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DYNAMICS AND ECONOMY OF GROUNDWATER RESOURCES IN HARYANA

Doctoral Dissertation Abstract (2017)

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Groundwater is the primary source of water on earth, with the largest being used for irrigation. The importance of the groundwater as a resource in India can be realized that at present about 50 per cent of the total irrigated area, 50 per cent urban and industrial water supplies and 85 per cent of drinking water requirements in rural areas are dependent on groundwater. In the agriculturally advanced state like Haryana, agriculture has undergone a drastic change from self-subsistence to market oriented production during the last five decades. The share of tube-well irrigated area to the net irrigated area has increased from 22 to 57 per cent during 1966-2013. Meanwhile, the number of tube-wells in the state has increased from 0.02 million in 1966 to 0.73 million in 2013, indicating a thirty times rise in their number. This impressive growth in groundwater irrigation has caused adverse impacts on groundwater resources of the state. The state has an annual, net available groundwater resource of 9.8 billion cubic meters against the annual withdrawal of about 13.06 billion cubic meters. Thus, the state with an annual deficit of 3.27 billion cubic meters is heading towards a major water crisis in future. The groundwater estimates show that out of 21 districts, 14 fall in 'over-exploited category' having groundwater extraction more than 100 per cent of annual replenishment, 6 are classified as 'critical' (stage of development 90-100 per cent) and 1 is in 'safe' category having groundwater draft less than 70 per cent of the annual recharge. The draft of groundwater in the state has increased by 251 per cent; whereas the development has increased from 92 per cent in 1992 to 133 per cent in 2011. In the light of these facts, the present study has been attempted to investigate the groundwater dynamics and its economy in Haryana.

Objectives

- To investigate the spatial and temporal groundwater development, variability and balance during 1990-2013.
- To examine the spatial and temporal trends in groundwater levels (pre and post-monsoon) for the period 1990-2013.
- To explore the structure, pattern and performance of groundwater markets.
- To understand the energy-groundwater irrigation linkages for

ensuring sustainability of both energy and groundwater resources.

Database and Methodology

The aims and objectives of the study have been accomplished both by primary and secondary sources of data. Secondary data were collected from the unpublished records of Groundwater Cell, Department of Agriculture, Government of Haryana, Panchkula, Department of Economic and Statistical Analysis, Haryana and India Meteorological Department, Chandigarh. Whereas, primary data were generated through a field survey. The spatial and temporal variations in depth of groundwater levels and balance have been exhibited with the help of maps. Tabular and graphical approach has been followed for analytical analysis. Frequency distribution analysis has been also used to quantify the relative significance of various factors.

Organization of Material

The present research work has been arranged into seven chapters. Introductory chapter of this research deals with the preamble, review of literature, objectives, data and methodology and practical utility of the study. The second chapter renders the detailed geographical identity of Haryana along with groundwater and other irrigation infrastructural development. The third chapter explains the spatial and temporal groundwater variability and its balance in the state. The fourth chapter imparts the description of pre and post-monsoon fluctuations, trends and various influencing factors of groundwater levels. The fifth chapter demonstrates an account of structure, pattern and performance of groundwater irrigation markets. The sixth chapter describes the various facets of energy-groundwater irrigation linkages. The last chapter focuses on conclusions along with the suggestions to manage the groundwater resources for sustainable agricultural development in Haryana.

Results and Discussions

The dependence on the groundwater in Haryana has increased drastically due to speedy growth of agriculture leading to over-exploitation of its aquifers. Therefore, groundwater level in the state has fallen at the rate of 28.7 cm/year during the period 1990-2013. Maximum decline in the depth of groundwater levels during the study period has been recorded in Kaithal district (84 cm), followed by Mahendergarh (82 cm), Karnal (68 cm), Fatehabad (64 cm), Gurgaon (53 cm) and Kurukshetra (38 cm) districts. Kurukshetra and Mahendergarh districts have been shifted from critical to over-exploited category, whereas Jhajjar and Rohtak districts in central part exhibited an increase in area under rising groundwater level depth during 1990-2013. Area under safe category (water table depth 3.1-10.0 m) has declined from 2539 thousand ha in 1990 to 1629 thousand ha in 2013 recording a growth rate of -55.8 per cent, while area under over-exploited category (more than 20.0 m) has increased from 356 thousand ha to 1285 thousand ha during the same period recording a growth rate of 260.9 per cent. Similarly, groundwater balance of the state as a whole has changed considerably and it has varied between -9832.7 to 12997.8 (00 ha-m). The share of development blocks with negative groundwater balance has increased from 28 per cent in 1990 to 71 per cent in 2013.

Guhla, Siwan, Kaithal, Pundri, Gurgaon, Sohna, Patudi, Badhra and Khol blocks have been observed as worst affected on account of groundwater balance during the study period.

The average depth to groundwater level ranged from 3.42 to 43.90 m, and 3.42 to 43.90 m, during pre and post-monsoon seasons, respectively. Thus, average of such fluctuations during pre and post-monsoon seasons have been found to the tune of -6.0 and -6.7 m. However, the average depth to groundwater level ranged from 2.48 to 43.68 m. Long-term variations of seasonal trends of groundwater level have been investigated by using the statistical approaches viz., Mann-Kendall test, Sen's slope estimator and Simple linear regression method. Significant declining trends have been observed in the groundwater levels during both pre and post-monsoon seasons in spite of monsoon rainfall regime. The study about the impact of climatic and anthropogenic variables on groundwater levels has demonstrated that increase in area under rice cultivation, number of tube-wells and tube-well irrigated area are the key factors affecting the groundwater level. Decline in groundwater levels has, in turn, has led to the drying up of dug wells and shallow tube-wells. Therefore, farmers have installed new deep submersible tube-wells, causing higher costs not only in installations but continuous maintenance activities also. Competitive deepening of tube-wells makes the access to groundwater increasingly skewed in favour of large and resource rich farmers leaving the resource out of reach for the poor farmers. Therefore, many small farmers with two-three acres of land are not able to invest for installation of deep tube-wells as it necessitates big investment and buy water from other farmers.

Groundwater irrigation markets have emerged as robust and dominant irrigation institutions and their prevalence supports about one-seventh of the total irrigated area in the state. However, their structure, pattern and performance differ considerably. The small farmers irrigate nearly 44 per cent of their cultivated land with water purchased from the groundwater irrigation markets. However, sellers of groundwater are medium and large farmers and have the financial capacity to install their own tube-wells. The groundwater buyers decrease as the size of farm increases and vice-versa. About 57 per cent of the total farmers and 15 per cent of the total area in Haryana have been benefited through groundwater irrigation markets. In addition, each seller, on an average supports 1.6 buyers, 6.1 ha of land and 34 per cent of buyer's land. Remarkably, groundwater sellers do not compromise on terms and conditions of the buyers and follow the principle of profit maximization, therefore, are able to recover the operational and maintenance expenditure of their tube-wells to a larger extent. Cash based transactions in the groundwater irrigation markets have been widely witnessed, thereby indicating a "mature stage" of groundwater markets. Groundwater buyers achieve higher cropping intensity and in no way worse off in crop production and yield.

A significant increase in number of electric tube-well connections, demonstrates the ample interest of farmers in electric tube-wells. Energy subsidy for groundwater irrigation approximately amounts to 46 per cent of the total subsidies provided to the farmers. The study reveals that both tube-well operating hours and its running hours per hectare as well as energy consumption and its use per hectare in rice crop is far more than

other crops grown. About 15 per cent large farmers own four or even more tube-wells with high horsepower ratings, thereby consuming more energy as well as groundwater. Therefore, it is the large farmers who are getting more benefited from the subsidized energy, while small farmers remain marginalized from energy subsidies. Utilization factor of large farmers is more than double than the small and medium farmers. Likewise, utilization factor during kharif season is nearly 7.5 times more than rabi season due to cultivation of rice crop, high temperature and evapotranspiration. Both tube-well owners and water buyers secure higher economic productivity in all the crops except rice as compared to Uttar Pradesh, Bihar and Gujarat but at the cost of more groundwater application. In other words, Haryana has to apply much more water for rice cultivation than other states to produce same amount of grains. Funding for installation of tube-wells in Haryana largely comes from commission agents and money lenders followed by the owner's savings despite the prevalence of excellent banking facilities. There is a growing concern about unreliable energy supply and falling groundwater levels among the farmers of Haryana.

A strong energy policy, especially in groundwater irrigation sector needs to be put into service as a powerful tool to control groundwater overdraft. An inability to manage this linkage will be a great opportunity missed towards the sustainable management of both energy and groundwater. Hence, following options need to be reviewed and implemented to address the energy-groundwater irrigation nexus. Appropriate tariff (flat or metered) closer to the cost of supply is most prudent option. Additionally, discouraging the setting up of new tube-wells and new electricity connections could also reduce pressure on groundwater use. However, politically it is a very sensitive issue for the state.

The second option pertains to the setting of energy tariff according to groundwater utilization. At present, Haryana Electricity Regulatory Commission sets energy tariffs for different consumers across the state based on pooled average cost of supply. Instead of this pooled average cost of energy supply tariffs should be fixed on the groundwater classification as over-exploited, critical and safe. This will not only bring two sectors to work closer, nonetheless it will also provide some accountability towards the groundwater utilization. Therefore, it is suggested that areas classified as over-exploited should have higher energy tariffs either flat or metered in the state, when compared to areas, which are classified as safe. High energy tariff rates would act as a constraint for farmers to grow water intensive crops in over-exploited and critical areas. In other words, higher tariff for the over-exploited and critical areas will act as an environmental cess, which the farmers in these areas will have to pay to utilize groundwater. Shifting to energy efficient pumping systems in conjunction with use of drip irrigation systems can reduce energy use by 70 per cent and water use by 60 per cent. It is suggested that energy supplied to the irrigation sector should be of standardized voltage so as to check the damage to motors and transformers to make it farmers friendly.