Integrated Watershed Management for Small Catchments Within Sana'a Basin, Yemen

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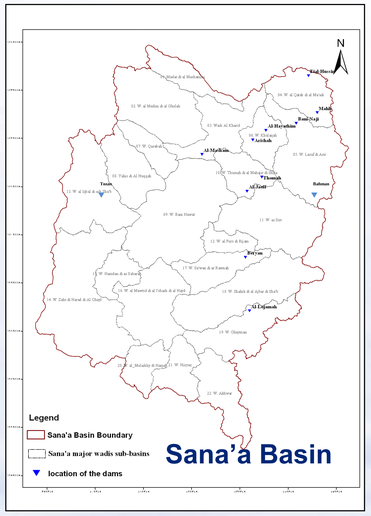
Introduction

- Water availability in Sana'a City, capital of Yemen, is one of the scarcest in the world.
- The region has no perennial surface water runoff, and is practically dependent on the use of groundwater.
- Over-exploitation is causing the groundwater table to deplete, with a water table drawdown of about 3 meters per annum, Yemen is amongst the worst affected areas in the country.
- Intermittent and intense rainfall events over an arid watershed can lead to short term surface water availability. ensuring that the available surface water remains within the catchment in the form of stored groundwater.
- Artificial recharge is becoming more prevalent in the recent years because it can be used to buffer against climatic variability and associated floods and droughts as well as augment recharge to groundwater aquifers.

Purpose

- Apply an integrated water resources management (IWRM) approach to assess the effectiveness of the supply management applied in the Sana'a basin to slow down the depletion of aquifer in the Sana'a basin.
- Quantifying induced recharge under two distinct types of structures for artificial recharge floods. This composes analysis of actual field data using numerical models. Based on them, the efficiency of the recharge process is evaluated and recommendations for management strategies are given. Thus, suggestions for engineers who are planning, designing and operating recharge dams in similar arid regions are given.
- Assessment of actual hydro-socio-economic benefit gained from these structures. For evaluation of options for resources management intervention, quantifying dynamic recharge volume alone would not be sufficient. There is need for detailed consideration of all components (technical and non-technical) to assess actual benefit of artificial recharge structure, including: environment, social and economic factors.

Location



Methods

Field Work

Reconnaissance field visits; identifications of:

- Hydrogeology and reservoir characteristics.
- Catchment characteristic and reservoir condition.
- Monitoring of water level at wells near the 10 dam Sites.
- Monitoring of water level at dam lakes.

Methods

The Approach

For selected studied 10 structures in Sana'a Basin, the following assessments were undertaken:

- Daily Precipitation.
- Daily Runoff estimation.
- Daily Recharge Assessment including :

  1. Reservoir simulation model (water balance).

  2. The developed model of reservoir simulation combined with a more refined Darcian approach.

  3. Groundwater Modeling (MODFLOW) .

- Hydro-Socio-Economic Dam Benefit Analysis including:

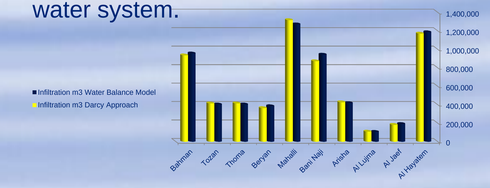
  1. Dams Cost Effectiveness.

  2. Environmental and Social Benefit.

  3. Recharged Water Chemistry Aspects.

Results and Discussion

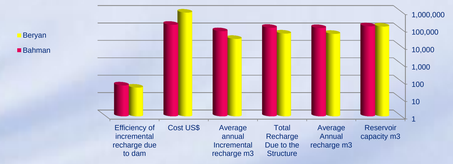
- The simple approach developed carefully can provide acceptable results for estimation of induced recharge under dam constructed in minor ephemeral wadis. Better understanding of the effect of different dam/groundwater through groundwater numerical simulation (MODFLOW) with reservoir package which simulates leakage between a reservoir and an underlying ground-water system.



- De-siltation of reservoir bottom should be thought of as an essential management practice to extend dam life time, too. The periodic removal of alluvial sediment (fine sand, silt and clay) and organic material (bacterial slimes and algae) that tend to accumulate, should be removed to restore the infiltration capacity of reservoir and that should be an essential aspect of the maintenance of all such structures.

Results and Discussion

- Checks dams show highest efficiency of recharge followed by smaller gravity dams. Check dams prove to be an excellent vehicle to engage local communities in practical action for water resources conservation.
- Check dams provide better chance for recharge through wadi bottom than gravity dam through increase infiltration opportunity. However, the number of the check dams should be evaluated accurately. One method to overcome limitation of data for these wadis, the implementation of the check dams in any wadi should be undertaken in more than one phase, without requiring expensive foundations required for gravity dam. Check dams also remove fine suspended materials through settlement, providing clear water to the downstream part, which infiltrates more readily



Recommendation

- The key mitigation measure is the need for the establishment of the WUA. Concerns over the current management of the dam and reservoir means WUA should be aware of and agree on the future management of the dam, the operation and maintenance of the outlet pipe, water quality and removal of silt. However it should be mentioned that WUA can not solve problem between upstream and downstream people.
- For an optimized recharge management: the recharge flow should be adjusted in such a way that the available water can infiltrate in an area as small as possible for as long as possible. However, longer periods can mean water quality deterioration and development of diseases caused by the availability of a surface water body.

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