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Gradual variation analysis for groundwater flow of Lahore by groundwater modeling techniques

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Abstract

Water is an important constituent of life. It performs a vital role in the continuity of life due to its distinctive qualities. The current study was to determine the gradual analysis for groundwater flow of Lahore by groundwater modeling techniques. The model was calibrated and validated for six years ranging from 2010 to 2016. The groundwater abstraction in 2011 was 1.27 meter per year which is now increased at the rate of 2.5 meter per year. The increasing gap between recharge and discharge is posing serious threats to groundwater levels. This excessive groundwater abstraction is making aquifer of Lahore unsustainable.

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Introduction

In fact water is an important constituent of life. It performs a vital role in the continuity of life due to its distinctive qualities (Narayanan, 2006).Clean water required for human usage does not constantly happen in nature, due to the existence of solved or suspended impurities in most natural aquatic bodies (Goldface, 1999). Human and natural events disturb almost all segments of the water cycle, frequently with additive effects. Over time the human events such as jungle clearing, agriculture and afforestation etc have worrying effects on the water cycle containing evapotranspiration, flow commands, sea level and ground water table. Human events effect cloud creation via the release of aerosols and their vaporous precursors (Kruger and Grabi, 2002). Major threats to water resources for humans comprise aquatic contamination (the pollution of surface water and groundwater ponds with elements and microbes), water shortage (the alteration of run-off rules and the alteration frequently dropping of the groundwater table) and maximum significantly. The worldwide climate alteration with significances such as rearrangement of precipitation, increasing sea levels (Stolberg *et al.*, 2003). In opinion of the uncertainties related with environment and hydrologic representations, the profits of developing measured guesses persist controversial. Water resources administration arrangements are very adaptive by nature (or through official involvement) and the typical differences in climatic and socio-economic circumstances have provided water directors with involvements that support them manage with probable variations in environment designs (Strzepek, 1998).

The chemical components of under groundwater and the aquatic types present in an environment are identified seriously by local geology, different types of minerals present in the environment through which the renew and under groundwater flows (Akpan *et al.*, 2010). The purpose of current study was to examine the gradual variation analysis for groundwater flow of Lahore by groundwater modeling techniques.

Material and methods

Study area

Lahore lies between 31^0 15’-31^0 45’ North and 74^0 01’-74^0 39’ East. It is bounded on the north and west by the Sheikh Pura district, on the east by Wagah, and on the south by Kasur district. The city covers a total land area of 1772 square kilometers and is still growing. Lahore population exceeding 10 million, it is a megacity and ranked as the country’s second largest city (after Karachi).During summer (June to August), the temperature is generally more than 40 °C, while the maximum temperature during winter (December to February) is generally between 15 and 25 °C (Fig. 1).

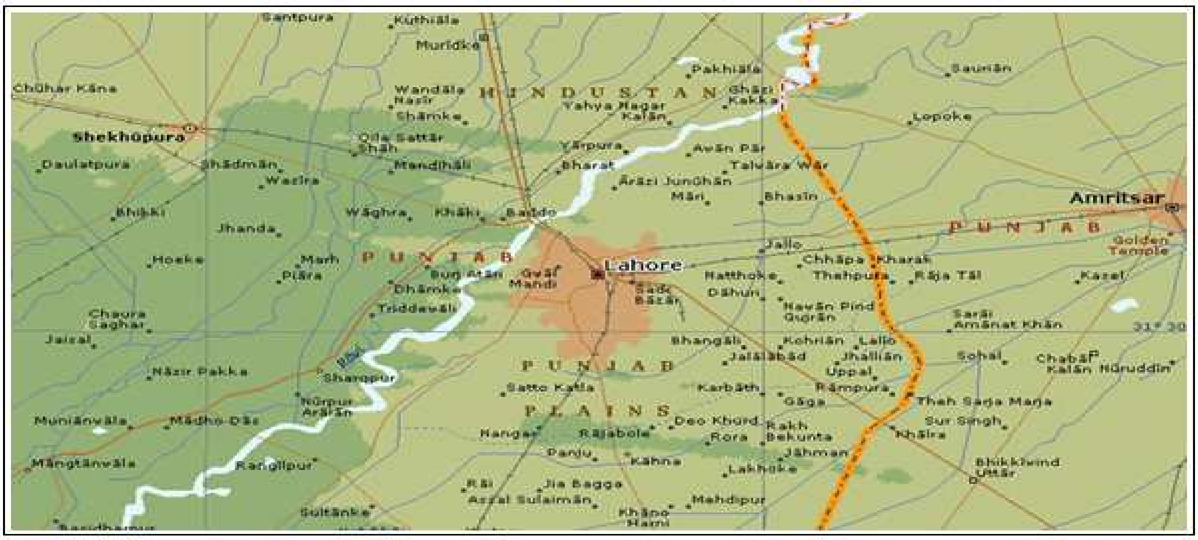

Fig. 1. Geography and short view of Lahore.

Data collection

Groundwater abstraction data of Lahore city was collected from the Water and Sewer Authority (WASA) office. After this Geographic Information Systems (GIS) database was developed for the model area for presenting the model area in an effective way. Mod flow model was setup for the Lahore area and calibrated for the year 2010-2016. Sensitivity analysis was carried out to estimate the effect of various parameters on the output of the model.

Use of Software

Land use map of the basin has been prepared with the help of Arc-GIS 10.2 software. The vegetal cover has been classified into various categories like cultivated land, rangeland, meadow, wooded forest, grass lands, open to closed vegetation etc. Digital elevation model (DEM) has included slope and digital terrain model, which is helpful in delineation of drainage patterns. The shape file format is a popular geospatial vector data format for geographic information system (GIS) software. It is developed and regulated by Esri as a (mostly) open specification for data interoperability among Esri and other GIS software products.

Processing mudflow for Windows

Mod flow has been developed by the United States Geological Survey Department (USGS). The model program uses a modular programming structure where in similar programming function are grouped together and specific computational and hydrologic options are constructed in such a manner that each option is independent of other options. Because of this structure new options can be added without the necessity of changing the existing subroutines. Input procedures have been generalized so that each type of model input data might be stored and read from separate external files.

Results

In the present study, the total period number and total steps were recorded one, while total simulation time was 1.E+0 recorded in seconds. The simulation flow type was in steady state, while multiplier flow and length was documented one respectively with no transport step size. In the present study, the total period number and total steps were recorded one, while total simulation time was 1.66667E–2 recorded in minutes. The simulation flow type was in steady state, while multiplier flow and length was documented one and 1.666667E–02 respectively with no transport step size (Table 1&2).

Table 1. Showing time interval in seconds.

Period	Active	Length	Time Steps	Multiplier (Flow)	Transport Step size
1	☒	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0
	☐	1	1	1	0

Total Period Number = 1

Total Time Steps = 1

Total Simulation Time = 1.E +0 seconds.

Simulation time unit in seconds

Simulation flow type in steady state

In the present study the total period number and total steps were recorded one, while total simulation time was 2.777778E–4 recorded in hours. The simulation flow type was in steady state, while multiplier flow and length was documented one and 2. 777778E–04 respectively, with no transport step size (Table 3).

In the present study, the total period number and total steps were recorded one, while total simulation time was 1.15741E–5 recorded in days. The simulation flow type was in steady state, while multiplier flow and length was documented one and 1.157407E–05 respectively with no transport step size (Table 4).

Table 2. Showing time interval in minutes.

Period	Active	Length	Time Steps	Multiplier (Flow)	Transport Step size
1	☒	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0
	☐	1.666667E-02	1	1	0

Total Period Number = 1 Simulation time unit in miniutes

Total Time Steps = 1 Simulation flow type in steady state

Total Simulation Time = 1.66667E -2 seconds.

Table 3. Time interval in hours.

Period	Active	Length	Time Steps	Multiplier (Flow)	Transport Step size
1	☒	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0
	☐	2.777778E-04	1	1	0

Total Period Number = 1 Simulation time unit in hours

Total Time Steps = 1 Simulation flow type in steady state

Total Simulation Time = 2.77778E-4 hours

In the present study the total period number and total steps were recorded one, while total simulation time was 3.16881E–8 recorded in years. The simulation flow type was in steady state, while multiplier flow and length was documented one and 3.168809E–08 respectively with no transport step size (Table 5).

Table 4. Time interval in days.

Period	Active	Length	Time Steps	Multiplier (Flow)	Transport Step size
1	☒	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0
	☐	1.157407E-05	1	1	0

Total Period Number = 1 Simulation time unit in days

Total Time Steps = 1 Simulation flow type in steady state

Total Simulation Time = 1.15741E-5 days.

Discussion

In the present study the total period number and total steps were recorded one, while total simulation time was 1.66667E–2 recorded in minutes. The total simulation time was 2.777778E–4 recorded in hours. In next total simulation time was 1.15741E–5 recorded in days. The simulation time was 3.16881E–8 recorded in years.

Table 5. Time interval in years.

Period	Active	Length	Time Steps	Multiplier (Flow)	Transport Step size
1	☒	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0
	☐	3.168809E-08	1	1	0

Total Period Number = 1

Simulation time unit in years

Total Time Steps = 1

Simulation flow type in steady state

Total Simulation Time = 3.16881E-8 years.

Climate alteration is easier to perceive on worldwide to local scales. Monitoring systems for perceiving alteration are especially appreciated when they are local or include local systems that are combined to allow local assessment.

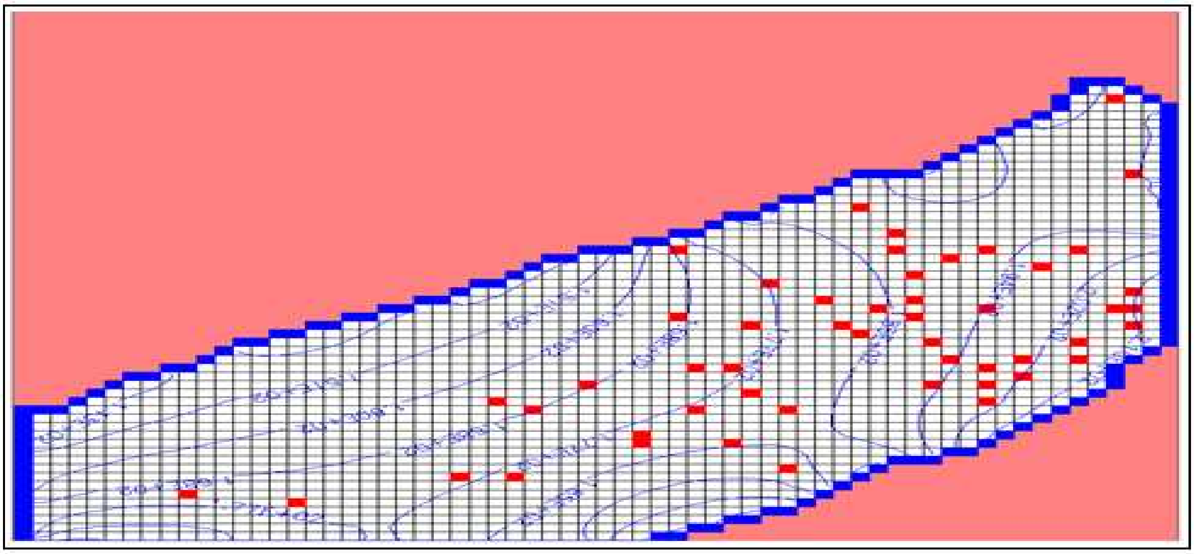

Fig. 2. Showing contours using water table elevation data of study area in minutes.

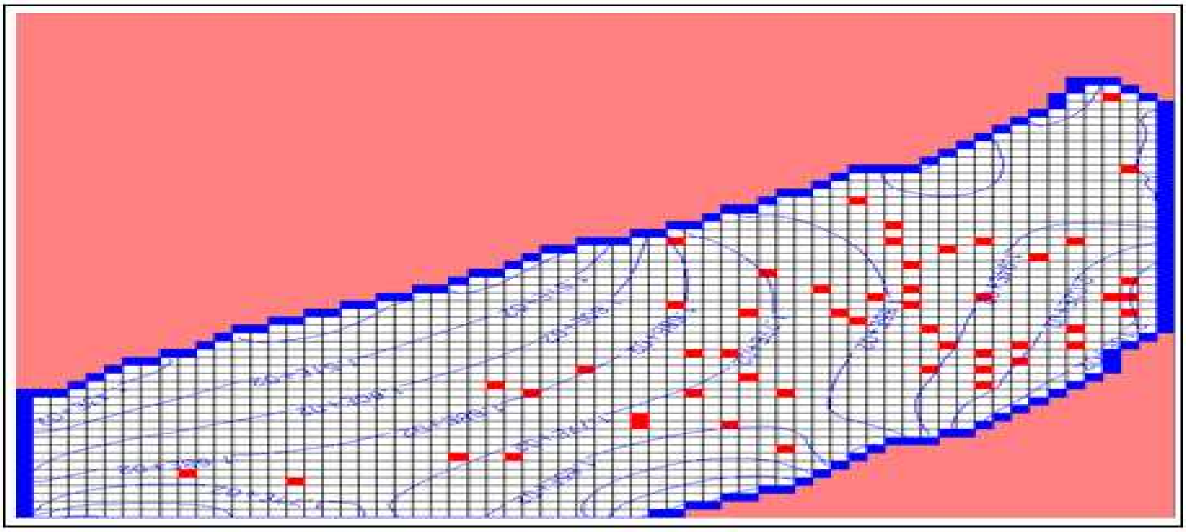

Fig. 3. Showing contours using water table elevation data of study area in hours.

Also required for planning and operative assessment is a comprehensive set of limitations that describe current and future climate situations by the Cohn and Lins, 2005. A study was conducted by Arias *et al.,* 2014 and reported that the investigation of climate alteration impact on water incomes has been focused on expecting the potential properties that variations in rainfall, temperature and CO_2 absorption will reason on stream flow. For this purpose, two simulation sets were performed. The first evaluates the effect reason in stream flow by variations in each of the variables like rainfall, temperature and CO_2 concentration. Aquatic demand and supplies is growing day by day than the aquatic supply. Another cause behind aquatic sacristy is periodic difference in rainfall.

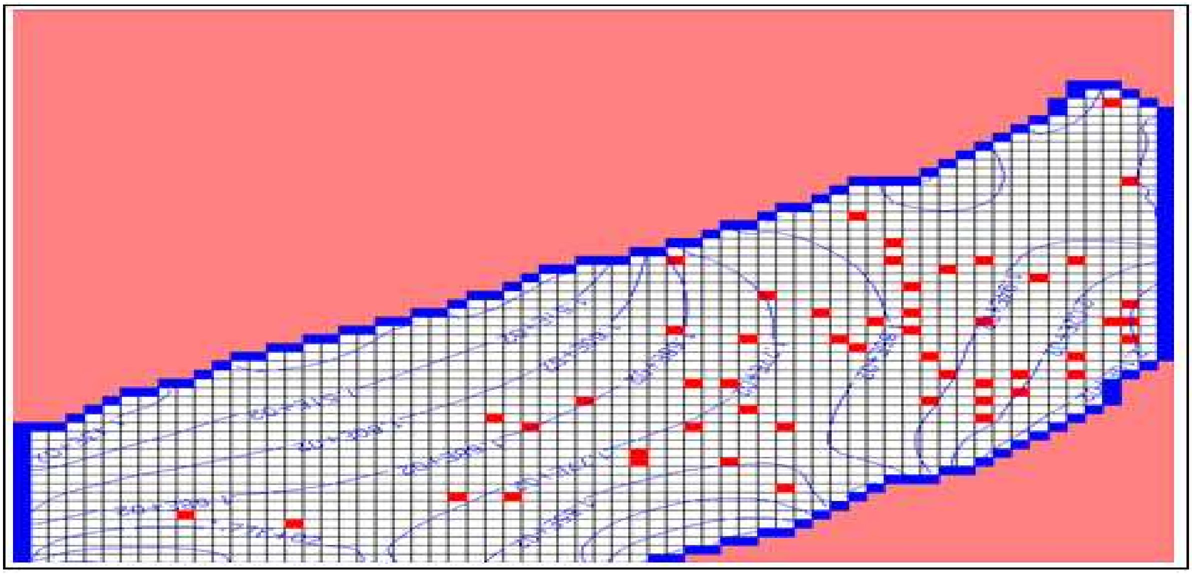

Fig. 4. Showing Contours using water table elevation data of study area in days.

Therefor the present aquatic connected issues can be explained by correct supervisions of water incomes. The country is facing like floods and drought circumstances due to stay in the building of water reservoir and immoral results. The country has old water administration plans which have been unsuccessful to resolve aquatic scarcity issues. Therefore, there is need to build large reservoir on emergency basis to achieve this periodic changeability in rainfall.

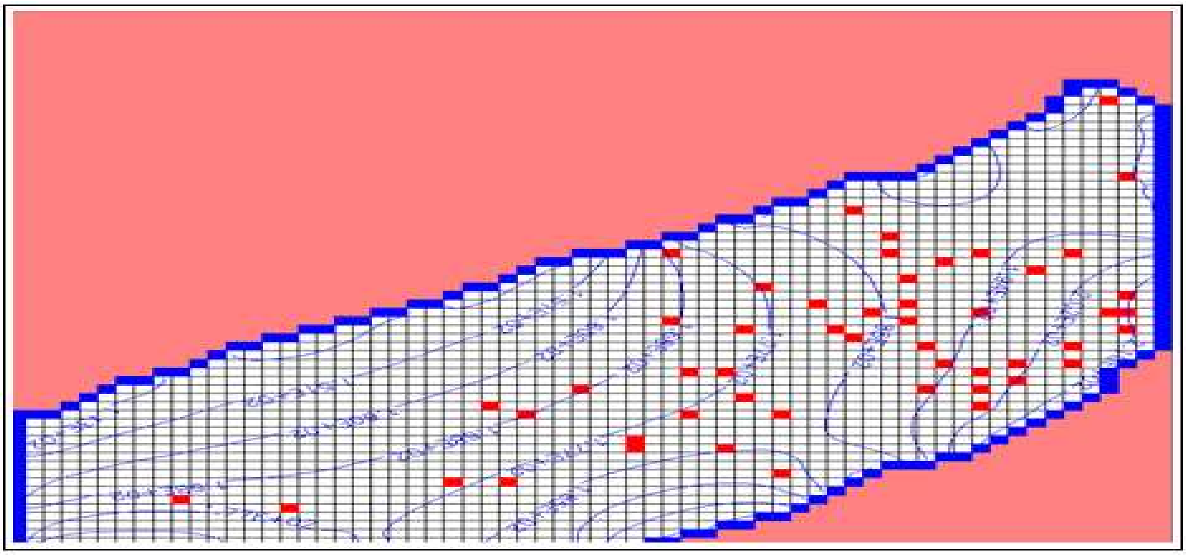

Fig. 5. Showing contours using water table elevation data of study area in year.

It not only caters the peak power supply demands but also fulfills the highest water demands of field crops and gathers the reserves to meet the requirements during low flow periods. But the country has to face drought like conditions in remaining months. Climate change has imposed rather negative impacts on the rainfall systems of the country, mainly by demolishing the seasonal rainfalls.

Conclusion

Groundwater numerical model mudflow is successfully setup, calibrated, validated and run for Lahore area. The model was calibrated and validated for six years ranging from 2010 to 2016. The groundwater abstraction in 2011 was 1.27 meter per year which is now increased at the rate of 2.5 meter per year. The increasing gap between recharge and discharge is posing serious threats to groundwater levels. This excessive groundwater abstraction is making aquifer of Lahore unsustainable.

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