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Upstream Effects on Aras Cascade Hydropower Plants System

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Abstract

Aras River is an international river whose water resources are shared by four countries of Turkey, Armenia, Iran and Azerbaijan. A major middle part of Aras River is exactly the border between Iran, Azerbaijan and Armenia and on this part the countries share several hydropower plant projects including two storage projects (Aras and Khodafarin) and four run-of-river projects (Megri, Gharechilar, Marazad and Ordubad). On the other hand there are some development plans in upstream countries of Turkey and Armenia which are expected to affect the energy production performance of the hydropower cascade system of Aras River. The principal motivation of this study is to demonstrate some of these effects and therefore the results are expected to be helpful for future action plans or possible hydro-political negotiations. To deal with this issue, the water resources demand-supply system of Aras River was modeled using WEAP (Water Evaluation and Planning) software. A script for hydropower simulation based on the sequential streamflow routing method was developed using scripting capabilities of WEAP. Results demonstrate that upstream projects construction will dramatically reduce energy production of the hydropower plants. We have supposed that the most influential effect of upstream development in Turkey and Armenia is 35% reduction in long-term average of Aras Dam inflow, the reality that revealed by a pervious study. Therefore based on our results, 30% decrease in the annual average of hydropower energy production of Khodafarin, Megri and Gharechilar power plants and 50% and 15% reduction in annual average of hydropower energy production of respectively Aras and Marazad power plants are expected.
Keywords: Hydropower plants cascade system, WEAP, Sequential Streamflow Routing, Aras River

1. INTRODUCTION

Transboundary issues associated with Aras River provide general perspective for effective cooperation among riparian countries including Turkey, Azerbaijan, Armenia and Iran. The existing agreements for cooperation are mostly between Iran, Azerbaijan and Armenia to develop hydropower plants (HPPs) along the shared river in the border of Iran and Armenia (Heidari, 2011). On the other hand the impact of Turkish activities in upstream of Aras River will change flow pattern and water pollution in this river. In this paper a hydro-energy simulation model is developed to assess effects of upstream activities on the hydropower cascade system performance. The famous Sequential Streamflow Routing (SSR) routine is embedded in WEAP model using scripting capabilities.

2. CASE STUDY

Aras River has high potential of hydropower development and consequently in recent years lots of hydropower projects have been under study or construction on the river. In this regard, Iran, Azerbaijan and Armenia have shared 6 main hydropower plants projects. The first one is Aras Dam and hydropower plant which is under operation since 1974 with installed capacity of 44 MW. The second storage project is Khodafarin Dam and hydropower plant whose construction is expected to be completed in 10 years. Installed capacity of Khodafarin plant is 200 MW and it consists of 2 plant units. Between these two storage projects there are four important run-of-river hydropower projects of Marazad, Ordubad, Megri and Gharechilar which are all under study now. Installed capacity of Marazad, Megri and Gharechilar are 35, 110 and 110 MW, respectively. Figure 1 shows schematic of Aras cascade hydropower plants system. There are some riparian municipal, rural and agricultural demand sites in the river system. ILF, AzLF and ALF represent tributaries flow into main body of Aras River respectively from Iran, Azerbaijan and Armenia sides. Table 1 shows long-term average of discharge of Aras River main body and its tributaries. In Figure 1, IDE, AzDE and ADE represent riparian demand sites respectively in Iran, Azerbaijan and Armenia and QEN represents minimum required environmental flow. Table 2 shows annual water requirement of these demand sites.