Abstract

Water stress and land degradation are major causes of food insecurity and poverty outreach in marginal and dry lands. Muooni catchment is facing increased risk of crop failure under rainfall fluctuation due to increased farming water operational costs, especially under drought. This study aimed to: (i) assess the kind of anthropogenic and environmental factors affecting efficient use of water and land by farmers at Muooni dam site; (ii) determine the extent to which land-use activities and environmental externalities impact on the active water storage capacity of Muooni dam; (iii) simulate the variations of farmers' actual water demand and related costs resulting from rainfall fluctuation; and (iv) estimate the farmers' water economic order quantity (EOQ), limit average costs (LAC) and minimum efficient scales (MES) under fluctuating rainfall regimes. The study area was stratified in two zones: the immediate sitting zone (ISZ) and the gradual sifting zone (GSZ). In total 66 farms were surveyed in the ISZ, and 60 key informants interviewed in the GSZ. GPS and GIS software were used to collect and process computational data, while DoView, SPSS and MS Excel spreadsheets helped processing qualitative and quantitative data. Techniques for assessing and predicting the impact of land-use activities and environmental externalities on Muooni dam's active water storage capacity and farmers' water demand included hydro-geomorphologic impact assessment, descriptive and non-parametric statistics, time series analysis and Spearman's Rho test, and operational research inventory modelling. Results of Mann-Witney U-test and Spearman's rank correlation indicated with 99.8% confidence degree that farming activities assessed at Muooni dam site did not have a significant impact on its soil erosion and water over-abstraction. Farmers' poor education and income did likely not allow them detect early effects of soil erosion and multiple cropping overuse, while El Nifo floods and droughts amplified these impacts by loading more than usual sediments in .Muooni dam reservoir. These externalities affected water availability in Muooni dam at a decreasing rate of 6.2% per year. Spearman's Rho test attributed with 99.5% confidence degree 65.7% of the total variation of the dam's active water storage to the obsolescence of its reservoir logistics, while the remaining 34.3% were explained by the reservoir sedimentation and water over-abstraction by eucalyptus and other alien trees planted in the catchment. The decreasing water levels in Muooni dam threatened smallholder farms' yield and income through increased farming water shortage costs and the cost of fertile soil excess loss. This constrained farmers to use less than required water by their plants, especially during drought. The operational research simulations revealed that LSF, MSF and SSF farmers were just ordering 28.9°10, 12.2% and 4.4% of their respective actual crops water requirement. An increase of 175%, 518% and 1,420% of their actual total costs was observed respectively under ANOR, NOR and BNOR scenarios. For efficiency, farmers needed to decrease their crops water requirement as soil moisture decreased by specializing to no more than three water friendly crop species. They should also optimize their water demand to the EOQ or the LAC level, or at least to the MES level. This would imply an increase of their actual water demand by at least 36%, 129% and 972% under respectively the ANOR, NOR and BNOR regimes, using innovative technological means, efficient on-farm management techniques and hydropolitical strategies to be implemented by the government in the Athi CMS and Muooni SCMP.