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Assessing Ground Water Recharge Potential in Wadi Zabid and its impact on Supplementary Irrigation of Crops in Spate Irrigation Areas Using IWRM approach

Fact sheet

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Background

Wadi Zabid is second larger of Tihama wadis, that has about 4360 Km^2 catchment area, where covers spate irrigated area about 15215 ha. The spate irrigation area in Wadi Zabid have annual average of floods waters about 118 MCM. Distribution of flood waters covered the target area, where Al-Jabarti system distribution (al'ala fal aala) that is implemented since 600 years ago. Wadi Zabid have modern diversion structures established at seventies, while Al-Jabarti distribution system still continued until now. Therefore, that led to iniquity in water allocation as well as change in crop patterns which economic crops replaced into other crops have large water requirements. Which depletes groundwater heavily with 75% such as banana crop, that covers area more than 3500 ha.

Groundwater recharge in Wadi Zabid

The rainfall in upper catchment areas in high where exceed 500 mm per year, while rainfall in low in downstream areas that's called spate irrigation areas located in Tihama coastal plain such as Wadi Zabid plain. Therefore, groundwater recharge in those areas depend on floods water as main sources for the recharge. The spate water flow through streams, or river beds which infiltrated occurred, then distributed by wadi canals into irrigated fields according to distribution system, where big amounts recharged to aquifer and the rest evaporated either by plants or soil.

Land use in Wadi Zabid plain where a study area located within spate irrigated areas, include agriculture fields, while there are many villages distributed in various areas of wadi. The spate irrigation areas in Wadi Zabid plain divided into three parts upper, mid and downstream, but spate water often allocated with upstream areas according to Al-Gabarti rule for water distribution. So the spate water is insufficient for beneficiaries in other areas, while the cope pattern in those areas included grain and fodder, fruits, vegetables and other cash crops (FAO 1987).

The relationship between surface water and groundwater in Yemeni spate irrigation areas is conjunctive use and the recharge, but unfortunately, those processes managed in unbalanced manner. Where cropping patterns in many coastal spate systems in Yemeni Wadis have changed dramatically, due to a remarkable increase in shallow wells. As a result, the increasing in the area under banana cultivation, e.g. the area of banana in Wadi Zabid has increased from 20ha in 1980 to more than 3,500ha (Steenbergen and Nawal). While the groundwater recharge occurred in upstream areas, while downstream areas can't recharged due to distribution systems of spate waters at inappropriate form.

Therefore, IWRM in spate irrigation areas became essential need, which groundwater and surface water are closely linked and within an IWRM approach all water should be managed as one resource (Owen, et al. 2010).

Table 1 crop pattern in Wadi Zabid spate irrigated areas

	Type of crop	%	Area ha	Groundwater irrigation %	Spate water irrigation %
	Cereal grains: (Sorghum grains, Sorghum fodder, maize)	53	8063.95	20	80
	Fruits (papaya, melon, banana)	23	3651.6	90[1]	10
	Vegetables (tomatoes, onion, cucumber, peppers…ect)	3	456.45	70	30
	Other cash crops (cotton, tobacco, sesame)	20	3043	90	10

Source: GSO (2002) modified by researcher

The crop patterns change led to increase of groundwater pumping duo to banana crop that have high water requirements, especially in upstream and some midstream areas as shown in table 2 a below.

Table 2 abstraction of groundwater irrigation according to crops patterns in spate area at Wadi Zabid

Site	Area of banana fields ha	The amount of water MCM	Area of fodder fields ha	The amount of water MCM	Area of other crops ha	The amount of water MCM	Total consumption MCM	Ratio of consumption %
Upstream	١،٩٠٠	١٠٩	١،٣٠٠	١٥,٠٠	٥٠٠	٦,٠	١٣٠,٠	%٤٥
Midstream	١،٧٠٠	١١٣	٢،٦٠٠	٣٠,٠٠	١٠٠٠	١١,٠	١٥٤,٠	%٥٣
Downstream	٠	٠	٤٠٠	٥,٠٠	١٠٠	١,٠	٦,٠	%٢
Total	٣،٦٠٠	٢٢٢,٠	٤،٣٠٠	٥٠,٠	١،٦٠٠	١٨,٠	٢٩٠,٠	%١٠٠

In this study rate 30% was selected that is may be real rate, result to size of fine soils in cultivated land and water requirements ET according to area conditions.

[1] In this not the banana crop have big water irrigation requirements

From the table (4) a below it is clear that the annual amount of groundwater recharge from wadi bed (channels) 57.63 MCM and Fields and 18.14, respectively, which is equal to 75.77 MCM, which constitute about 64 % of the total amount of water entering

Table 3 Groundwater recharge form irrigated fields by floods water

Area	Allocation %	Averge of flood allocated MCM	Waid bed Recharge MCM	irrigation water MCM	water infiltrated by fields MCM
Upstream	٥٢	61.412	36.85	24.56	7.37
Midstream	٤٠	47.24	15.87	31.37	9.41
Downstream	٨	9.448	4.91	4.54	1.36
Total	100%	١١٨,١	57.63	60.47	18.14

Water balance

We have many inputs for water in Wadi Zabid floods average 118 MCM and rainfall about 30 MCM. The total water extracted from the aquifer for irrigation about ٢٩٠ MCM, and considering that 30% of this water extracted return to the reservoir in infiltration process, the amount of the annual loss from the reservoir is 203 MCM plus amount of water for domestic and industry use about 10 MCM as well as amount of evapotranspiration about 45 MCM

Water balance = inflow – outflow = (floods + rainfall + return irrigation) – (pumping + requirements human + Eto)

Water balance = (118 + 30 + 87) – (290 +10 + 45) = -110 MCM

The annual deficit of the reservoir = -110 MCM

Recommendations

1. There is not coordination between the relevant authorities , so must be activate the role of integrated water resources management (IWRM)
2. Review of water rights in Wadi Zabid that conform with last changes in groundwater situation, as well as equity manner between beneficiaries
3. Banana crop has major reason for ground water depletion, so you must take effective steps to replace it to other crops that is compatible with spate irrigation conditions, As that replace of banana crop will reduce the imbalances in distribution of flood water between the beneficiaries
4. Making of processors immediate to groundwater reservoirs before the biggest problem