HYDRAULICS, WATER RESOURCES, COASTAL AND ENVIRONMENTAL ENGINEERING

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Preface

In the process of development, quality and quantity of the resources are generally depleted day by day unless they are replenished by natural or artificial process. Water resource which is an important resource to sustain the life on earth is under tremendous pressure all over the world due to climate change, population growth and socioeconomic development. Hence effective management of water resources with use of latest available technologies and scientific research have become very crucial for water resources planners and engineers. Aiming with this HYDRO 2104 INTERNATIONAL CONFERENCE on Hydraulics, Water Resources, Coastal and Environmental Engineering jointly organized by MANIT Bhopal and ISH in association with NIH Roorkee, IIT Bombay, VNIT Nagpur, SVNIT Surat, People's University Bhopal during December 18-20,2014. HYDRO conference is organized every year by ISH in association with Institutions/organizations.

We have received overwhelming response from researchers, academicians, scholars, water resource managers across the globe and received two hundred ninety papers for the conference. One hundred twenty papers have selected for the publication of the book. This book contains one hundred twenty chapters covering in twenty five themes which includes Advance in Fluid Mechanics, Application of Geospatial Techniques, Costal, Harbour and Ocean Engineering, Computational Fluid Dynamics, Decision Support System, Drought Assessment and Mitigation, Effect of Climate Change on Water Resources, Environmental Hydraulics, Environmental Impact Assessment, Flood Forecasting and Protection Measures, Fluvial Hydraulics, Ground Water Modelling and Management, Hydel Energy, Hydrological Modelling and forecasting, Hydraulics of Spillway and Energy Dissipaters, Hydraulic Structures, Integrated Watershed Management, Rehabilitation of Dam, Reservoir Operation and Irrigation Management, Reservoir Sedimentation, Risk Reliability

Analysis and Design, Soft Computing Techniques, Water and Wastewater Management, Water Quality Assessment and Modelling, Water Resource and Hydrology.

We wish to take this opportunity to express my sincere appreciation to all contributors, who have helped on bringing out this for dissemination of knowledge to the society, organisations, planners, researchers and managers. We are thankful to the Dr. Appukuttan K. K., Director, MANIT Bhopal for his constant encouragement and guidance to bring out this book. We place our sincere gratitude to efforts of ISH office bearers who have helped to complete the book. We are grateful to Dr. A. K. Sharma, Prof. and Head, Civil Engineering Deptt., MANIT for constant support and help to publish this book. We are grateful to all the authors who contributed for this book. We are also thankful to all those who have helped directly or indirectly in this regard.

With warm regards
Dr. H. L. Tiwari
Dr. S. Suresh
Er. R. K. Jaiswal

Contents

Chapter - 23

Assessment of Groundwater Level In Southwest Punjab, India

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Abstract : The current evaluation and analysis of groundwater level monitoring has been carried out in 6 observation wells in 6 blocks namely Bhatinda, Maur, Nathana, Phul, Sangat and Talwandi of Bhatinda district in southwest Punjab. Across these blocks, detailed water level data sets has been generated sequentially on monthly basis over the last 8 years between January 2006 to December 2013 for assessing the patterns of groundwater level trends.

The observed datasets point towards the declining and fluctuating groundwater levels in the Bhatinda district. Analysis of water table depth has shown that the groundwater depth shows variation from 7.63 to 10.58 m (bgl) in Bhatinda, 10.95 to 12.09 m (bgl) in Maur, 11.83 to 16.51 m (bgl) in Nathana, 11.71 to 18.64 m (bgl) in Phul, 6.77 to 7.86 m (bgl) in Sangat and 7.20 to 8.32 m (bgl) in Talwandi. Graphical statistics interpret a steep increase in water level depth of 6.92 m as observed in Phul block, followed by 4.69 m in Nathana and the least increase in water level depth was observed in Sangat block. Existence of fresh water zones upto deeper levels, as have been established in the current work in the Phul and Nathana blocks, reflect on the declining water table levels and the consequential difficulty of its extraction.

Keywords: groundwater, fluctuation, trend, Bhatinda, Southwest Punjab

1. INTRODUCTION

The ever-increasing demands of agriculture, industry and domestic sectors have put a severe pressure on the available resources and have adversely impacted in the form of long-term decline of groundwater levels (Rodell *et al*. 2009). The intense agricultural and industrial activities in the semi-arid southwestern part of Punjab state has resulted in numerous changes in cropping pattern. Hence, the consequential steep increase in demand for irrigation water has arisen, with immense stress on the quality of groundwater as well. Rising of water table, high salinity and water-logging are visible effects, reflected in geological and sedimentological conditions in the hydrological basin (Vashisht, 2008). Combined together, in Punjab, Haryana, Delhi and Rajasthan, falling in arid-semiarid region with around 50cm of annual rainfall, groundwater is being depleted at a rate of 4.0 (Huffman et al., 2007; Rodell *et al*. 2009). The latter information is based on the satellite data, related to Grace satellite programme (The Gravity Recovery and Climate Experiment) instituted by NASA. Different trends in water table decline from Central Punjab have been suggested by Vashisht (2008) upto more than 10m in a year. Further, Punjab has highest average stage of groundwater development of 98% and is overexploited (Jha and Sinha, 2009).

The Punjab plains in the past 3-4 decades witnessed a boom in groundwater use and numerous important works exist on the problem of depleting water quality and fall in water tables (Dhawan 1995; Sondhi *et al*. 2001; Ambast *et al*. 2006; Krishan *et al*. 2013a, b; Krishan *et al.* 2014a, b, c; Sharma *et al.*, 2014). Many districts of Punjab show 100% or even greater levels of exploitation and the same is exhibited by a secular decline in pre-monsoon water tables except for extremely wet years. Irrigation has been a major cause for high water level depletion (Rodell *et al*. 2009).

To assess the groundwater level fluctuations and trend monitoring has been carried out in 6 observation wells in 6 blocks namely Bhatinda, Maur, Nathana, Phul, Sangat and Talwandi of Bhatinda district in southwest Punjab. Across these blocks, detailed water level data sets has been generated sequentially on monthly basis over the last 8 years between January 2006 to December 2013 for assessing the patterns of groundwater level trends.

1.1 Study area

The study is carried out mainly in the Bhatinda district of Punjab. The district covers an area of 3369 sq. km and comprises of 7 blocks (Bhatinda, Nathana, Rampura,Phool, Talwandisabo, Sangat, Maur). The study area is situated between 29°33' and 30°36' North latitude and 74°38' and 75°46' East longitudes in the southern part of Punjab (Fig. 1). It is nearest to the Thar Desert of Rajasthan and far away from the major rivers that run through the state. The monsoon is scanty and meager. The average rainfall is 410 mm. The district is situatedwithin the Satluj-Ganga plain.

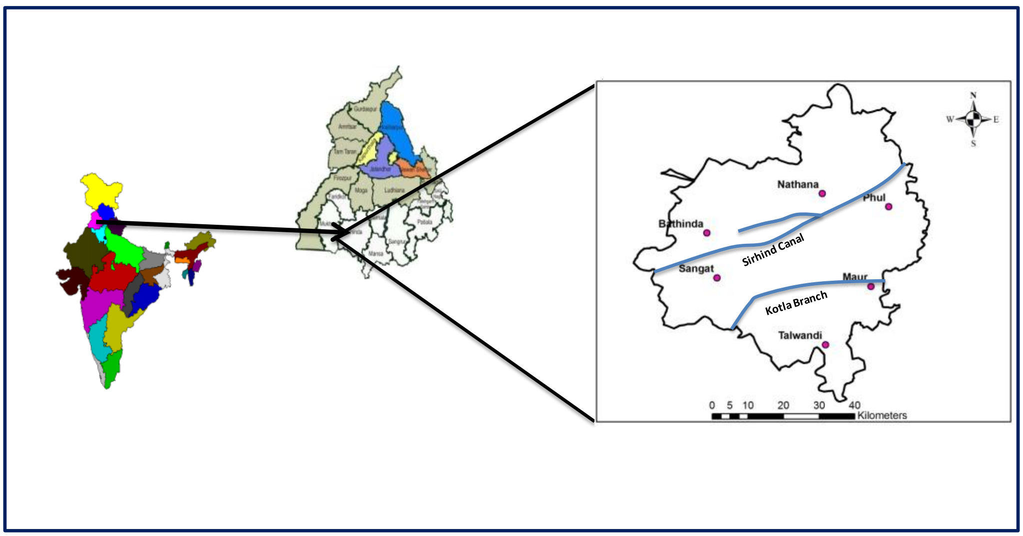

Figure 1. Study area.

2. MATERIAL AND METHODS

The monthly water level data at a depth of ~60 m aquifer was measured from 6 blocks namely Bhatinda, Maur, Nathana, Phul, Sangat and Talwandi of Bhatinda district in southwest Punjab. Across these blocks, detailed water level data sets has been generated sequentially on monthly basis over the last 8 years between January 2006 to December 2013 for assessing the patterns of groundwater level trends. The data processing was done to remove the erroneous data before statistical analysis. The erroneous values were rectified. The box plot method is used to statistically analyze the data. The box part of a box and whisker plot represents the central 50% of the data or the Inter-quartile Range (IQR). The lower edge of the box plot is the first quartile or 25th percentile. The upper edge of the box plot is the third quartile or 75th percentile.

3. RESULTS AND ANALYSIS

As evident from the figures 2 and 3 that the water table depth shows variation from 7.63 to 10.58 m (bgl) in Bhatinda, 10.95 to 12.09 m (bgl) in Maur, 11.83 to 16.51 m (bgl) in Nathana, 11.71 to 18.64 m (bgl) in Phul, 6.77 to 7.86 m (bgl) in Sangat and 7.20 to 8.32 m (bgl) in Talwandi. Graphical statistics interpret a steep increase in water level depth of 6.92 m as observed in Phul block, followed by 4.69 m in Nathana and the least increase in water level depth was observed in Sangat block. Existence of fresh water zones upto deeper levels, as have been established in the current work in the Phul and Nathana blocks, reflect on the declining water table levels and the consequential difficulty of its extraction.

It was observed from figure 3a that the groundwater level depth was maximum in the month of March in Bhatinda, Maur, Sangat and Nathana blocks and minimum in the month of August in these blocks. It was due to the extraction of groundwater is more in these blocks during the period February-March. It has been found that 78% of the total rainfall occur in the monsoon period (June to September) and during this period the water level depth is also found to decrease in Sangat, Maur, Talwandi and Bhatinda blocks, while the water level is found to increase in Nathana block during September to December and no effect of rain is observed in Phul block.

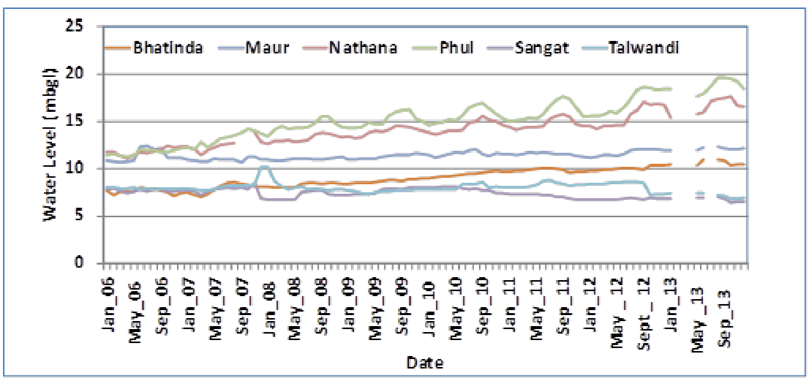

Figure 2. Variations in Water Level during 2006-2013 in 6 blocks of Bhatinda

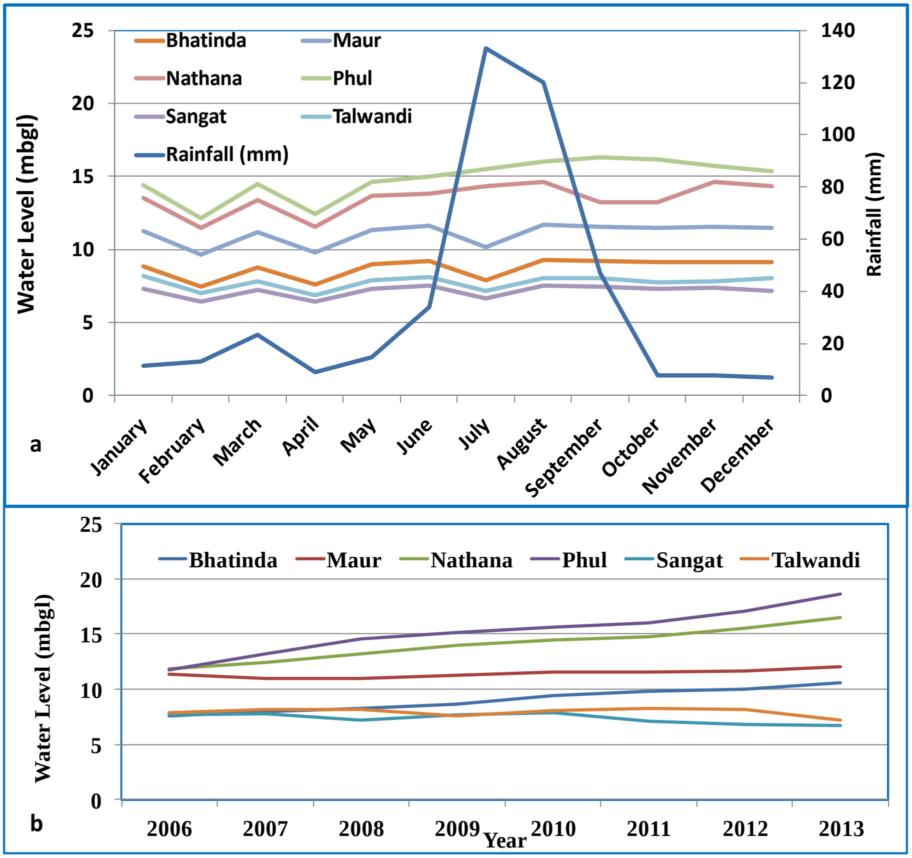

Figure 3. Monthly (a) & Yearly (b) variations in Water Level (2006-2013) in 6 blocks of Bhatinda

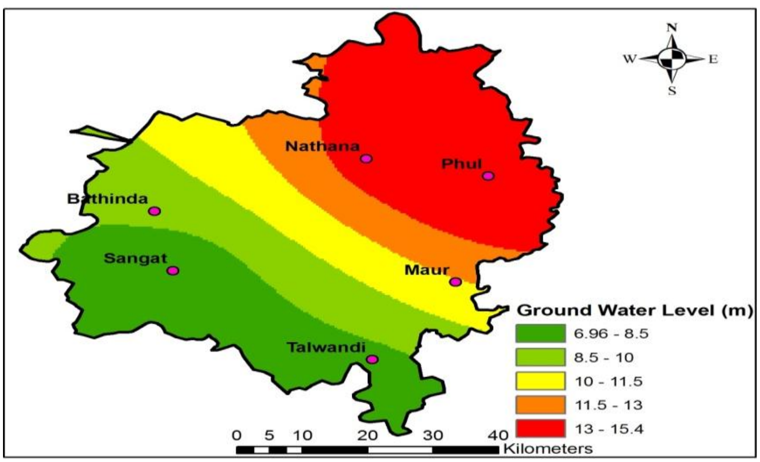

Figure 4. Spatial variations in Water Level (2006-2013) in 6 blocks of Bhatinda

The spatial variation plot shows (figure 4) that the water level is shallow in western parts comprising of Talwandi, Sangat and Bhatinda blocks, where the water level depth is found in the range of 6.96 to 10 mbgl. Intermediate range of 10-11.5 mbgl is found in middle of the district comprising of Maur block. The deep groundwater area is the eastern part of the district comprising of the Nathana and Phul blocks where the water level depth is observed in the range of 11.5 – 15.4 mbgl. This variation is found due to the difference in gradient from east to west.

The water level trend (fig. 5) shows continuous decline in the water table in the order as: Phul>Nathana>Maur>Bhatinda>Talwandi>Sangat

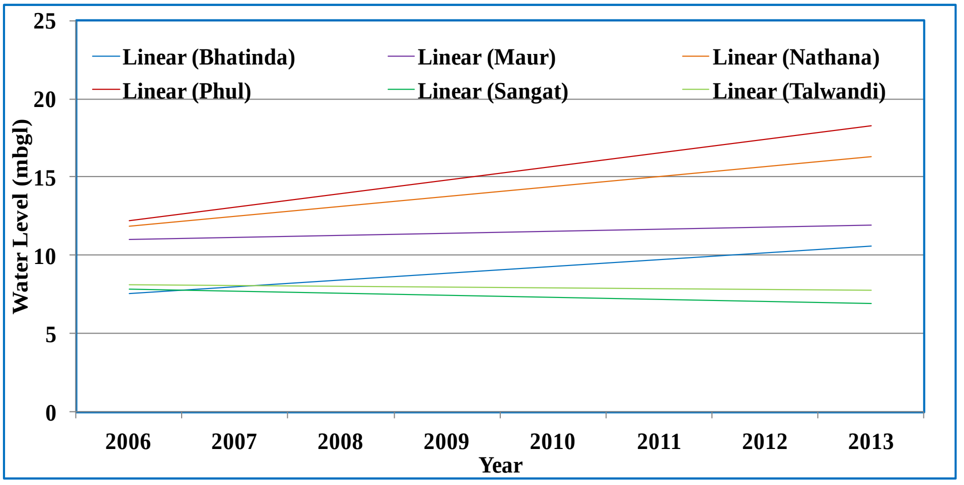

Figure 5. Water Level Trend during 2006-2013 in 6 blocks of Bhatinda

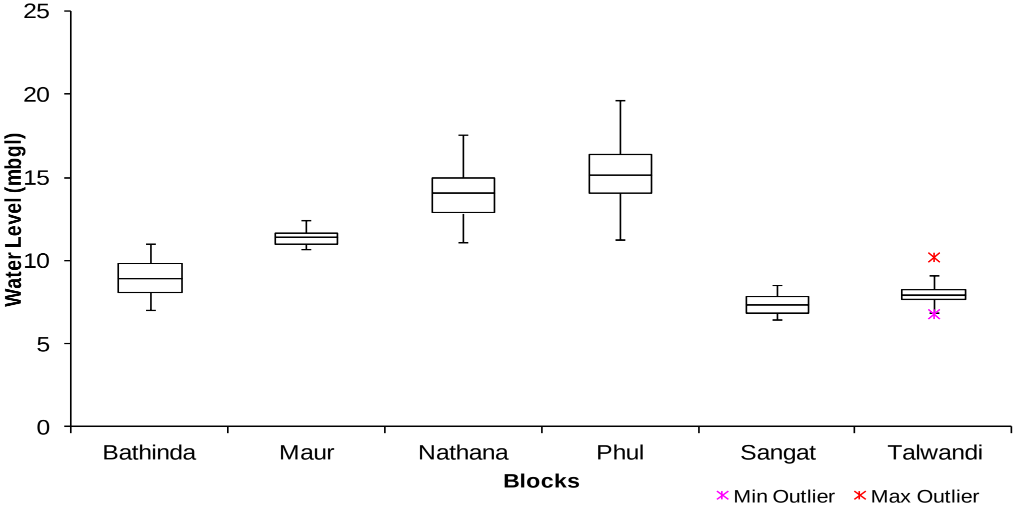

Figure 6. Box plot of water Level (2006-2013) in 6 blocks of Bhatinda

Table 1. Box plot statistics in 6 blocks of Bhatinda

Labels	Bathinda	Maur	Nathana	Phul	Sangat	Talwandi
Min	7.03	10.70	11.10	11.30	6.43	6.80
Q_1	8.11	11.04	12.89	14.07	6.88	7.71
Median	8.91	11.40	14.06	15.14	7.36	7.90
Q_3	9.85	11.71	15.03	16.43	7.84	8.27
Max	10.98	12.45	17.60	19.62	8.50	10.22
IQR	1.74	0.67	2.14	2.36	0.97	0.56
Upper Outliers	0.00	0.00	0.00	0.00	0.00	2.00
Lower Outliers	0.00	0.00	0.00	0.00	0.00	2.00

As evident from the table 1 and figure 6 that distribution of the data is almost symmetrical. The maximum inter quartile (2.36) is observed in Phul block and the least (0.56) is found in Talwandi block. There are 2 outliers each in upper and lower are found in Talwandi block.

4. CONCLUSIONS

Graphical statistics interpret a steep increase in water level depth of 6.92 m as observed in Phul block, followed by 4.69 m in Nathana and the least increase in water level depth was observed in Sangat block. Existence of fresh water zones upto deeper levels, as have been established in the current work in the Phul and Nathana blocks, reflect on the declining water table levels.
Further, the declining water level trends need to be checked through groundwater recharge and groundwater conservation measures at an early stage. An alarming situation in the near future would seriously damage the agricultural production, which would underpin the regional economy and planning strategies.

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