Water demand and climate adaptation measures in downstream of the Zeravshan river

Temur KHUJANAZAROV[1], Kenji TANAKA[1], TOUGE Yoshiya[1], Kristina TODERICH[2]
[1] Water Resources Research Center, Disaster Prevention Research Institute, Kyoto University, Japan
[2] International Center for Biosaline Agriculture for Central Asia and Caucasus, Tashkent, Uzbekistan

1. Abstract

Balancing water demand for the whole basin efficiency is priority task in the world. This is especially true in the arid regions with the limited resources and political conflicts over water availability. The balanced usage of the water between participators to reach the most outcome from available resources could ease tension and provide a better economic outcome between argues. Water demand and analysis of the possible water resources distribution in the case study of Zeravshan river basin to achieve positive benefits for both countries were analyzed. The impact of the dam operation for irrigation to the downstream show flow reduction to 10% while improving energy outcome. Possible solution in using marginal (return flow) water for irrigation is investigated. Results show that several crops can provide relatively high growth rate even treated by saline waters as solution in reduced water flow.

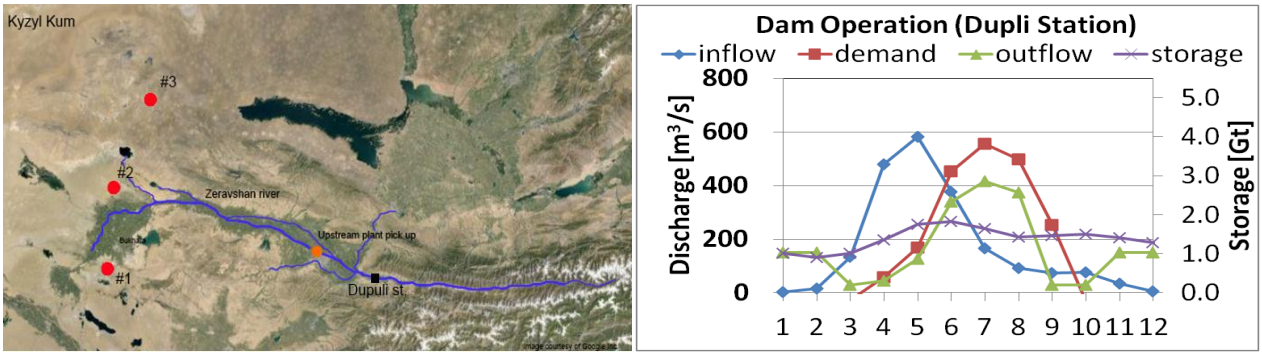
2. Water demand analysis

Zeravshan is a transboundary river in Central Asia affected by mismanagement of the water resources due to the huge diversion for irrigation, poor functioning and maintenance of the drainage networks, as well as high rates of water losses. Zeravshan river (fig. 1a) is shared between two countries Tajikistan and Uzbekistan and currently Tajikistan uses only 4% of the river run-off, all remained is fully utilized for irrigation in 4 districts of the Uzbekistan. Soviet time emphasis to the irrigation and favorable to irrigation hydrograph has changed the river basin environment and socio-economic goals in the region to produce much in summer (high flow) period. However, recent investigation showed poor state of the irrigated lands (MAWR, 2004), additionally more active action from the upper stream Tajikistan to involve in usage of the river in terms of energy outcome. Analysis of the water demand and understanding impact of the climate change with the future water resources distribution for both countries will be key for the livelihood of the local community.

The methodology of this research consist of 4 stages. First irrigation demand and inflow are analyzed, on the second stage storage of the dam and outflow are simulated, on the third stage results were combined and analyzed to balance usage. The framework assess weights of each solution impact and provides percentage suitability of the method to the region. Currently main water resources consumer has been downstream with highest population rate compared to upstream and most of them involved in the agricultural activity. As such we gave this region more priority due to social impact shortage of the water can cause. However, dam operation if well agreed can increase water outflow, shown in our simulation. Dam operation in the upstream has second highest priority, to produce hydro-power. Environment and river operation is given third weighted priority. Total irrigated area of the Uzbekistan from the Zeravshan river is 577400 ha and total water usage is 130%, where excessive 30% comes from reused return flow of the irrigated area. According to calculations 10% reduction in the irrigated area and moving crop calendar to 2 weeks earlier can reduce water consumption to 25% present (fig. 1b). However, winter months with lowest inflow wouldn't provide much needed inflow amount for operational purposes and climate change simulations shows likely decline of the water flow and shift to the earlier months. We assume two option for the river operation, using dam for improving irrigation and producing energy in summer months that would be fully utilized in Uzbekistan and swap it in winter of the same amount to Tajikistan or searching maximal benefit for both countries. The first case scenario the economic benefit compared to second solution exceed it to 17.35% for both countries. But these action should be supported with better water management in downstream and political agreement with upstream.

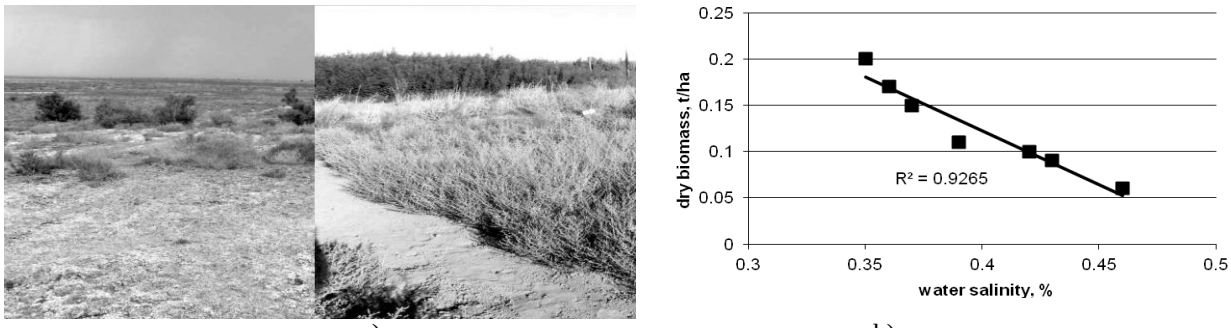
3. Using marginal waters for forage

According to different global and regional climatic scenarios, in the next 20-35 years the annual average air temperature will increase by 1.5-2.5°C in Central Asia (Hagg *et* al, 2007). One of the possible solution to overcome water shortage under climate extreme conditions in future and shortage of water is reusing water. Such called marginal waters, return flows from irrigation fields or waste waters has been discussed before (Khujanazarov et al, 2012). In this research several experimental sites were setup in the downstream of the Zeravshan river basin to study strategies using salt tolerant plants under extreme dry climate conditions Two sites, #1 and #2 are situated in the Bukhara oasis (fig. 1a), established outside of the traditional irrigation areas, mostly with brackish water flow, to assess impact of polluted water on plants. Site #3 established in Kyzylkesek (Central Kyzyl Kum desert) to check adaptation to extreme climatic conditions. It is characterized by higher temperature variation and much dryer conditions compared to the Bukhara oasis sites, and there is no direct access to the fresh water, but there is an available mineralized artesian thermal water source.



a) b)

Figure. 1. Zeravshan river basin study area (a) and dam operation on Dupuli station (b)



a) b)

Fig. 2. Comparison of the fields under marginal water usage (a), correlation of the water salinity to biomass (b)

To control climatic conditions, a meteorological station measuring wind speed, air temperature, humidity, and others related parameters was installed. The question how plants respond to the marginal water application was emphasized in our second research objective. The performance of investigated annual and perennial plants on saline soils and irrigated with marginal water shows high growth rates, comparable to those in agricultural irrigated land (fig. 2a). It is important to emphasize that an upper limit of salt concentration in soil and water as well as in groundwater levels should be preserved and controlled. The fresh biomass of investigated species sharply decreased with the increasing gradient of soil salinity as shown on the (fig. 2b). The limits of mineralization of the marginal water optimum for crops growth and green biomass accumulation were found to be varied in the range of 2000-8200 mg/l-1.

4. Conclusion

Investigation of the impact of the dam operation and benefit for both upstream and downstream countries were calculated. Results show that if dam construction is inevitable than both sides has to agree on reduction of the irrigation area from Uzbekistan side and dam storage decrease from Tajikistan. These action will lead to less damage on economic and social output for both countries with benefit of more then 15%. Other solutions include improvement in drainage network, reduction of the water consumption that could be a trigger to whole region example of water management. One of possible solution of the marginal water usage is investigated showing promising results under extreme climatic conditions. By implementing these methods and processes, there is the added benefit of reducing waste discharge and thereby improving water quality within the catchments as well as decreasing water stress and adapting to limited water availability.

References

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