*) Department of Water Resources, Faculty of Engineering, Brawijaya University
**) Master Program at Water Resources Engineering, Brawijaya University

Abstract

This paper studied the effect of climate change to optimization of irrigated water supply at Segaran Irrigation Area. Global climate exchange caused some effects to hydrological factors such as temperature, humidity, seasonal time exchange and the quantity of rainfall. These exchanges would give contribution exchange to the operation of water irrigation. The methodology consisted of optimization irrigated water supply with Simplex Linear Programming for two time series such as before and after climate exchange. Results can use as the pattern of allocating water supply at Segaran irrigation area, due to the effect of climate exchange. Global climate exchange did not cause irrigated water supply and crop intensity.

Key words: climate exchange, irrigation water, linear programming

Introduction

Conservation and demand management are the keys to sustained use of any resource.. With the rapid increase of population, a secure water future for much of the world remains elusive. Planning and management of water resources is not an easy job especially when the problem is national wide. Water resources development in Indonesia was targeted to supply water needs. The water needs used for irrigation, hydro electrical power, industry, recreation, and daily human needs. (Montarcih, 2010a)

High Level Conference at Rio de Janeiro, Brazil in 1992 about global climate exchange has given more influence in the world. Climate exchange is global phenomena, increasing by human activity such as the use of fossil gasoline and land use exchange (Montarcih, 2010b). One of the global climate exchanges are the increasing of frequency and intensity of climate extreme such as hurricane, flood, and drought. Some research before were shown many indicators climate exchange as rise in sea level (Susandi, 2008), flood, drought, some wealthy problem and any problem in water resources development.

The main objective of water resources planning and management is to solve the equation of demand and supply of water resource for a specific area taking into account various dimensions like space, time, economy, politics, environment, and other aspects. Also, water management means the reconciliation of all users, preservation of water and related land resources, and previous of enough water for constantly expanding needs (INWRDAM, 2001)

Segaran is one of the irrigation areas (262 ha) in Malang Regent. Restrictions of surface water resources, mainly in dry season intensify the need for an optimum capacity and operation (Gakpo *et al*, 2006). Global climate exchange is too influence the crop intensity. Thus, it was needed to compare the allocation of water use as efficient as possible before and after global climate exchange. To reach this target, it was needed to make a system model for optimization. Optimization analysis would give more information for allocating water of each objective function.

Materials and Methods

Location of this study was in Segaran Village, Pakisaji District, Malang Regent, East Java Province, Indonesia. Maps of Malang Regent and Segaran Village are as the figure below.

Figure 1. Map of Malang Regent

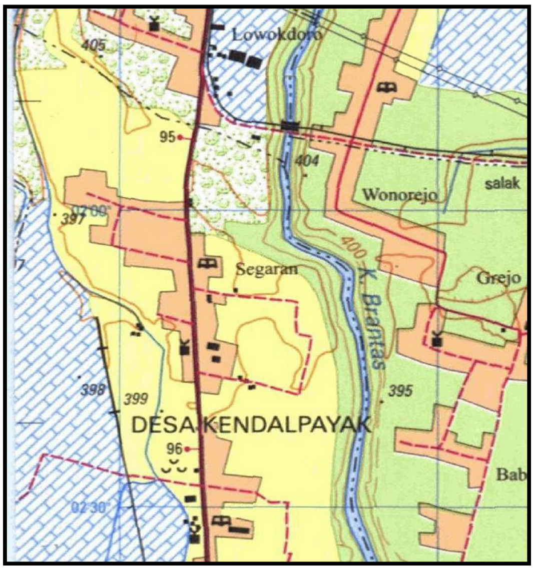

Figure 2. Location of Segaran Village

Several models have been applied in the optimal allocation of water resources, mainly from a static equilibrium. Simulation and optimization models are the two basic categories of models applied to water resource allocation (Tung *at al*, 1987). With simulation, the optimal allocation of water is determined independently for each time interval. On the other hand, optimization models carry out multi-interval analysis on optimal solution. It is important to recognize the uncertainties involved in water resources analysis and design. The uncertainty in water resources may be attributed to the following resources (Gakpo *et al*, 2006): (1) natural uncertainties associated with the inherent randomness of natural processes; (2) model uncertainty reflecting of the simulation model or design technique to represent precisely

System analysis using mathematical model provides a suitable methodology to analyze various aspect of water resource system planning. (Holko *et al*, 1997). Linear Programming is used for this study. This program would give some advantages for analyzing water resources system planning as follow (Cheng Yun *at al*, 2008): (1) Constraints and objective function which are used in this program are linear function; (2) This program is quite simple because there are many solver can use to solve this problem; (3) If it can be build the optimization procedure (the objective function with any kinds of constraints), it can be approached the real problem.

The step by step to carry out Linear Programming is as follow (Locks, 1982: (1) To built optimization models (Figure 2); (2) To determine the resources which would be optimized (for this case study are irrigation and hydro electrical power); (3) To calculate the quantities of input or output for every kind of activity unit; (4) To build the mathematical modeling.

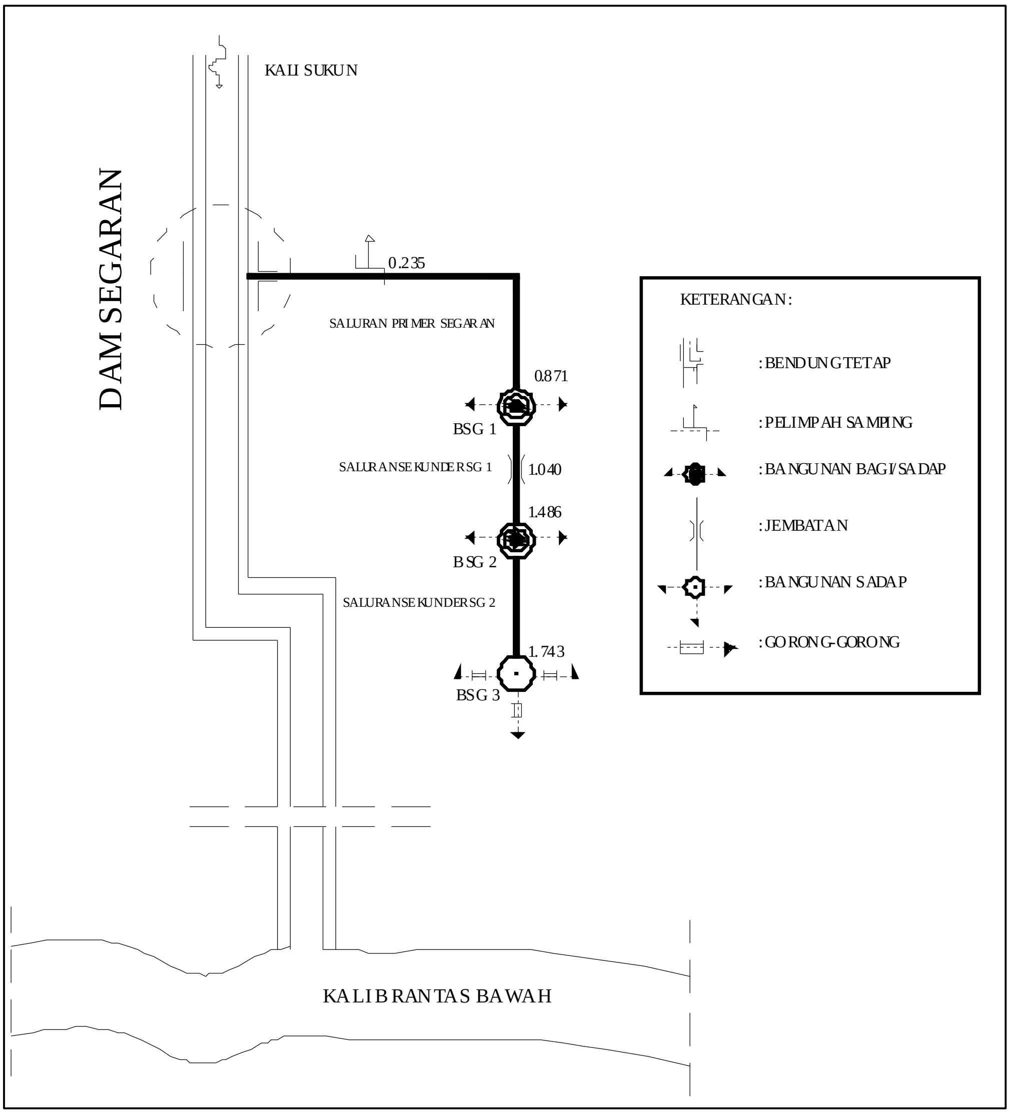

Figure 3. Location of Segaran Dam

One of the global climate exchanges is move of season. Move of season latterly causes dry season occur in a long time so that there are drought in any way. This condition will influence harvest. Climate exchange mark such as move of rainy season and dry season was not only global detection. According to Rainfall Recorder at Segaran Irrigation Area such as Sukun, Wagir, and Kepanjen, move of season was occurred since 2003. Thus, optimization for Segaran Irrigation Area was carried out before and after 2003.

Result and Discussion

The water resources system was restricted as Figure 3. Optimization was carried out for before and after global climate exchange (before and after 2003). Objective function was due to net benefit of each periodical of cropping season. There were needed 4 constraints and 12 variables in each cropping season. The optimizations were iterated two times (before and after climate exchange) and each for this was done for 3 cropping seasons. Simplex linear programming was used for analyzing this case, with step by step were as followed: (1) To convert all of the constraints to Simplex equation with plus new variables such as slack, surplus, and artificial variables; (2) The objective function was removed to the left side; (3) To carry out the iterations. Iterations were used for making coefficients of objective function as a positive number. Process of iteration was carried out in rotation constructively and it was begun from the maximum of objective function coefficient. This process was stopped if all of objective function coefficients were not negative.

The optimizations above were to compare the results of reduce discharge after using for irrigation, irrigation areas, cropping intensity and net benefit, between before and after climate exchange (before and after 2003). Reduce discharge was occurred in all cropping season. Dependable discharge (in volume) before climate change was 0.239 x 10^6 m^3 (cropping season I), 0.290x10^6 m^3 (cropping season II), and 0.149x10^6 m^3 (cropping season III), but after climate change was 0.114 x 10^6 m^3 (cropping season I), 0.118x10^6 m^3 (cropping season II), and 0.070x10^6 m^3 (cropping season III). Water requirement for irrigation was reduced too after global climate change. The farmers had suffered a loss of Rp. 2,748,143 (standard price of 2010)

Conclusions

According to the analysis as above, global climate exchange was occurred since 2003. Reduce dependable discharge caused net benefit were decreased after global climate exchange. The farmers had suffered a loss of Rp. 2,748,143 (standard price of 2010).

References

1. Cheng Yun; Cheng-Haw Lee; Yhi Chi Tan; and Hsin Fu Yeh, 2008. An Optimal Water Allocation For An Irrigation District In Pingtung Country, Taiwan. *Published on li*ne in Wiley Inter Science (www.interscience.wiley.com), DOI: 10.1002/ird.411)
2. Gakpo, E; Tsephe, J; Nwonwu, F. and Vilkoen, M. 2006. Application of Stochastic Programming (SDP) For The Optimal Allocation of Irrigation Water under Capacity Sharing Arrangements, *Agrekon Journal*, Vol. 44 Number 4, page 436-451
3. Holko, L. and A. Lepsito. 1997. Modelling the Hydrological Behaviour of Mountain Catchment Using TOPMODEL, *Journal Hydrology* 196: 361-377.
4. INWRDAM. 2001. Decision Support System in the Field of Water Resources Planning And Management. *Published on line in* http://www.nic.gov.jo/inwrdam/dss.htm1 . March 12, 2001
5. Loucks, P, Daniel, 1982. Water Resources System Planning And Analysis, New Jersey: Prentice-Hall, 559 pages
6. Montarcih, Lily. 2010a. Optimization of Water Needs at Kepanjen Dam and Sengguruh Dam
7. -------------------. 2010a. Possible Climate Change Effect on Water Irrigation at Golek, East Java, Indonesia. Journal of Economics and Engineering No 3 August 2010, 15-17
8. Susandi, Armi dkk. 2008. Dampak Perubahan Iklim Terhadap Ketinggian Muka Laut Di Wilayah Banjarmasin. *Jurnal Ekonomi Lingkungan* Vol. 12/No.2/2008
9. Tung, B.Z.; Yeh, Y. K.; Chia, K, and Chuang, J. Y., 1987, Storm Resampling for Uncertainty Analysis of a Multiple-Storm Unit Hydrograph, Journal of Hydrology, 194:66-384.