Policy of Eutrophication Control in Cirata Reservoir, West Java, Indonesia

Hasan Zahidah[1*] and Gunawan W.[2]
1. Faculty of Fisheries and Marine Science, Universitas Padjadjaran, West Java, INDONESIA
2. School of Life Science and Technology, Institute of Technology, Bandung, West Java, INDONESIA
*ibuzah@gmail.com

Abstract
The aim of this research is to understand the dynamics of ecosystem quality in Cirata reservoir that is utilized for fish net cage aquaculture (FNCA). The nutrient loading due to aquaculture and accelerated eutrophication was modeled by a system dynamics approach. The system dynamics model was divided into eutrophication and oxygen sub model. Both sub model simulations were run for 30 years and showed decreased oxygen at epilimnion and hypolimnion, meanwhile nutrient, biomass of phytoplankton, and detritus increased. Acceleration policy simulation mean fish farming accelerated showing that oxygen tended to rise and nutrient, biomass of phytoplankton and detritus tended to decline.

Keywords: FNCA, system dynamics, eutrophication, model, policy.

Introduction

Cirata is one of three reservoirs of the Citarum cascade. Cirata is located between Saguling and Juanda. Cirata Reservoir has to be cared after Saguling Reservoir receive pollutants and nutrient from Bandung area. The consequences as Reservoir second after Saguling, Cirata Reservoir will receive pollutants and nutrient or derived from Saguling Reservoir.

Cirata reservoir at the start of inundated has mesotroph state, meanwhile in 1999, or when the reservoir was 11 years old, the reservoir has been eutrophic or even hypertrophic.[1] Further signs of eutrophication of the Cirata Reservoir are the high density of phytoplankton (in 1997 the density of 44.80 x 103 sel/cm^3 up to 62.28 x 103 sel/cm^3) and phytoplankton community dominated by Cyanophyceae strengthens the evidence that the reservoir has become eutrophic as according to the criteria proposed.[2-4]

The trophy state of the waters can be seen also by the concentration of nutrients in addition to the types of biota[5]. Oligotrophic waters have low nutrient concentrations whereas waters with eutrophic state have a high nutrient concentration. Dissolved oxygen has a decreasing tendency in Cirata reservoir (Fig. 1) whereas the carbon nutrient and BOD representing the detritus have a tendency to increase from year to year.[6,7]

Changes in state of water quality and increasing the state of the trophy are often disadvantageous for reservoir users, especially for fisheries that require good water quality for the growth of the organism to be maintained. Therefore, research on eutrophication dynamics and water quality in Cirata reservoir and the effect of policies are needed to maintain high productivity of the reservoir.

Material and Methods

The study was conducted in Cirata Reservoir, West Java. The study includes primary data collection in 2003-2006 and a review of secondary data including time series data for 5-10 years. The parameters in this study are grouped into primary data and secondary data. Primary data consists of four key variables: commotion (in this case represented bicarbonate as raised)[5], phytoplankton biomass, dissolved oxygen and BOD representing detritus[5]. The fourth variable is an indicator of eutrophication which is used by several researchers.[2-4,8-10]

Measurements of these variables are provided in table 1[11]. Parameters of the secondary data obtained from various sources, are: Quarterly Report of Management Board Cirata Reservoir[12], Open Water Fishing Preservation Institute (BPPPU)[13], State Electricity Company (PLN)[14], Center for Irrigation Research and Development Department of Public Works[15], Research Centre for Natural Resources and Environment Universitas Padjadjaran, Bandung, Indonesia. Primary data and secondary data are modeled using system dynamics approach.

The policy was developed based on the model produced using the routine shown in figure 2. Selection of system dynamics is based on the requirement that the problems being investigated had a dynamic nature which involves a time-varying quantity. In addition, the problem being modeled is a problem that illustrates the closed-feedback relationship that occurred in the activity of fish farming in cages and in water bodies. The system dynamics method is used also by Arquitt and Johnstone[8].

Results and Discussion

The aquaculture in Cirata reservoir is a dynamic system. Sustainability is associated with poor water quality of the reservoir, especially due to eutrophication. The process of eutrophication is related to the interaction of the concentration of nutrients, plankton abundance, feeding rate of fish in farm cages, human activities, fish faeces and the number of cages that keep changing from time to time. To understand the dynamics of eutrophication in Cirata reservoir, we built two models namely an eutrophication model and an oxygen model.