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A Study of groundwater depletion and its impact on agriculture in Eastern Haryana

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Abstract
Ground Water is the major source of freshwater available for various human activities worldwide. In the semiarid region of the Indian state of Haryana groundwater is primarily used as source of water supply for drinking and irrigating the agricultural land. Due to the rapid growth of population and the intensive agricultural activity and agriculture based industry dependency on ground water have increased the by manifold. In this research an attempt was made to study the groundwater depletion and its impact an agriculture in eastern Haryana. The principal objectives were to quantitatively analysis the spatial temporal aspect of groundwater depletion in the light of previously development methods and techiniques. The specific question which this study has addressed are: (a) what is magnitude and rate of groundwater depletion? (b) what are the impact of groundwater depletion on agriculture (c) what are the ecological, industrial and technological aspect of managements strategies which may be helpful to overcome this depletion?.

Keywords: Groundwater, Monsoon, Agriculture

Introduction

Water is the most important input for survival of not only plant, human beings, animals and other living beings, on the earth but also economic development and environmental sustainability. At the same time, it is a dynamic component at the soil and plant system. This is the most scarce and precious natural resource. In arid areas water is known as Liquid Gold. Indeed few other resources affect so many areas of the economy or of human and environmental health as water. Water is in short a blessing for humanity.

Water is most essential for the survival of human life on earth. It is the most indispensable resource after air for the existence of life on planet earth. The earth's population has quadrupled in the last 100 years and water use has grown by a factor of seven. Unfortunately, water is increasing becoming scarce in many parts of the world. Groundwater depletion appears to be the most severe crisis receiving scantiest attention both at the level of planning and management. Studies conducted in the Kolar district of Karnataka, Anantpur district of Andhra Pradesh, Amravati district of Maharastra, Mehsana district of Gujarat, Kurukshetra, Karnal, Kaithal, Panipat, some parts of Sonipat, Gurgaon, Rewari, and Mahendergarh district at Haryana indicate falling of groundwater table (25-30 metres in the last forty five years). Such negative trends have to be arrested. These conditions accentuate groundwater recoup studies which are necessary in affected areas to avoid harmful social, economic, and ecological consequences.

Groundwater plays an important role for irrigation, domestic consumption and industrial water supply. Over exploitation of groundwater in certain areas has become a matter of deep concern among geographers and hydrologist. Overexploitation of groundwater does not signify total exhaustion but depletion of the stock of groundwater

Groundwater is currently contributing more than 85 per cent of the drinking water requirements of rural areas, about 58 per cent of irrigation needs and more than 50 per cent of the urban and industrial water supply in India. It shall continue to play a key role in meeting the water needs of irrigated agriculture in a big way in the next millennium as well. The large number of tubewells creating huge burden on the groundwater storage in the Indo-Gangetic plains. The Punjab –Haryana plain is one of the most agriculturally advanced regions which have witnessed groundwater depletion in many administrative blocks.

Haryana is mostly arid and semi- arid State with limiting rainfall ranging from 300 mm in the southwest to 1200 mm in the northwest. There is no perennial river which passes through the State except the Yamuna River and about two third of the area is underlain in the brackish water with rising water table and inadequate natural drainage. The State receives the water from the Sutlej and Yamuna Rivers and equal amount of surplus water from the Ravi and Beas rivers. According to the Groundwater Cell of Agriculture Department of Haryana, the total water resources available in the State is about 24.5 billion cubic metres out of this nearly 11.2 billion cubic comes from normalized monsoon recharge and 6.7 billion metres from annual groundwater recharge.

Groundwater irrigation plays an increasingly critical role in Haryana's share of irrigated cultivation in total cultivated areas. The rapid extension of groundwater use has been a major factor contributing to the increase in net irrigated area. Consequently, the depletion is taking place in eastern Haryana especially in fresh groundwater quality zone. It is taking place in many districts of the State, namely, Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat, some parts of Sonepat, Faridabad, Gurgaon, Mewat, Rewari, Mahendregarh, Kaithal and some parts of Bhiwani. Hence, this sinking water table behavior is playing negative role in the development of agriculture.

The alarming depletion of groundwater resources in the last few decades has made it a focal point of attention for academicians, scientists, administrators, agriculturists, planners, and policy makers all over the world. Therefore, there is an urgent need for scientific, rational management and utilization of surplus available water which is possible through interventions like design of suitable groundwater structures. The practice will commensurate the rate of draft and will bridge the gap between water availability and requirement (Sethi, Kumar, Sharma. Moreover, the phased construction of water harvesting will resulting in an increase in the shortage of surface water resources which in turn will augment the groundwater reserve and subsequent availability.

Overview of Literature

Nace (1970) [7] postulated that pumpage from the Ogallala formation of USA has reduced storage by nearly 110 Km3 and annual withdrawals in recent years have been about 62 Km3. This is about six of fifteen times of variously estimated natural recharge rate, so the reserve is being depleted and could be exhausted in the foreseeable future. Depletion of groundwater due to overdraft has caused various environmental problems in the different part of the world. Ridgley (1991) [8] examined the loss of agricultural land and fall in aquifer level in central Oahu, Hawaii. He explored these limit by employ the result of a water balance simulation with in a multi-objectives land use programming model. Bradley and Carpenter (1986) [9] studied the fall of groundwater table in Texas, Arizona and California and explained that falling groundwater table was the cause of land subsidence in these States. Land subsidence due to groundwater withdrawal is a relatively recent problem. However, the effort to control subsidence and resulting damage is in its infancy stage. Das Gupta (1990) [10] recognized adverse environmental effects of groundwater overdraft in the Bankok metropolitan city. He indicated that the major cause of land subsidence in the Bankok metropolitan area is due to excessive groundwater pumping leading to depletion of groundwater reservoirs. The subsidence has caused some parts of the drainage systems to be below normal water level and has rendered them ineffective. These factors together with high intensity rainfall result in the frequent flooding of the Bankok metropolitan area. Land subsidence is quite common in various parts of USA. Al-Saleh (1992) [11] indicated decline groundwater level in Saudi Arabia. Rapid expansion in irrigated agriculture requires large quantity of groundwater. As a result, the actual volumes of water pumped from the Minjur Aquifer in this area for irrigation have been in excess of recharge rates. Therefore, groundwater level in this area started to decline. Ferguson (1996) [12] reported that the development of a model of monthly direct runoff consistent with the monthly book keeping format. The model was evaluated by comparison with direct runoff estimated by daily calculation using the Soil Conservation Service (SCS) method. The comparison employed six stations representing different climatic regions of the contiguous United States and eight values of SCS curve number. The results are statistically significant and produce little error. Craige (1998) studied environmental litigation in the USA. This study isolated key concepts which reveal knowledge about groundwater contamination, traces them forward, and links them to knowledge held by industrial based managers in the past. Loaiciga (2003) summarized the theory of the climatic change and the relationship of climate change forcing to hydrologic and aquifer process. He introduced a methodology to calculate the effect of climatic change and population growth on hydrologic response basi

Objectives

To establish the climatic water availability.
To evaluate the impact of depletion on agriculture.
To suggest certain management strategies.

Data Source: This study requires both primary and secondary data. Therefore descriptive and analytical research design is used in this research. The relevant and supportive data on various aspects of groundwater resources such as groundwater quality and data collected from groundwater cell at Agriculture Department of Haryana. The relevant data about cropping pattern are collected from the State Agriculture Department and district revenue offices. In this research primary data is collected from the personal survey of sampled villages. Systematic Random Sampling is used for the selection Random Sampling is used for the selection of villages. Questionnaire is circulated to extract, those information which are not available through the secondary data sources.

Findings: Groundwater depletion appears to be the most severe crisis receiving scantiest attention, both at the level of planning and management. Groundwater resource has not been protected and managed to the extent as surface water, even though the former supplies nearly half of the water requirements in drought prone areas and is extremely important for water storage, treatment and distribution. The question arises for the management of the excessive overdraft of groundwater so that this valuable gift of nature can be preserved and sustained for a long time. Thus the problem of depletion can be solved or minimized by the introduction of proper management that answers the question of when to use water, how much to use it and evaluates the purpose for which it is used. For effective management of groundwater depletion, it is imperative to know other associate problems of groundwater use in the affected areas so that scientific study is made to understand the magnitude, rate and causes of depletion. In many areas in India, groundwater mining is taking place, either by design or by mismanagement. As the consequences, water table has been declining rapidly resulting into many undesirable and often irreversible environmental consequences. Overdevelopment of groundwater resources is increasingly recognised as a major environmental crises in eastern Haryana. The above conditions accentuate the groundwater depletion studies which are necessary in affected areas to avoid harmful economic, social and ecological consequences.

The study has indicated that in the absence of sufficient amount of rainfall, farmers are extracting groundwater to meet water requirement for crops. Groundwater has, thus, been depleted to the extent that the aquifer no longer yields water to meet the demand. Consequently, water has been sinking at a very fast rate with depth ranging from more than 3 metre to less than 57 metre in June, 1974 and from more than 4 metre to less than 57 metre in June, 2016. Thus, it will be noted that during June, 1974 to June, 2016 depth to water table increased in many new blocks. The block wise average depth to water table below the ground surface in June, 2016 has been worked out and is compared with June, 1974 to arrive at the total change and also the average annual fluctuation in June, 1974- June, 2016. During this period except 2, all administrative blocks have experienced decline in water table ranging from 0.54 metre in the AmbalaI block of the Ambala district to 0.94 metre in the Siwanii block of the Bhiwani district. The groundwater conditions of the study area, 65 blocks have experienced average decline in water table ranging and remaining 2 blocks have experienced average rising in water table. The minimum declining in fluctuation is -0.08 in Nuh block of Mewat district and maximum declining in fluctuation is -48.04 in Ateli block of Mahendragarh district. The minimum rising in fluctuation is 0.54 in Ambala-I block of Ambala district and maximum fluctuation is 0.94 in Siwani in Bhiwani district.

It is clear from that recharge due to fluctuation during monsoon varies from less than 1000 ham to more than 20,000 ham in the entire study area. Ambala and Mahendergarh blocks have fluctuation recharge is more than 20,000 ham while Pehowa, Ladwa, Baibain, Gulha, Nissing, Nagina, Touru and Rai blocks have less than 10,000 ham fluctuation recharge. It shows that recharge due to non-monsoon rainfall is 78989.60 ham in the study area. It is very less comparative to monsoon rainfall recharge. In the study area, it is worked out that recharge due to seepage through canal is very low. Due to modernization of canals the total recharge through seepage in the study area is 6098.66 ham which is very low.

It has been worked out that in 2016, shallow tube wells extracted 88.59 per cent (667256.2 ham) of total groundwater draft followed by pumping set, i.e. 3.01 per cent (22681.45 ham) and augmentation tube wells i.e. 8.39 per cent (63209.0 ham). The region has made impressive development of groundwater resource through tubewells.

It is found that negative change in storage volume ranged from -38587 ham in the Ambala-I block of Ambala district to -191445.4ham in the Mahendergarh block of Mahendergarh district. More importantly, change in groundwater storage is the maximum in the Mahendergarh district, i.e. -191445.4 ham in Mahendergarh block followed by Ateli -124480.70 ham. The second and third ranking districts in negative change in groundwater storage is Bhiwani and Kurukshetra and change is maximum in Laharu and Pehowa blocks i.e. -190751 ham and 183090 ham respectively. Minimum change in storage is observed in Ambala. 2 blocks of the study area experienced rise in water table. The total change in groundwater storage in the entire area during 1974- 2016is -2654156.27 ham over an area of 2261262 hectares.

Total volume of groundwater withdrawal in the study area is 20634154.19 m3 / day which creates an average deficit of 307972.46 m3 /day/block. More importantly, this study has revealed that groundwater depletion is taking place at an alarming rate of 0.34 m3 / year creating a magnitude of 40938.37 m3 / day.

Under the ecological strategy, two broad aspects, namely, agriculture and irrigation practices were taken into account. Wheat and rice are two important crops in the region requiring large amount of water in the form of irrigation. Due to lack of surface water, farmers have been extracting groundwater in most unplanned and unsystematic manner. The study has further indicated that groundwater extraction has led to ecological degradation in the region. The following strategies were suggested to overcome this pattern (1) change in the present crop sequence, (2) awareness among farmers about crop water requirement through farmer's educational programme, and (3) conjunctive use of surface and groundwater. More importantly, the bulk of groundwater development has been seen primarily in the private sector with lakhs of scattered pampers exploiting the groundwater at will. It was also found that actual institutional management in the State had been done by limiting (NABARD) funds in the block classified as gray and dark. Loan and subsidies for tubewell installation were not being provided in the dark block. Along these institutional strategies, the following technological strategies were working in the study area: (1) efficient and water saving irrigation methods like sprinkler irrigation, drip irrigation and direct irrigation tubewells, and (2) the State government is trying to educate farmers through various programme.

Conclusion

Conclusions can be drawn from this study. First, groundwater is largely used by irrigation. It meets major part of drinking needs. Secondly, to meet these needs lakhs of tubewells have been dug for extracting the groundwater. Thirdly, the extraction rate of groundwater is more than recharge in all the blocks leading to permanent lowering of water table. Fourthly, the lowering of water table is causing various ecological and socio- economic variations throughout the study area. Fifthly, this study has contributed significantly to understand and explain the complex dimensions of groundwater depletion and to improve the policy making and management strategy.

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