MODELING OF WATER DEMAND AND SUPPLY OF CHEBARA RESERVOIR USING WEAP MODEL

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ABSTRACT

Chebara reservoir faces a number of challenges related to integrated water resources management (IWRM), the major challenge being meeting the rising water demand as a result of population pressure from Eldoret town and seasonal variability of rainfall which can be attributed to climate variability and catchment degradation. These have led to high fluctuations of water level in the reservoir. During the rainy season (between April-August), there is a considerable amount of rainfall and river inflows, while during the dry season (September-March) when rainfall is at a minimum there is low inflows. IWRM approach at the catchment level, especially for a water stressed system, creates room for conflicts resolution among the upstream and downstream users. Decision Support Systems (DSS) provides an effective tool for water allocation, supply and demand analysis. In this study Water Evaluation and Planning System (WEAP) was applied as a DSS tool to carry out a Modeling of water demand and supply of Chebara reservoir. The main objective was to apply WEAP to model water demand and supply of the Chebara reservoir and to assess the impact of various proposed water demand management options. Inputs to the model include reservoir inflows (direct rainfall and streamflows); reservoir outflows (reservoir evaporation, environmental flows and water withdrawals); storage-surface area relation and simulation parameters (initial storage, start of rationing level, minimum storage level). Ground-water inflow and outflow were assumed negligible. The geology of the region in which the reservoir is located consists of clay soil which is of low permeability and poorly drained. Hydrometeorological and water use data were obtained from the Ministry of Water and Irrigation, Water Resources Management Authority (WRMA), Kenya Meteorological Department (KMD) and Eldoret Water and Sanitation Company (ELDOWAS). The collected information was geo-referenced in GIS software (ArcView) to create spatial database. The Food Agriculture Association (FAO) Rainfall-runoff method was used to simulate runoff. In the simulations using WEAP, the catchment was lumped into one where the supply (catchment runoff) and demand nodes were spatially located. Three main scenarios were built from the reference scenario; Population growth scenario, infrastructure development in the Chebara reservoir and climate variability scenarios. Four sub-scenarios which are demand management options were built to analyse current abstraction levels; reduction of water leakages from the current 31% to 21%, rain water harvesting which was assumed to be 1 million cubic meter per year, demand side management which was taken to be 25% so as to decrease water demand, drilling of boreholes and the abstraction rate was taken to be 7,200m^3/day after studies were done. The model was calibrated and validated from the year 2009 to the year 2011 using the observed Chebara reservoir water levels and water demand at the major demand point which is Eldoret town. Results indicate that infrastructure development in Chebara reservoir Treatment works is a favourable option in terms of demand side reliability for the scenarios developed as the percentage reliability varies from 36% to 50% while as per the reference scenario the demand reliability varies from 30% to 44% showing an improvement. It was recommended for new water sources for Eldoret town be identified and explored since Chebara reservoir with infrastructure development and water demand side management, can only be able to meet the water demand for Eldoret town up to the year 2015 and if the management options are combined the reservoir will be able to meet water demand till the year 2017.