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An Analysis Of Haryana's Groundwater: Growth, Quality And Accessibility

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Abstract: Water is an essential resource for promoting sustainable development and plays a pivotal role as a considerable energy source. Furthermore, the agriculture industry and numerous enterprises also deem it crucial. The global community acknowledges the advantages of ecosystems in terms of water resources. The Earth's surface is estimated to be encompassed by water to the extent of around 75%, the majority of which consists of salt water inside the oceans, accounting for 97%. The remaining proportion consists of freshwater, which is mostly distributed in lakes, rivers, icebergs, and groundwater reservoirs. The supply of freshwater supplies for human civilization is finite, and there is a noticeable decline in its freshness and purity. This research examines the availability of groundwater in Haryana, India, with a specific emphasis on geological parameters like the makeup of underlying strata, topographical characteristics, and patterns of precipitation. The net availability of groundwater in Haryana had a significant rise throughout the period from 1998 to 2017, rising from 724.84 thousand hectares to 1029.67 thousand meters. This expansion represents a growth rate of around 42%. The observed rise in levels might perhaps be attributed to an escalation in irrigation intensity facilitated by canal systems, as well as changes in precipitation patterns. Nevertheless, a discernible discrepancy in the accessibility of groundwater may be seen in the state of Haryana. The districts of Jind and Faridabad have recorded levels over 100%, but Karnal and Panipat have shown marginal decreases. In 1998, Mahendragarh had the most limited groundwater supply, whilst Hisar and Fatehabad showed the greatest quantities of groundwater. According to the data from 2017, Hisar exhibited the most abundant groundwater availability, whilst Mahendragarh shown the least amount of groundwater resources. The regions situated in the eastern and northeastern parts, namely Ambala, Y. Nagar, Kaithal, Panipat, Karnal, and Sonipat, have a greater abundance of groundwater resources. In the year 2017, it was observed that all districts in the state of Haryana have a minimum of thirty thousand groundwater sources, except for the districts of Rewari and Mahendragarh located in the southwestern region.

Keywords: Groundwater Resources, Haryana, Geographical conditions, Development, Quality.

Content

Water is widely recognized as an essential need for sustaining life on the planet Earth. The significance of water as a resource is paramount in the context of sustainable development. In addition to fulfilling the fundamental requirements of human beings, it also functions as a significant energy resource. Renewable energy is widely recognized as a substantial and underutilized resource. It is well recognized as an essential component for the agricultural sector as well as several businesses. The world community has recognized and valued the substantial and advantageous contributions provided by ecosystems in relation to water supplies. Approximately 75% of the Earth's surface is covered by water, with 97% of this water being present in the form of salt water inside the Earth's seas. The remaining percentage of water present on the Earth's surface consists of fresh water, which is mostly found in lakes, rivers, icebergs, and groundwater. The fresh water available on Earth may be divided into many categories. Water vapor accounts for a mere 0.001 percent, while groundwater makes up around 0.9 percent. Ponds, lakes, and rivers together represent 0.02 percent of the fresh water supply, with the remaining 1.8 percent being stored in glaciers. Hence, the accessible freshwater reserves for human civilization are comparatively limited. While freshwater is often seen as a renewable resource, its availability in terms of both freshness and purity is seeing a noticeable decline.

Aquifers often consist of fragmented geological formations, such as limestone, sand, gravel, or sandstone. These entities possess extensive interconnected areas, resulting in their permeability. As a consequence of this phenomenon, water is able to permeate these substances. The speed of groundwater flow is influenced by factors such as the connectivity and size of voids inside the rock, as well as the characteristics of the soil. Groundwater may be obtained in many locations, regardless of the depth of the water table. There are several elements that contribute to the fluctuation of its decline or ascent. The increase in groundwater levels within the water table may be attributed to the process of snow melting and the occurrence of substantial rainfall. Conversely, the decline in groundwater levels within the water table can be attributed to the extensive extraction of groundwater for various uses related to water supply. The replenishment of groundwater resources occurs via the infiltration of precipitation, such as melted snow and rainwater, which permeate the subsurface fractures and fissures. In several global places, the natural replenishment of water resources is being outpaced by the fast use of groundwater, resulting in a significant challenge of water scarcity for the inhabitants of these areas. Human activities contribute to the pollution of groundwater in numerous different regions.

The provision of potable water is mostly reliant on groundwater sources, accounting for 51 percent of the global population's access to this vital resource. In rural regions, there is a notable escalation in this proportion, making it the only source for potable water supply, since it caters to ninety-nine percent of the rural population. An further noteworthy use of groundwater is seen in the agricultural sector, namely in the cultivation of crops, wherein it is utilized for irrigation purposes, accounting for a significant proportion of sixty-four percent. It is of considerable importance in several industries. Wetlands, rivers, and lakes serve as important sources of replenishment.

The present study aims to analyze the groundwater availability scenario in the state of Haryana. The presence and accessibility of groundwater within a particular area are primarily determined by geological factors, including the composition and arrangement of underground strata, the topographical features of the region, and the frequency of precipitation events. The net availability of groundwater in Haryana had a significant rise from 724.84 thousand hectares in 1998 to 1029.67 thousand meters in 2017, reflecting a growth rate of almost 42%. One possible explanation for this phenomenon might be the escalation of irrigation intensity via the use of canals, along with changes in patterns of rainfall. A discernible disparity in the availability of groundwater is seen in the state of Haryana. A significant rise in the availability of groundwater has been seen in the districts of Jind and Faridabad, with reported levels above 100%. In contrast, it has been observed that the districts of Karnal and Panipat have seen a minor reduction in their respective categories. In 1998, the district of Mahendragarh exhibited the lowest level of groundwater availability, measuring at 13.94 thousand meters. Conversely, the districts of Hisar and Fatehabad recorded the greatest levels, reaching 123.59 thousand meters. In the year 2017, the district of Hisar had the highest level of ground water availability, measuring at 133,000 meters, while Mahendragarh had the lowest availability, measuring at 25.63 thousand meters. The eastern and northeastern areas, including the districts of Ambala, Y. Nagar, Kaithal, Panipat, Karnal, and Sonipat, have a higher prevalence of ground water availability. With the exception of the south-western districts of Rewari and Mahendragarh, all districts of Haryana possess over thirty thousand sources of groundwater. In 2017, a same regional variance pattern was seen in the overall accessibility of groundwater resources throughout the state.

The per capita accessibility of groundwater had an increase from 16.16 hectares in 1998 to 23 hectares in 2017. The net annual water availability in 1998 exhibited geographical variability, with values ranging from 0.07 hectares. The area of land in Karnal, located in the Mahendergarh district, measures up to 0.29 hectares. In the majority of the eastern and northeast regions, the state has an average availability above 0.16 hectares. The availability of resources per hectare in the south-west and west directions had a much lower magnitude compared to the eastern and northeast regions. In the year 2017, the district of Jind exhibited the most quantity of ground water available per hectare, specifically measuring 0.37 hectare, while the district of Bhiwani had the lowest availability at 0.12 hectare. Over the course of a 16-year period spanning from 1998 to 2017, there has been an observed rise in the availability of groundwater inside the state. The studied area has an elevated level of ground water accessibility, with a notable concentration of development seen in the eastern and northeastern regions of Haryana. This research examines the availability and expansion of sources of Global Web Information Network (GWin) across several academic disciplines. Haryana has a discernible disparity in the accessibility of groundwater resources. The year 1998 had the lowest groundwater availability, measuring 159.59 thousand meters, in the LGAR region, while the maximum availability, reaching 341.92 thousand meters, was seen in the HGAR region. In the year 2017, it was observed that HGAR exhibited the greatest level of groundwater availability, measuring at 524.48 thousand meters, while LGAR had a lower level of availability at 228.03 thousand meters.

The data indicates that there is a notable elevation in groundwater availability under the high groundwater availability regime (HGAR) and low groundwater availability regime (LGAR) as compared to the average levels. In contrast, the Medium Ground Water Availability Regime (MGAR) had a lower percentage (24 percent) compared to the average of the state. In 1998, the net annual water availability in Haryana was recorded at 0.16 hectares. The LGAR region had the lowest net availability (0.10 ha-m), as anticipated. The availability of land in the HGAR and MGAR regions exceeded the average land availability of 0.16 hectares in the state. From 1998 to 2017, there was a recorded increase in the availability of groundwater by 0.07 hectares per meter. In the year 2017, the region with the greatest ground water availability per hectare was identified as HGAR, with a value of 0.31 ha. Conversely, LGAR exhibited the lowest ground water availability per hectare, measuring 0.15 ha. The data indicates that HGAR and MGAR have shown the most substantial development in relation to the accessibility of groundwater resources.

The use of groundwater for industrial, domestic, and agricultural applications has seen a significant increase in recent decades, giving rise to concerns. Haryana is a prominent consumer of groundwater for several applications. The use of groundwater for agriculture irrigation has paramount significance within the state. In 1998, the state had a water drainage capacity of 607.98 thousand meters, which subsequently saw a substantial growth to 1391.57 thousand meters by 2017, representing a remarkable rise of 129 percent. The draft of groundwater in the districts of Bhiwani, Hisar, Jind, Rohtak, Sirsa, and Sonipat has seen a significant rise of over 230 percent. This observation indicates that there has been a notable rise in groundwater depletion in regions where the initial levels of depletion were comparatively lower. Indeed, the groundwater level in the Mahendergarh district has decreased significantly in the southwestern regions, resulting in a deepening of the water table. A reduction in the draft in Karnal district has also been seen. The net annual draft of G.W. shown a significant improvement, increasing from 0.13 to 0.31 hectares per hectare throughout the course of the research conducted in 2017. The districts of Kurukshetra, Kaithal, Jind, Yamunanagar, Karnal, Panipat, and Sonipat in the eastern and northeastern regions of Haryana saw significant groundwater depletion, with annual rates exceeding 0.34 hectares. In the year 1998, a region characterized by a significantly elevated annual groundwater extraction was only identified within the Northeastern Region. This demonstrates that the state is seeing an increased emphasis on the use of groundwater aquifers, leading to the widespread extraction of groundwater resources. The investigation indicates that there has been a significant rise in groundwater levels above 160 percent in the regions of LGAR and MGAR. This observation indicates that there has been a greater growth in groundwater extraction in regions where the initial extraction rates were comparatively lower. In the year 2017, MGAR and HGAR saw a notably elevated rate of groundwater extraction, surpassing 0.33 hectares per year. In 1998, the HGAR regime stood as the only entity, exhibiting a groundwater draw rate of 0.23 hectares per year. This observation suggests that there has been an increased emphasis on the exploitation of groundwater aquifers in the regions of HGAR and MGAR, leading to extensive extraction of groundwater resources.

In the state, the groundwater balance in 1998 had a positive value of 116.86 thousand hectares. This indicates that the recharge amount exceeded the yearly draft. However, while examining the district level data, it is seen that the groundwater balance in Hisar district varies from 84.49 thousand meters in Karnal to 39.29 thousand meters. Among the total of 16 districts within the state, it has been observed that 7 districts located in the eastern area and 2 districts situated in the south-western region exhibit a deficit in their groundwater resources. However, the dynamics of groundwater equilibrium in the state saw significant alterations during the subsequent fifteen years. In general, it can be said that Haryana had a deficit in groundwater resources in the year 2017, specifically amounting to 361.90 thousand cubic meters, indicating a discrepancy between groundwater extraction and recharge. With the exception of the four districts of Ambala, Rohtak, Rewari, and Mahendragarh, all other districts in the state had negative groundwater balances. The presence of a significantly unfavorable G.W. balance is evident in the geographical regions of Kurukshetra, Karnal, Panipat, Kaithal, Sonipat, and Y. Nagar, located in the northeastern and eastern parts. The district of Hisar, located in the western region, had the second most substantial deficit in water balance within the state.

The groundwater balance in districts such as Bhiwani and Gurugram, located in the southwestern and southern regions, exhibited a negative trend, even with the use of tube-well irrigation to a limited extent. This observation unequivocally suggests that there is an excessive extraction of groundwater in the state of Haryana. The data demonstrates that the state achieved a net balance of 0.03 hectares per meter. This implies that the state saw a cumulative yearly growth of 3 cm in its groundwater reserves. A total of nine out of sixteen districts within the state exhibited an upward trend in groundwater levels. The district of Hisar had the most substantial development, with the districts of Sirsa, Rohtak, and Sonipat following suit, each seeing an increase in area of 9 cm. This growth was seen as a transition from the Middle Eastern regions to the North-Western sections. Conversely, an unfavorable groundwater balance was seen in the northeastern regions of the state, as well as in the districts of Mahendergarh and Rewari in the southern areas. However, it should be noted that in the year 2017, the state had an overall deficit in groundwater. The state had an annual decrease of 8 centimeters. A marginal rise in groundwater resources was seen in just four districts of the state, namely Rohtak, Ambala, Mahendragarh, and Rewari.

Eleven of the sixteen areas in the state had a negative groundwater balance. Kaithal's Kurukshetra had the most freshwater loss, at 29 cm at a rate of 56 cm per year. The groundwater balance for MGAR was very positive in 1998, at 100.26 thousand H-M. It was followed by LGAR, at 41.84 thousand H-M, and then HGAR, at -26.23 thousand H-M. HGAR, on the other hand, had a negative groundwater balance of -26,23 thousand ham in 1998. There were some changes in groundwater balance over the next fifteen years, though. It is clear that all three systems of groundwater supply had a very negative groundwater balance. The MGAR and LGAR in HGAR had the most negative groundwater balances. HGAR only saw a drop in groundwater resources (-0.03 Ha/M) in 1998. The amount of groundwater rose in both MGAR and LGAR. The biggest rise was seen in MGAR (5 cm), then LGAR (1 cm). But in 2017, there was a negative groundwater balance in all groundwater systems. After MGAR, HGAR had the most groundwater loss, at 11 cm, which is about 12 cm. In 2017, the least amount of groundwater was lost in LGAR (3 cm).

The assessment of groundwater status may be observed via many classifications. Spatially considerable differences may be seen in the amount of groundwater development. The percentage varies from 32% in the district of Hissar to 203% in the district of Kurukshetra. The presence of surplus groundwater has been documented in the northeastern and southwestern regions of Haryana. The districts, namely Hissar, Sirsa, Ambala, Rohtak, Bhiwani, and Sonepat, fall under the classification of "safe." The remaining 24% of the state's regions may be classified as either "critical" or "semi-critical" in terms of their impact on groundwater development. However, by the year 2017, there has been a significant transformation in the realm of groundwater development. The percentage saw a rise from 84% to 135% in the year 1998. It has been claimed that the amount of water removed exceeds the yearly recharge by 35%. The data presented indicates that about 78.62% of the region of Haryana is now characterized by an excess of groundwater resources. In this context, it is worth noting that the districts of Rewari, Mahendragarh, Rohtak, and Ambala stood out as outliers. These four instances fall under the classifications of "moderately severe" and "severely severe" in terms of groundwater extraction. It is evident that in 1998, around 54% of regions within Haryana were safeguarded from the excessive extraction of groundwater. The degree of groundwater use under this specific group is below 70%. However, after about 15 years, every zone inside the state can no longer be classified as safe. In contrast, there has been a significant rise in the extent of overexploited areas, rising from 25% to 79%. This observation also indicates significant variations across states in terms of groundwater extraction.

Notable differences in water table behavior along longitudinal and latitudinal axes have been observed in the state of Haryana. It is evident that throughout the period of 1998-2017, the state experienced a mere 5% of regions that did not exhibit significant fluctuations in the depth of the water table over an extended period of time. Indeed, this particular region functions as an intermediary zone between two distinct places within the state, characterized by both an increase and a decrease in the water table. The data indicates a decrease in water levels in about 53% of the geographical region within the state. Approximately 25% of the geographical expanse of Haryana exhibits a water table that reaches a depth of up to five meters, while 11% of the region has a significant decrease in the water table, exceeding a depth of 10 meters. A notable decline in water levels was seen in many districts situated in different regions of Haryana, India. Specifically, the north-eastern plain including Kurukshetra, Kaithal, and Karnal, as well as the southern districts of Gurugram, Faridabad, and Aravalli, experienced this phenomenon. Additionally, some locations within the districts of Bhiwani and Rewari, located in the south-western Aravalli region, also had a substantial decrease in water levels. The northeastern plains of the state have shown a significant deficiency, with the exception of the Siwalik and south-west Aravalli areas. Between the years 1998 and 2017, the state has seen a rise in the water table, which stands in contrast to the prevailing trend of a little decrease in just over 40% of the region. Indeed, it has been observed that in around 5% of the geographical regions within the state, there has been a notable rise in the water table, ranging from 4 to 6 meters.

The rise in water levels in the Middle Zone may be attributed to the diminished capacity of farmers to use integrated irrigation techniques, such as conjugated irrigation and intense canal irrigation, due to the decreased salinity of the water. There are several factors that contribute to the accelerated degradation of groundwater levels. The mix of wheat and rice crops is a significant factor in this context. These two crops, which have a high water need, require substantial quantities of water on an annual basis. The extensive use of groundwater for the purpose of irrigating these crops has resulted in a depletion of groundwater reserves in the state of Haryana. The geographical expansion of the wheat-rice crop combination has occurred during the course of the last two decades. The cropping pattern in the northeast and eastern portions of Haryana is primarily characterized by the dominance of these two crops. A strong correlation exists between the increase of the wheat-rice crop combination and the regions in the north-eastern and eastern areas that are experiencing both water overflow and depletion of groundwater resources. The significant decrease in the water table within the Aravalli zone, specifically in the south-western and southern regions of the state, can be attributed to the extensive use of tube-well irrigation practices implemented in this arid area. Consequently, the ecological degradation of the soil can be attributed to the extensive mining and extraction of construction materials. It is feasible.

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