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Domestic Water WithdrawalSystems Management in Kandahar City, Afghanistan

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Abstract: *This study determined the evaluation of domestic water withdrawal systems (DWWS) in the fields of environment and economics in Kandahar city, Afghanistan. The study assessed currently used systems such as water supply piping system WSS 23% and bore well system BS 77%. In order, by a questioner and observation data form, two kinds as primary and secondary were collected from 25 units (houses) per municipality districts and 275 units in the entire city, average data on districts level was entered to a simple calculation model.*
Based on the observed data, the construction cost as19962 Afghani/house with maintenance 0.92 Afghani/house/day of BS were determined high related to 1449 Afghani/house and 0.104 Afghani/house/day of WSS, but costs of water as 0.0012 Afghani/liter by BS was illustrated less than 0.025 Afghani/liter of WSS. Also, the quantities of water losses were 660 liter/house/day for BS and 626 liters/house/day in WSS, these variations illustrated low management in water extraction from ground water resource.
With groundwater depletion the costs of(construction, maintenanceand water) were increased for both of the systems, these increased values determined the effects on local economy by Ground Water Depletion with replacing the BS system to WSS.
Key Words;*Bore well systems, Domestic water usage, Groundwater extraction, Groundwater resource management, Water supply piping system*

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I. Introduction

This study illustrates to evaluate the domestic water withdrawal systems (DWWS) in the fields of environment, economics and aesthetic. Water withdrawal is defined as the amount of water removed from the ground or diverted from a water source for use, while “consumption” refers to the amount of water that is evaporated, transpired, incorporated into products or crops, (Macknick et al.2011).

The value of water for a particular location depends on the amount of water to be supplied. In addition, the world economic development and comfort life is directly related to water, thus Kandahar city has also significant promotion of economic, socialization, and cultural parts. If we supply water with having low price and fixed time for domestic use, the improved water withdrawal systems are needed to save the time, money and have important role in the sustainability of ground water resource. Water has economic value only when its supply is scarce relative to demand. Whenever, water is available in unlimited supply, it is free in the economic sense. Scarce water takes on economic value because many users compete for its use. If water is for free, then the water provider does not receive sufficient payment for its services, consequently, the provider is not able to maintain the system adequately, and, hence, the quality of services will deteriorate, eventually the system collapses, people have to drink unsafe water or pay excessive amounts of money to water vendors, while wealthy and influential people receive piped water directly into their houses, at subsidized rates, Thus the water for free policy often results in powerful and rich people getting water cheaply while poor people buy water at excessive rates or drink unsafe water, (Rogers et al.1997).

Domestic water is about 8% of the total water used worldwide, there is an upsurge in the quantity of water required for domestic purposes due to population increase and sophistication in the standard of living, (Keith, 1993, Gleick, 1993 and UN, 1997). In a market system, economic values of water, defined by its price, serve as a guide to allocate water among alternative uses, potentially directing water and its complementary resources into uses in which they yield the greatest total economic return. Combination of population growth and economic development leading to increasing human freshwater use and enhanced climate change effects on the global water cycle, water scarcity is becoming an increasing environmental concern. Although freshwater is a local resource, water scarcity is leading to the threat of a global water crisis, with a large share of global population being affected.

There is no single method is available which comprehensively describes all potential impacts derived from fresh water use, (Kounina et al. 2013). Economic impacts of the drought on crop production, livestock and dairies, drought results in reduction in surface water available to agriculture, this loss of surface water is partially replaced by increasing groundwater pumping, net water shortage is caused losses in crop revenue, dairy and other livestock value, plus additional groundwater pumping costs, (Howitt et al. 2014). Water supplies like other commodities only have economic value in relation to their scarcity, (Charles et al. 2003).

Today, many concerns about the country's ground-water resources involve questions about their future sustainability. The sustainability of ground water resources is a function of many factors, including depletion of ground-water storage, reductions in stream flow, potential loss of wetland and riparian ecosystems and changes in ground-water quality. Each groundwater system and development situation is unique and requires an analysis adjusted to the nature of the existing water issues.

In many areas of Kandahar city, however, pumping of ground water has resulted in significant depletion of ground-water storage, because, attention is being placed on how to manage ground water in a sustainable manner.

The systems of domestic water withdrawal DWW are equipped with the local economic, available tools for the system in market and their cultural aspects. As water is being essential for life and for numerous human activates. It's necessary to knowing the amount and cost of the withdrawn water, because a developed system is desirable to be described. In Kandahar city, a few number of the population has access to potable water supply system and many of the population use different systems for withdrawing the domestic water. For the systems, it is not clear to which of the system is economical and efficient for groundwater resource.

The demand for clean water in urban areas is increased due to ever increasing the population, while the water sources decline over time. As the growth of population shows that many of the people will be faced with scarcity of potable water, as an improved and economical system is required. Therefore in this research the assessment of current used system for domestic water is to be considered. Different DWWS are used in Kandahar city such as electrical pumps and piping systems. It's known, the value of systems differ to each other, but it is not clear that which of the system is efficient to prevent high water losses, till now therefore it needs a research among this necessity.

The research study will be inspecting possible answer to the question, how to find out a system to be effective for groundwater resource and economically for DWW in Kandahar City, Afghanistan?

Objectives of this study that find the possible solutions for the study question are;assessment the current used systems for DWW, finding water extraction losses during the operation of the systems, determining which of the system is effective in the context of groundwater resource and considers the economically and qualitative effects of GWD on the systems, to assess groundwater withdrawal management for domestic purposes in Kandahar city.

II. Study Area

Afghanistan has the condition of imbalance timely and special diffusion precipitation is caused of the scarcity of water resource. as well as, approximately 80 percent of the precipitation falls where the elevation is high than 2000 m and the remaining 20 percent falls on the area that is lower than 2000 m in winter, approximately 47 percent from the total precipitation is discharged outside the country, (Favre. 2004). Water consumption in Afghanistan for the sectors such as agriculture, domestic, and industrial are 98%, 1.5%, and 0.5% respectively, (Alim. 2006).

Figure 2.1 Map of Kandahar City

Kandahar city is the study area of this research, it is known with arid and hot climate, and has all four seasons. The summer is hot with mean temperature is about 30°C during June, July and August. In the winter, the minimum temperature reaches even to 0°C during December and January. The average annual precipitation is less than 200mm, and it falls in the form of rain. The rainfall duration is almost from December to April, but rarely occurs in July.Two kinds of resources (Surface and ground water) are supporting water consumption in Kandahar. The surface water is mainly received from Arghandab River, which crosses the area near to Kandahar about six Km in west of the city and gets started form Dehla Dam. The Dam is far about 34Km from the city in the northeast of Kandahar City, that was constructed for the capacity of 478.6 million cubic meters.Ground water is the second source which stands at first position of domestic and industrial consumption in Kandahar City. The availability of ground water is highly dependent on the water in Arghandab River. The water table is depleting while there is not water in the Arghandab River or it is less than its normal flow rate, especially in ZahirShahi canal, because the location of ZahirShahi canal is in center of City, so, it definitely affects water table of the lower part of city (USAID,2008).

III. Methodology

This study includes the area of Kandahar city, Kandahar, Afghanistan, the area was divided by 11 municipality districts, and residence of the city generally used two systems for their water withdrawal as: head water pump and water supply piping system. Tow kind of data as primary (construction cost of the system per unit, increased construction cost of system per unit by GWD, Water withdrawal per house, resident per house) and secondary (Water consumption)was collected from 25 units (houses) per municipality districts and 275 units in the entire city, after that the collected data sample was divided on two systems as BS and WSS. After that the following equations revealed the average values of the systems in total districts.

$$BS_{(average\ )} = \frac{\sum_{i=1}^{n} BS_i}{i} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1$$

$$WSS_{(average\ )} = \frac{\sum_{i=1}^{n} WSS_i}{i} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 2$$

The data was collected by a designed observation data collection form, the form was considered by questionnaire and observation parameters in general of water demand and extraction. The obtained data from ever of two systems were analyzed and compared for investigating of the systems, which of the system is economically and effective for groundwater resource.

In this study, independent, intermediate and dependent variables were demonstrated based on the theory. Independent variables described intermediate variables and obtained from the area by questioner and observation data forms, after that, intermediate variables contributed the relation between independent and dependent variables. The victors show direction of analysis that is resulted of dependent variables

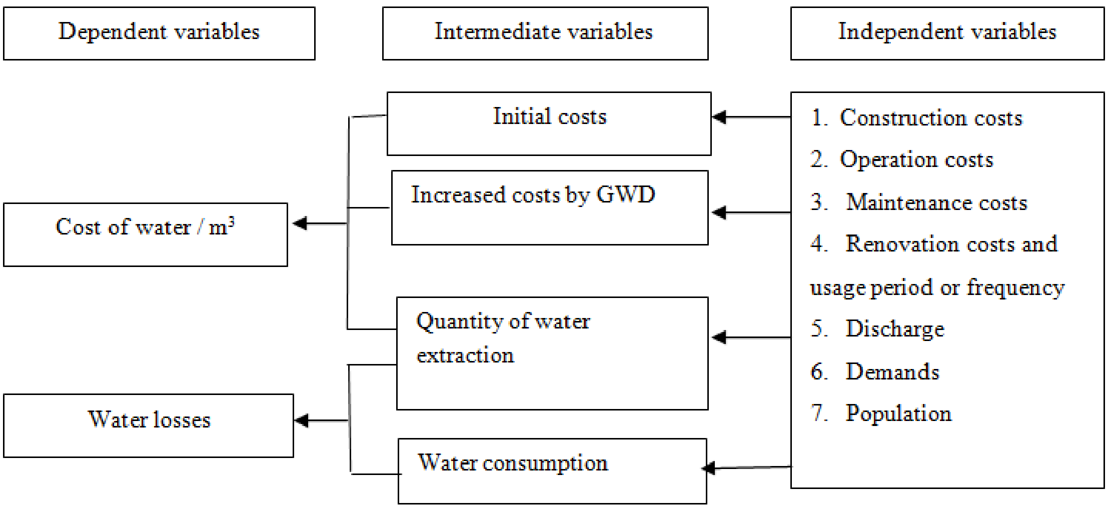

Figure 3.1 Variables diagram with their calculation direction

IV. Data Analyze Procedure

A quantitative research model was arranged for this study to attain the objectives by examining the relationship between the prepared variables, the variables were measured by instruments and observed data was analyzed with using statistical procedures. This simple model was prepared for one unit (house) and after that, it

was adjusted to average values for the systems, the model has some simple equations for water withdrawal and total cost of the system.
In a simple equation,water losses ($W_{(l)}$)is equal water withdrawal minus water consumption as,

$$W_{(l)} = W_{(w)} - W_{(cons)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots .. 3$$

Where
$W_{(w)}$: water withdrawal in a unit
$W_{(cons)}$: water consumption in a unit
For the borewell system, water withdrawal is equaled to maintenance cost divided by water cost, but in water supply piping system, water price should be added to the maintenance,

$$W_{(w)} = \frac{M}{W_{(c)}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 4$$

Where
M : Maintenance cost
$W_{(c)}$: water cost
The maintenance cost will be increased with enlarging the water extraction, thus we can write,

$$W_{(w)} = \alpha(M) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 5$$

From Eqs. (4,5) we have the $W_{(c)}$ is indirect proportional to α coefficient,

$$W_{(c)} = \frac{1}{\alpha}$$

Also water cost is enhanced with increasing water consumption (W_{cons}), as in equation below,

$$W_{cons} = W_{(c)}\beta = \frac{\beta}{\alpha} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 6$$

β ; Coefficient
The values of Eq. (5,6) are placed in Eq. (3) yield,

$$W_{(l)} = \alpha(M) - \frac{\beta}{\alpha} = \frac{\alpha^2(M) - \beta}{\alpha} \dots\dots\dots\dots\dots\dots 7$$

V. Result

The data assessed the existing water extraction systems for domestic purposes, it calculated water losses during the operation and defined theactual system in the context of groundwater resource management that would be economically effective forgroundwater depletion. As groundwater was the main source for domestic water consumption, BorewellSystem (BS) and Water Supply System (WSS) thatdrew the water from groundwater resource wereclarified by percentage. Separated observed data of both traditional systems demonstrated the usage percentage on districts level, it showed that the practice of BS about 77% was high related to 23% of WSS.

Specifications	**Water Supply System (WSS)**	**Bore well System (BS)**
Water extraction systems	23%	77%
Construction costs	14049 Afghani/house	19962 Afghani/house
Maintenance costs	0.104 Afghani/house/day	0.92 Afghani/house/day
Water extraction	1340 liters/house/day	1389 liters/house/day
Water consumption	714 liters/house/day	729 liters/house/day
Water cost	0.0251 Afghani/liter	0.0012 Afghani/liter
After Groundwater Depletion		
Construction costs	29954 Afghani/house	30567 Afghani/house
Maintenance costs	8 Afghani/house/day	9 Afghani/house/day
Water cost	0.0251 Afghani/liter	0.0081 Afghani/liter

Table, 5.1 Research outcome for water extraction systems

The model estimated construction costs of the systems in two category as before and after Ground Water Depletion GWD. Average values were illustrated as 19962 Afghani per house (Af/H) of the BS before GWD, while the GWD, the cost has increased to 30567 Af/H that showed the variation as 10605 Af/H. The data considered, the cost in district 9th is highly increased as from 29910 Af/H to 50530 Af/H due to water depletion, and the difference between these values is 20620 Af/H, thus it is supposed, the local economic of the people in the district is extremely affected by GWD.At the time, when the residence used WSS and wells systems, the average constructed cost of the system was 14049Af/H before water depletion, but in these years, the system was changed to BS which was caused of increasing in construction cost as 29954 Af/H.

In two conditions, initial maintenance (M_C) about 0.92 Afghani/house/day and maintenance after GWD ($M_{I,C}$) as 9 Afghani/house/day of BS showed high variance as 8.08 Afghani/house/day by water depleted. In order, for WSS, these values were 0.104 Afghani/house/day before and 8 Afghani/house/day after GWD that exhibited the difference as 7.9 Afghani/house/day. In the result, increasing the value by GWD affected the economic state of the people.

The average daily water consumption was 59.4 liters per capita per day (Lpcd), (Haziq, 2012). In this study, the value was changed to average consumption by 729 liters/house/day in BS and 714 liters/house/day for WSS. In order, the calculation resulted, the average values of water extraction were about 1389 liters/house/day by BS and 1340 liters/house/day of WSS.

Average costs of water as 0.0012 Afghani/liter by BS and 0.0081 Afghani/liter of the system after water depletion, while, the cost from WSS was 0.0251 Afghani/liter. In order, the analyzed showed average costs as 0.67 Afghani/house/day before and 3.61 Afghani/house/day after GWD from the BS, also for WSS it was 15.69 Afghani/house/day.

VI. Conclusion

In the study area, there was used 77% of the bore well system, that has the construction cost as 19962 Afghani per house with maintenance cost of 0.92 Afghani per house per day, while, the construction cost of water supply system (which was used 23% in the study area) was 1449 Afghani per house by the maintenance cost about 0.104 Afghani per house per day. The cost of water from bore well system about 0.0012 Afghani per liter was less rather water supply system as 0.025 Afghani per liter. Regarding the low construction and maintenance costs of water supply system, it is recommended as economically outcome of this study, in addition, the high water cost of this system would be resulted to decrease the losses of water that was obtained as 626 liters per house per day,and could be effective for groundwater resource.

Low management in groundwater extraction hasaffectedthe groundwater resource, the water resource depletion has increased the construction cost about 10605 Afghani per house and maintenance cost 8.08 Afghani per house per day in the bore well system. In order, the depletion has affected water supplysystem, and bore well systems were replaced instead of water supply system, that has enhanced the construction cost about 15905 Afghani per house with maintenance cost 7.9 Afghani per house per day. These increased values determined the effects on local economy by groundwater depletion.

In the result of this study, water supply small projects with policy procedures should be prepared and implemented with local investment, and modify the management of water withdrawal and consumption from ground water resource in Kandahar city, Afghanistan.

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