

QUANTITATIVE GROUNDWATER ASSESSMENT OF PASHIN, BALOCHISTAN FOR SUSTAINABLE WATER MANAGEMENT

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Groundwater is the key source of water for survival in the Pishin, Balochistan area, which is decreasing with rapid urbanization. Karez, however, are considered as the major sources of irrigation and drinking water from many decades, but rapidly growing installation of tubewells in Baluchistan is adversely affecting functioning of the karez. The present study was conducted on groundwater pumpage to overcome the situation of scarcity in the context of ground water by measuring water table fluctuation rates and water discharge in Pishin district of Baluchistan, Pakistan. For this purpose data from WASA was incorporated to find out the fluctuation rate of water table over the period from 2005 to 2016 using GIS based Inverse Distance Weight (IDW) technique for making Water Level maps. The study shows a decline in all four Tehsils of Pishin district and the condition was worst at HURAMZAI tehsil as groundwater was depleting here rapidly. The main reason for this decline in the groundwater table was Tubewell pumping from groundwater resources which got exceeded than the natural recharge. Moreover, the rapid increase in urbanization decreased the infiltration rate in the recent years. According to 2017 census, total population of district Pishin was 736,481 with 51.48% male and 48.52% female in comparison to 376,728 in 1998 (MIC 2017). Based on the results the water table got fluctuated approx. 25 to 30 ft in past decades. Minimum and maximum water depth for 2007 were recorded 67.00 ft and 1214.98 ft respectively. In 2013 Minimum and maximum water level were recorded 80.00 ft and 266.98 ft respectively and water level further declined 2014. The decline continued up to 300 ft in 2015. The most affected areas in Pishin district are Pishin city tehsil and HURAMZAI tehsil. It is recommended that the government should strictly implement well laws in the area in order to avoid excessive pumping which is lethal stigma in the area.

Keywords: Groundwater depletion, sustainable management, spatio-temporal distribution, karez, inverse distance weight (IDW).

INTRODUCTION

Apart from glaciers and polar ice caps (Joshi *et al.*, 2009) groundwater is a valuable and extensively distributed water reserve at this planet. From consumption point of view, 80% of ground water is used for irrigation purpose (Dawn News, 2003). In addition to agricultural usage, groundwater is also used for drinking, domestic and industrial purposes all over the world. However, multiple factors like salinization, rapid depletion and contamination are causing stress on groundwater resources (Famiglietti *et al.*, 2011). The level of groundwater table is not constant in fact it fluctuates due to different reasons sometimes due to variations in supply and release, urban sprawl, earthquake, forces due to tides, land sinking and weather-related process and worldwide climate change (Shiri *et al.*, 2013). Rainfall is the most important indicator for groundwater fluctuation in any aquifer (Fan *et al.*, 2013). Pakistan is in the list of regions experiencing water stress (Wada *et al.*, 2010). In Pakistan Karez system is still in practice in some parts of Baluchistan (Lodhi and Mikulecky, 2010). Karez is a tunnel through which groundwater is conveyed to the command area under gravity. Karez system

becomes the more advanced technological innovation when it becomes a system that gave birth to a new spring – manmade spring (Abudu, *et al.*, 2011). It is believed that in Baluchistan, until 1970, around 3000 Karez systems were in use providing water supply to towns and for irrigated agriculture. Afterwards, with availability of the electric power and tubewell technology, the Karez systems started to decrease but over one third are still functioning, constituting as one of the major water source in Baluchistan (Tareen *et al.*, 2014). From a study, it was observed that the transition from Karez system to tubewell irrigation system is not very beneficial as it was merely the result of some deliberate government policies. This transition also caused some negative impacts on social equity and environmental quality (Mustafa *et al.*, 2008). Another study conducted in Kuchlugh sub-basin in Pishin Lora Basin reveals that in 1970s there was an insignificant use of groundwater through karez but with economic expansion and Afghan migrations the usage of groundwater got increased in 1980 whereas in early 2000 the main alluvial aquifer of Kuchlugh got completely exhausted (van Steenberge *et al.*, 2015). A survey was conducted in 2009 that shows rapid depletion in water table

due to several factors including increase in number of tubewells, policies of groundwater management and annual average rainfall (Khair *et al.*, 2010). Therefore, the present study was designed to evaluate the spatial and temporal variability in groundwater level using Inverse Distance Weight for its sustainable use.

MATERIALS AND METHODS

Study Area Description: Pishin was separated from Quetta after gaining district status on 18th January, 1975. It comprises four tehsils which lies between 30° 04' to 31° 17' North latitudes and 66° 13' to 67° 50' East longitudes. The district is bounded by Qila Abdullah in the north, Qila Saifullah in the east, Quetta and Ziarat in the south and Afghanistan in the west. The climate of Pishin can be categorized as delightful summer and dry and bitterly cold in winter. Pishin lies outside the sphere of monsoon currents (Khan *et al.*, 2010; Qasim *et al.*, 2011). For this study, 20 tubewells (5 from each Tehsil) and 15 karezes were selected from the whole district in order to analyze ground water depletion and surface water quality and its effect on ground water depletion respectively (figure 1). The primary objective of this research is to indicate the cause of depletion and suggesting how to overcome this intense ground water depletion.

Data Collection: The data of tubewells including depth of wells, their location, names, and discharge of wells was collected from Irrigation department of Pishin district, WASA, WAPDA, Public Health and Engineering department (PH&E) and NGOs. GIS data and district boundary were collected from Pakistan Geological Survey department. The weather data of Pishin and its adjacent area was acquired from Pakistan Metrological Department (PMD), Lahore which consists of annual rain fall, precipitation, and maximum and minimum temperature of study area. The time period of data was eleven years (Jan 2005 to September 2016).

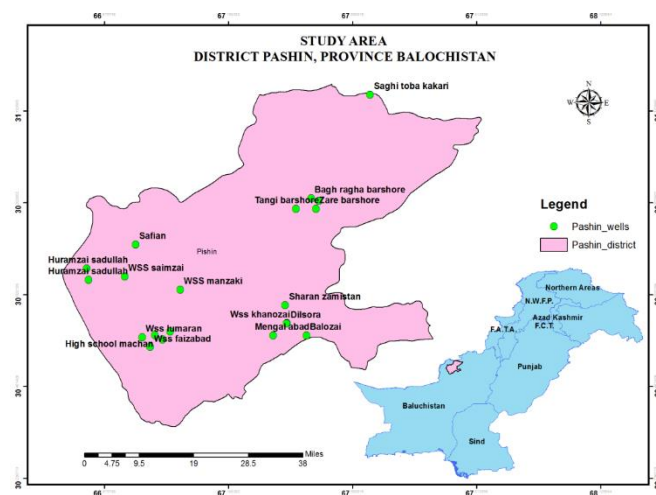


Figure 1. Location Map of Pishin District Tubewells.

Data Preparation and analysis: First of all, the eleven year data of for all tubewells including their locations names, coordinates, discharge, depth, length and water quality were entered into Microsoft excel 2010. For data processing two software were used, one is Arc GIS 10.2.2 that was used to handle GIS data in order to make maps. An Interpolation technique named as Inverse Distance Weight (IDW) was used to produce contour maps and to evaluate variability in water levels. The other software used in data processing was Microsoft excel 2010, with the help of this software Graphs for each location was produced.

Depth of water table: Depth of water table is one of the basic requirements for groundwater studies. During last ten years, various studies were carried out to determine the ultimate potential of groundwater and possible decline of water table in response to groundwater withdrawal. In order to update the information of water table and to exist water table configuration and various sources of recharge and discharge, the WASA conducted the survey for the depth of water table at selected locations. Observations on the depth of water table at the selected area and WASA tube wells were made to study yearly fluctuations of water table. The maps for depth of water table were prepared for various periods, indicating that excessive ground water extraction have form cup shaped depression in various areas of town which gradually attain equilibrium. Based on available data and field survey change in depth to water table was analyzed using Surfer software.

RESULTS AND DISCUSSION

In 2005, minimum depth of water level is 50.02 ft and maximum depth is 172.340 ft and it varies from tehsil to tehsil. However, water level was good at that time. While the water level varied in the next year with overall fluctuation of 10 to 12 ft. Minimum and maximum water depth for 2007 were recorded 67.00 ft and 1 214.98 ft respectively. It shows that Pishin district has been subjected to intense famine and excessive pumping in 2007 (Report Drought Risk Assessment in the Province of Balochistan, Pakistan, 2007). Similar trend continued in 2008. The water table was fluctuated about 25 to 30 ft per year (figure 2).

In 2009, minimum and maximum water level were recorded 74.0008 ft and 245.9811 ft respectively and water level further declined about 15 ft in 2010. The decline continued up to 9 ft in 2011. There was a continuous decline in water table by the year 2012 that indicates water table of Pishin district is subjected to depletion in intense way (figure 3).

In 2013, minimum and maximum water level were recorded 80.00 ft and 266.98 ft respectively and water level further declined 2014. The decline continued up to 300 ft in 2015. The most affected areas in Pishin district are Pishin city tehsil and Huramzai tehsil. This map shows water level fluctuation and it even crossed figure of 350 ft in 2016 it is quite clear that there is an alarming situation for Pishin district (figure 4).

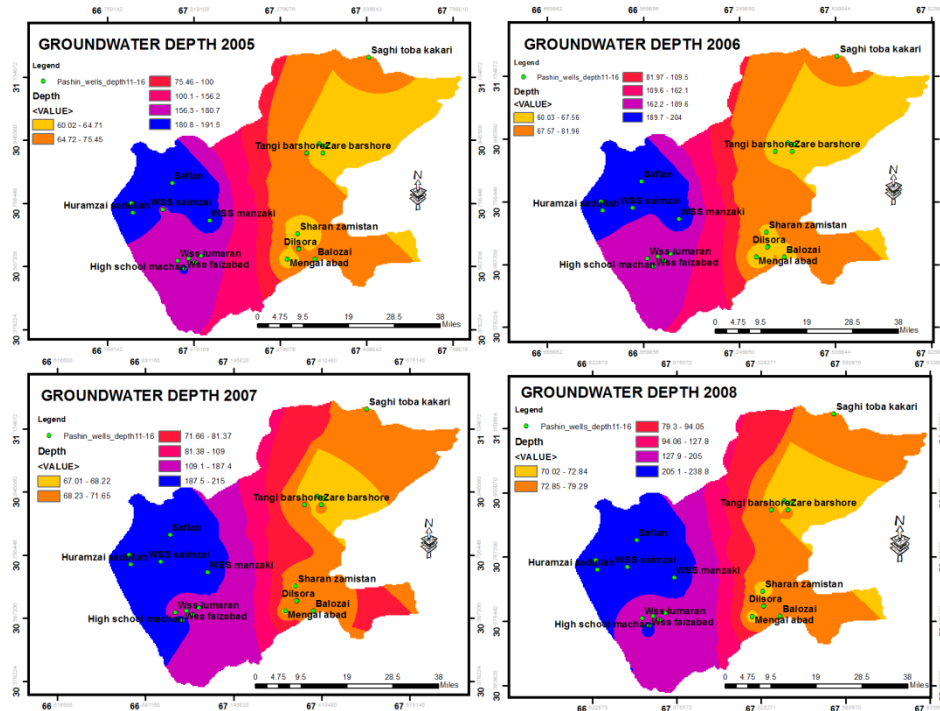


Figure 2. Groundwater Depths (2005, 2006, 2007, and 2008).

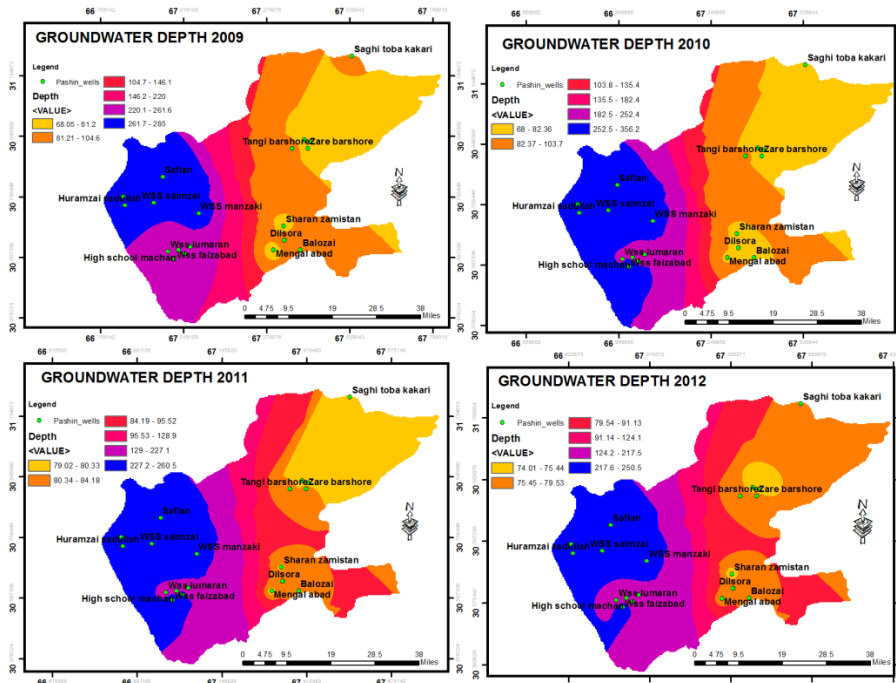


Figure 3. Groundwater Depths (2009, 2010, 2011, and 2012)

Fluctuations of water table 2005-2016 in Pishin district

Fluctuation Rate of Pishin City Tehsil: The graph shows fluctuation in water table, average decline is 136 ft. in New Surkhhab Tharata Well area per ten years. The minimum water

table level in this area was 166 ft. in 2005, which increased 303 ft. till 2016 the decline in the water table, is 137 ft. from 2005 to 2016. In Wss Lumaran, the water level in 2005 was 166 ft. which was decreased to the level of 293 ft. in 2016

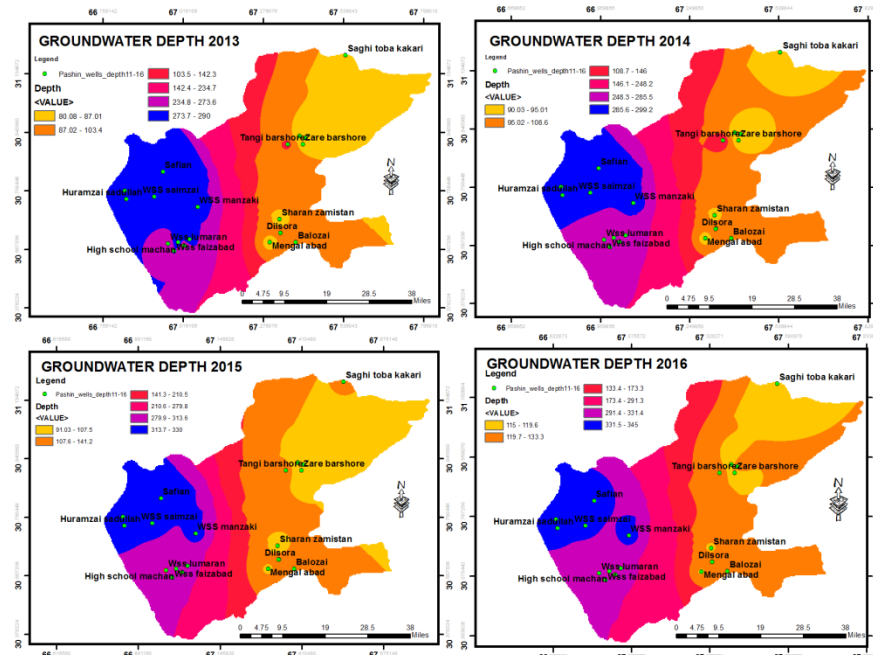


Figure 4. Groundwater Depths (2013, 2014, 2015, and 2016)

decline of water table in this area is about 126 ft. In Wss Faizabad Well, the minimum static water level in 2005 was 187 ft. The decline in water table level is 118 ft. in this area. Minimum water table level at Jungle Bagh was 37.61 m in 2004 continuous decrease in water table level leads it at 43.65 m depth (Fig. 5).

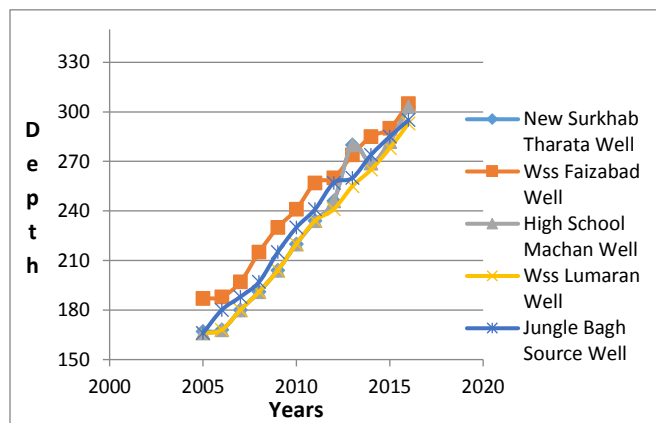


Figure 5. Fluctuation rate of Pishin City Tehsil

Fluctuation Rate of Huramzai Tehsil: Minimum water table level at jail road was 37.61 m in 2004 continuous decrease in water table level leads it at 43.65m depth. Minimum water level at Safian was 188 ft. in September 2005. Continuous decrease in water table level leads it at the depth of 335 ft. till 2016. At Huramzai Sadullah water level lowers from 191 ft. to 342 ft. about 145 to 151 ft. Decline has been noted in this area. At Huramzai the graph shows fluctuations in water table

with increasing trend. Average decline is almost 155 to 160 ft. in this area. In September 2005, the water level of Wss Saimzai was 180 ft by fluctuation it reached 345 in 2016. About 165 ft. drawdown is noticed in this area, and it is the most affected area in Pishin district. This area shows water table fluctuations in different areas which may be used by high infiltration or due to recharge and rapid discharge (Fig. 6).

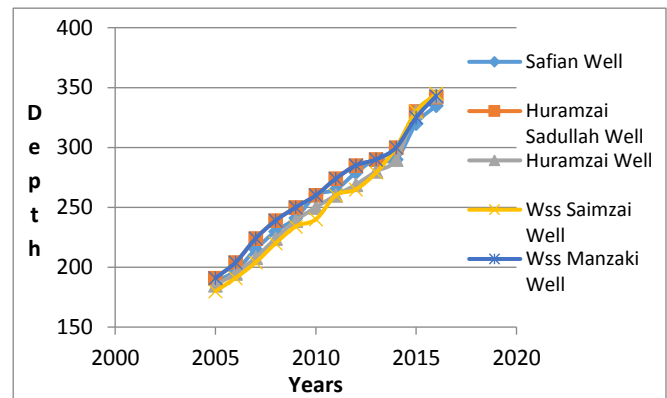


Figure 6. Fluctuation Rate of Huramzai Tehsil.

Fluctuation Rate of Khanozai Tehsil: In 2005, 2006 and 2007 water table level was almost at same depth at Mengel Abad Well but from 2009 to 2016 water table decrease was noticed. This area of Wss khanozai shows water table fluctuations in different years which may be caused by high discharge or due to less recharge.

In Dilsora area, the water table level from 2005 to 2007 was almost at the same level and the graph shows decline in water table from 2009 to 2016. It shows continuous fluctuations from 2009 till May 2016. The fluctuation of Balozai is almost same as the variation of water level of Dilsora. The water table of Sharan zamistan was low in 2005 but increased to 58 ft. in 2016 (figure 7).

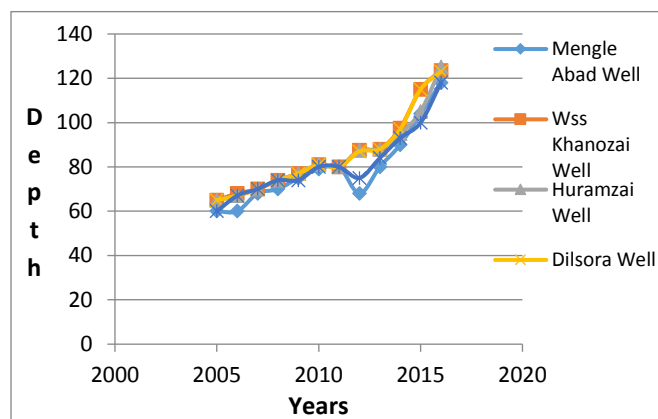


Figure 7. Fluctuation Rate of Khanozai Tehsil.

Fluctuation Rate of Barshore Tehsil: The water table fluctuations in this area are very low, because these areas are mountainous and snow fall also occur once a year. In 2005 the water level of Khatt Barshore was 64 ft. which increased to 124 ft. in 2016. Water table is decreased to 60 ft in last 12 years. At Zare Barshore 64 ft. was minimum level which increased to 115 ft. in these years' water table drawdown is 51 ft. The minimum level at Tangi Barshore in 2005 was 65 ft.; from 2004 to 2014 water level got decreased, whereas an increment was noticed by 126 ft. in 2016. The overall decline is 61 ft. in 11 years. In 2004 the water level of Saghi Toba Kakari was 66 ft. by fluctuating it reached 118 ft. in September 2016. about 52 ft. drawdown is noticed in this area (figure 8).

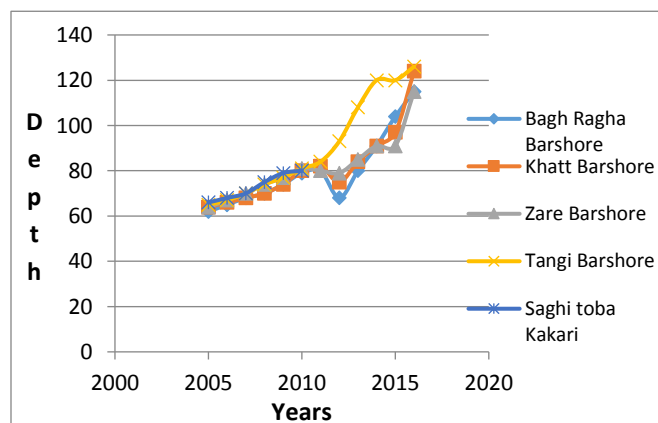


Figure 8. Fluctuation Rate of Barshore Tehsil.

Conclusions: The analysis of results indicated negative trends from 2007 to 2015 in groundwater levels of Pishin and Huramzai tehsil to decline by a magnitude ranging from 167 to 300 ft and 180 to 350 ft. respectively. In Khanozai and Barshore tehsil, the groundwater levels were found fluctuating in a relatively narrow range of 50 to 120 ft. and 60 to 120 ft. respectively. It could be established from the maps and graphs that the depth of water table was increased over the span of twelve years because of excessive abstraction for irrigation and decrease in rainfall. Changes in irrigation methods are needed in Pishin District for sustainable groundwater management.

Acknowledgement: The authors are highly grateful to WASA, WAPDA, Public Health and Engineering department (PH&E), private NGOs for providing the relevant data.

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