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A Study of Various Groundwater Management Strategies and Technological Aspects in India

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Abstract – Groundwater is directly associated and influenced by natural recharge. Since the natural recharge in the areas having low and medium rainfall is restricted. Thus, groundwater in these areas is prone to depletion, resulting in a permanent decline in the water table. The depletion in groundwater reserve, in this way, causes major economic, social and ecological consequences in the region. It has been observed that in many parts of the excess groundwater withdrawal by private tubewells used for rice cultivation has resulted modification of hydrological setting. Groundwater Estimation Committee, the level of groundwater development is more than 80 per cent which is quite alarming in comparison to the national level of 30 per cent. This region has registered as appreciable decline in groundwater level since 1974 due to high rate of extraction. This study has demonstrated that average depletion is taking place in groundwater reservoirs at an alarming rate of 0.529 meter per year. In this way the problem of ground depletion in the area seems to be both shortage and managerial. The new technology is of little significance until it reaches to the actual user. Sometimes it takes several years for a new technology to reach to its end user. The innovation of new techniques in the field of irrigated agriculture is of utmost importance particularly for the semi-arid area like the study area. For example, evolution and implementation of new irrigation technique that could save water is considered as one of the promising strategies. Water saving modern devices is the growing need of the study area because the survey by the Central Groundwater Board reveals that the spurt in the number of tubewells has caused the groundwater table to decline as the withdrawal exceeds the average annual recharge. Groundwater irrigation is a critical factor in the study area as canal water is scarcely available. It has also been observed in this area that centrifugal pumps used for water lifting are being replaced by submersible pumps. Installation of submersible pump requires heavy investment which is beyond the reach of most farmers. Various improved irrigation methods such as sprinklers, drip irrigation and Deep Tubewell Irrigation Technology (DTIT) could be useful methods for the study area.

Keywords: Groundwater, Management Strategies, Technological Aspects, India Low and Medium Rainfall, Tube Wells, Irrigation Technology.

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INTRODUCTION

Water is one of the most important things that life on this planet needs. For the survival of humans, surface water and groundwater are two main water sources. Even if India is rich in soil waters, it has nevertheless not been protected and managed as much as surface water, even as it is used as a drinking water by over half the world's population. This precious gift of nature must urgently be preserved and protected. In India, the demand for groundwater supplies is estimated at approximately 45 million hectares (mham). Assuming 70% of this amount is available, the useable potential can still be developed at 23 mham. In India, an estimated amount of about 450 billion cubic meters (BCM) of annual groundwater charging was achieved 1). Following consideration of the system's natural loss, the net annual availability of groundwater in the country is estimated to be around 380 BCM. The total annual water drainage, on the other hand, was approximately 160 BCM. Groundwater development has not yet been recovered in some parts of the country, including the north-east. In some countries, however, the development of groundwater is more than 85%, such as Haryana and Punjab. Heavy groundwater withdrawal in some parts of the Haryana has led to a high development stage. In addition to this complex tool, a wide range of non-replenishable storage options are available at deeper levels. A rough estimate indicates that the total groundwater supply in storage is roughly BCM 10,812. In the alluvial reserves of the Indo-Gangetic Brahamputra region, which range in the north and northeast parts of the country, there are especially abundant groundwater retainers. Groundwater availability in quantitative and qualitative terms is influenced in general by the different geology, physiography and climatic conditions. Nevertheless, the intelligent use of this natural resource and its efficient management are critical today in India because they have played an important part in sustaining the Indian economy, climate and living standards.

The increase in demand in various sectors, such as agriculture, domestic and industrial use, is making groundwater more important. This has occurred since the country's independence was gradually settled. The demand for water has risen day by day because more and more food is needed to meet the increased demand of the population. It takes approximately 1000 tons of water to produce one ton of wheat. For rice, this demand is nearly twice that. For the industrial sector, a significant amount of water is also needed. A sharp calculation shows that almost 56 tons of water must be provided for one ton of fibre. Likewise, an estimated 1000 megawatt (MW) thermal power plant needs approximately three million cubic meters of water a day. Therefore, the number of wells (sallow and deep tube pipes) has increased dramatically since independence, in order to meet the increasing demand for water across various sectors. Nevertheless, the establishment of the National Bank of Agriculture and Rural Development (NABARD) in 1963 gives rise to the impetus of institutional investing. Thanks to rural electrification through Rural Electrification Corporation (REC), the extraction of water through these abstraction systems has been introduced, as this provides critical support for lifting water. There is therefore a high likelihood of groundwater exploitation in the absence of surface water irrigation as the groundwater abstraction structures in India are private. A private individual can create wells of any size and capability by investing their own capital. According to the 1882 Land Facilitation Act (LEA), groundswater is regarded as a land-based facility. The landowner who is free to harvest and use the land, as he sees fit, is thus to own the groundwater. LEA was initially promulgated, but dug wells were the most popular and prevalent method of drain. The situation has changed significantly with the introduction of electrically powered pumps and modern boiling methods. The total number of tube wells and pumping sets was only approximately 25,000 during the time Haryana was set up in 1966-67. By 2014-151, this number rose to some 8,00,000. Only small and smallholder farmer's exclusive rights over water, as well as those of groundwater resources, have been exploited. As a tropical country, it is important for India to improve the management of our water resources. The reliance on groundwater has increased in order to meet the ever increasing demand for water. As the production and use of groundwater resources have been mostly unsystematic, unplanned and unregulated, the general situation is becoming worse. This has contributed to overuse of capital with unintended consequences.

REVIEW OF LITERATURE

Asghar, M. N. Shafique, M. S. Ahmad, S. what's more, Kahlown, M. A. (2014) contemplated the local groundwater in the focal areas of Doabs of the Indus Basin of Pakistan which is profound and saline in light of the marine cause of the hydrogeology arrangement. Permeation of crisp water system waters framed a new groundwater focal point over the saline groundwater. The thickness of this crisp groundwater focal point differs from a couple of meters to 150 meters. They indicated that skimming wells of 10-18 liters for every second (lps) release rates can be introduced and worked effectively.

Shah, T. (2014) examined that, locales that have maintainable groundwater balance are contracting step by step all through the world. Three issues overwhelm groundwater use: consumption because of overdraft; water logging and salinization because of insufficient waste and contamination because of human activities. They revealed that springs in the Fuyang bowl in China are under twofold attack: ranchers are draining the lower springs and businesses are dirtying the upper ones.

Villholth, K. G. what's more, Sharma, B. R. (2015) saw that groundwater over the globe is under expanding risk as far as overdevelopment, over-extraction and contamination, because of expanding population pressure, expanding living measures, industrialization, and an absence of legitimate administration to coordinate the requests and use designs with the regular resource base. This is a worldwide pattern, and however provincial contrasts exist, this is no special case in south Asia and southeast Asia. India, China, Pakistan, Bangladesh and Nepal.

Soltani, G. also, Saboohi, M. (2018) examined the financial and social impacts of groundwater overdraft in Iran. As indicated by them the unreasonable withdrawal of groundwater for water system raised the issue of supportability of inundated agriculture in many pieces of the Middle East and North African (MENA) nations. The destinations of the investigation were to decide the extent of groundwater overdraft and its outside expenses in Iran. Both quantitative and subjective impacts of groundwater overdraft were assessed. Appraisal of the impacts of groundwater overdraft demonstrated a desolate picture of groundwater resource consumption in the investigation regions. The discoveries suggested a tradeoff between satisfying quick population need for nourishment and maintainability of groundwater based cultivating. They outlined that for a country like Iran, utilizing outside trade profit to spare its essential groundwater resources might be viewed as a savvy venture.

Dhawan, B.D. (2012) expounded that issue of groundwater misuse are basically those of plain locales where groundwater based agriculture comes into vogue. He proposed different systems of water guideline since it is considerably more restricted than surface water. He recommended that electric tax ought to be identified with actual utilization of power rather than torque of engine. He is of the supposition that the volume of groundwater misused for water system purposes in a year must be proportionate with the volume invading into the ground each year. Something else, groundwater draft in abundance of the intermittent recharging would exhaust the groundwater resource.

Gasp, N. (2012) expressed that even in U. P. which structures some portion of extraordinary supply of groundwater, the issue of bringing down of water table is disturbing in Varanasi, Agra, Moradabad regions. Attributable to less precipitation characteristic revive is not exactly the release in every one of these areas.

Mehta, M. (2016) said that there has been extraordinary groundwater improvement in India in view of which the water framework potential has extended complex from 6.5 million hector (mha) to 45.7 M ha before the completion of the VIII Plan. Out of a normal most noteworthy water framework ability of 81.4 mha in the minor water framework division, 64.0 mha (79 percent) is assessed to be connected with groundwater. He depicted the groundwater assets openness in different bits of the nation, He brought out areas, which are feeling the squeeze, and moreover a locale where groundwater advancement is at a modestly low and further improvement of groundwater is conceivable. The polluting of groundwater due to geo-genic sources is likewise examined with exceptional accentuation on the arsenic and fluoride defilement, which has antagonistically influenced an enormous population in the country.

Jha, B.M. also, Sinha, S.K. (2016) stressed for territory based strategies for groundwater the board contingent upon the organic market of a district. According to the most recent evaluation, the annual replenishable groundwater resource of country has been assessed as 433 billion cubic meter (bcm), out of which 399 bcm. Viewed as accessible for development for different employments. The water system sector remains the significant customer of groundwater, representing 92 percent of its annual withdrawal.

Dhiman, S.C. what's more, Thambi, D.S. (2015) talked about the hydrogeological situation of the beach front territory of India, identifying with the ocean level changes before and the present. He pointed that a dangerous atmospheric devation has the impact on the waterfront springs particularly that of the little islands. The springs of Lakshadweep are exceptionally touchy since crisp water is considered skimming to be a dainty focal point over ocean water here. The issues are likewise mind boggling in the waterfront territory. Ocean water interruption is accounted for in Gujarat and Tamil Nadu and the saltiness in different zones are generally gotten from the spring materials.

As per the Tribune (2012) the Prime Minister Dr. Manmohan Singh while initiating the India Water Week at Vigyan Bhawan, he communicated worry over exhausting groundwater table and stated, "the present legitimate circumstance gives each land holder the privilege to siphon boundless amounts of water from a drag well without anyone else ground". There is no guideline of groundwater extraction and no coordination among contending clients. Insufficient and problematic estimating of both power and water is advancing the abuse of groundwater. Without sound lawful structure, drinking water systems frequently lose the challenge. The Planning Commission has distinguished the test of overseeing water resources in a levelheaded and practical way as one of the basic difficulties in the twelfth Multiyear Plan.

GROUNDWATER MANAGEMENT STRATEGIES

In the present research work, three management strategies: ecological, institutional and technological are suggested for sustainable of groundwater development in Southern Haryana.

ECOLOGICAL STRATEGIES

Groundwater depletion at such an alarming rate needs to be monitored in the study area. Some ecological groundwater management strategies have been established to track environmental consequences. It should be borne in mind that these approaches would aim to avoid further depletion of groundwater resulting from over-exploitation of resources for the production of the various conservation and management practices. The following sections are presented;

i. Cutting pattern shift.

ii. Knowledge of water efficiency.

iii. Heat mix.

iv. Harvest of rainwater and artificial groundwater recharge.

v. Conveyance loss elimination.

vi. Reduction in losses of demand.

vii. Water resource allocation.

viii. Waste water treatment and re-use

Change in Cropping Pattern: While there is a mixture of cereals, pulses and oil seeds in the current cropping pattern, there has still been a significant boom in the region under wheat and some rice. With the increase of irrigation facilities the preference of farmers for wheat and rice is growing. In the other crops such as sarson, bajra, guar, jowar and cotton the prevalence of the wheat and paddy crop was estimated. The productivity of rice-wheat rotation has diminished, due to declining soil health given the comparatively benefit of improved technology. However, the study included an increase in fertilizer consumption and irrigation plants, leading to an increase in crop yield and an increase in ground water reservoir depletion. Tendency to continually deplete the crop production may also be reversed in the long run. In order to maintain soil productivity, to prevent groundwater depletion and meet food grain and fodder demands of the people of the area, the following crop sequences and inter cropping are recommended:

1. Arhar – moong – wheat
2. Millets – sunflower
3. Millets – toria – sunflower/moong
4. Cotton – pulses
5. Millets – surson
6. Millet – surson – potato/onion
7. Millet – wheat – lobia/moong/urad

The forgoing mentioned crop sequence requires less amount of water and hence will help to maintain balance crop production, high water productivity and return soil productivity.

Awareness about efficient use of water: Farmers ' ignorance of the right watering schedule poses a major hurdle in water production. Uncontrolled irrigation contributes to inefficient use of irrigated water by drought, open field irrigation and premature irrigation. The survey clearly shows that farmers prefer to be irrigated regardless of soil characteristics, essential plant growth level, and evaporative atmospheric demands. It is suggested that effective and simple technologies should be built in order to improve irrigation water quality so that farmers can easily use the water. The farmers should know how much water should be added to a specific crop and how much time should be. Farmers must be made aware of the need for practical use of water to achieve maximum yield and long-term sustainable development. To achieve this goal, farmers must be trained on the following aspects:

1. Pick the crop pattern in accordance with water and soil type availability.
2. Land leveling is an advantage for effective irrigation water use as even surface movement of soil water almost uniformly.
3. For a particular crop, it is essential to know about the irrigation time and depth. It is also important to know the critical watering stage and the ability of water to hold different soils.
4. The utility of modern irrigation systems like sprinklers and drip needs to be understood. It is important for us to know that such micro irrigation systems give a uniform weathering and save up to 50% water. The use of small irrigation techniques also increases crop yield considerably.
5. Knowledge of the appropriate timing for the use of fertilizers and pesticides improves crops and efficiency in water use.

Conjunctive use of water: Conjunctual water usage means cumulative water multiple uses, so that when each source is used separately, the net output is more than the total output1. At one point on the earth, surface water becomes groundwater at another point, so it may emerge again at the third point as surface water. So groundwater and surface water are part and parallel to the same hydrological cycle. Maximum returns can be achieved without degrading the region's water resources by the combined use of water techniques. The following steps should be taken in several schemes for conjunctive water use in the region:

- The increase of canal water by pumped groundwater through deep tubewells along the canal system.
- In reservoirs, in lakes, rain waters are collected so that they can be used with the river and groundwater.
- Maintenance of the water table in water reported areas and replacement with canal water and vice versa of slightly bad quality ground water.

Rain water harvesting and artificial recharge of groundwater: The method of rainwater harvesting and artificial charging is widely accepted in order to stop decreasing rates in groundwater levels. This practice is seen as cost effective as well as increasing the resources of the groundwater. Because of the scarce rainfall and the limited network of canal water, pumping of whole groundwater in this area cannot be stopped. In order to increase groundwater resources, therefore, harvest and artificial recharge infrastructure must be strengthened. Rainwater harvesting and artificial recharge technologies have shown promising results in different parts of the country. The implementation of this scheme will help society in various ways, i.e. increasing soil regeneration, controlling groundwater level and reducing surplus drainage. Such technics can boost water harvesting efficiency, soil quality by increased soil humidity and improving groundwater levels by effectively implementing such techniques. This plan will enhance the storage of surface water, stopped run-off which, in turn, will enhance the groundwater reserve at the lower reaches, by building small water resers, perpolation tanks and ponds at the right locations in this region.

In the study area1 there are also the Aravalli Hills. Such mountains are rich in diverse flora and fauna. It makes it green all year round. The area of the hills and hills may be used for storing precipitous water by building tanks for storage and percolation. This area could be used in this way for the aquifers of the study area as the possible recharge zone. The rise in the groundwater supplies of the study area could also be the Aravalli Hills that are otherwise environmentally poorly affected.

Reduction in Conveyance losses: For the people of this area, the Yamuna River is the only source of surface water. Water from this stream is transported by main canals, branches, distributors, minors, streams and channels to the farmer's field. Due to the water runoff and percolation enormous amounts are lost during transport. The irrigation grid is important to mitigate these losses in order to improve irrigation water quality. In order to get best profit from every drop of water, modern flow technology should be adopted to efficiently transport and distribute the available river water for the farmers in need.

Reduction in application losses: To date, in most study areas flooding and furrow irrigation techniques have been in use. Using these processes, percolation and evaporation leads to increased water losses. Therefore, these techniques urgently need to be substituted for those which allow smaller losses. One of the most effective techniques in micro-irrigation systems consisting of sprinklers and drip irrigation is where irrigation water is used to the fullest and losses are minimized. The introduction of micro irrigation methods would improve the efficiency of water consumption and therefore allow for additional irrigation with the same amount of water available. Furthermore, the use of micro irrigation methods will not increase the area's production significantly.

Allocation of water resources: Availability of water, irrigation intensities and the irrigation requirements of the crop depend on a wide array of factors. The distribution of water therefore represents a balance between demand and supply of water resources available. Usually, a full supply discharge (FSDD) irrigation network is designed to meet demand and supply in a specific area. In cases where FSDD is running an irrigation system during a month, one of the major factors is the channel system capacity factor. To order to ensure an optimal allocation of water to crop crops, these capacity factors are determined according to kharif and rabi season. Nevertheless, once set capacity factors should never bear fruit. The demand may also continue to change from year to year or season to season by changing crop patterns or irrigation techniques. Consequently, it is important to look from time to time at the capacity factors.

Recycling and reuse of waste water: In the developed world the recycling and reuse of waste water was a very popular exercise. Throughout India and Haryana, including the area of study, this technique has great potential to be used. Every day in the towns of the test area thousands of tons of sewage containing both solids and liquids are generated. Water is easily separated from the solid portion of the water sludge using the modern technologies available. The waste water can be further treated and recycled. In addition to meeting the demand for water to some degree, a robust use of this activity will also help to reduce water burdens.

INSTITUTIONAL STRATEGIES

The organization is a term that discusses concepts, actions, including social behaviour, laws, traditions, customs, conventions, fashion and legislation. The institutional structure was defined differently by various research studies. Craine1 established institutional arrangements as a composite of legal, administrative and functional power. Nelson2 however defined it from another perspective, who regarded it as forms of government, agencies, legislation and other social guidelines designed to influence human behaviour. Such concepts clearly indicate that the institutions must include laws and regulations; institutional structures; economic and financial arrangements; political structures and traditions and principles of history and tradition. Nowadays, a study of how institutional structures handle evolving needs due to internal or external pressures should be the most relevant area of research. It was observed many times that, due to the varying attitude of the person involved, the operational guidelines of resource management institutions adversely affect the implementation of the resource policy. Thus, for the successful implementation of the resources policy and potential modifications to the current model, an enhanced understanding of various components of the resource management organization is needed.

1. Water Right System

Rapid expansion of lifting water systems is contributing to a worsening of the crisis in groundwater. Actually, groundwater extraction at one's own request has caused a major degradation of groundwater in the country and the study area. There is therefore an immediate need for more complicated solutions, such as a water retention scheme, capable of efficiently restricting the removal of individual and collective water. As this natural source is not used efficiently, there is a need for legislation on groundwater control and regulation in the region, including the research area. Seeing that the issue of water is on the state agenda, the legislature is the right authority to enact groundwater legislation. The concept of property law in Haryana is not applicable in the case of groundwater resources. In the state farmer, one tubing extract on his land could use, move or sell all or part of water. Without obstacles and constraints, farmers capture water by pumping. The result is that people tend to overlook this phenomenon without regard for the future. Furthermore, the pump proprietor does not realize that its over-drawing has consequences on other consumers. Since the aquifers do not understand boundaries, every farmer has exhausted the common pool for which no individual is liable. This procedure also involves the participation of an entity with regulatory authority over individual users in the identification and defense of property rights. This requires a significant shift in decision-making from individual farms to administrative installations.

2. Legal Institutions

Until now, farmers in the state have rotated channel water. Rationing is enforced at all levels and at the level of rivers, waterways and fields, including allocation of water. Management decisions and schedules control the rationing of canal water in the state, including the area of study. To order to regulate extraction in all regions, the government of India has long tried to set up a Groundwater Authority. Nevertheless, up to now no water legislation has been implemented or enforced by either the central government and the State government. Human participation in groundwater resource management is increasingly needed. Legislative mechanisms should include guidelines or restrictions on tubewell owners ' involvement. The people should be responsible for controlling groundwater resources. The implementation, unless people participate in the planning, execution and maintenance of any large-scale groundwater development program will not be effective. Furthermore, it was thought that different platforms were urgently required for common farmers to share information and knowledge about groundwater science. Therefore, comprehensive management strategies should be initiated to increase scarce groundwater capacity including educational institutions, not government organisations, social groups and local autonomous bodies. This ensures long-term sustainable development in the country.

Water is available both in the country and in the area of study without any financial liabilities. Electricity is highly subsidized for water extraction. Consequently, famers and communities have taken unfair advantages of not charging water or high subsidies for energy. Some regulatory standards must therefore be enforced through the public sector, financial institutions and the State Electricity Commission. Actually, in blocks labeled as gray and black, only certain limitations on allocation of NABARD funds are available. In these situations, the overall water system must be re-evaluated and the integrated guidelines formulated and implemented so as to ensure that this precious natural resource remains sustainable in the long term.

Not only needs to be the regulatory mechanism transparent, it also needs to be friendly. A proactive approach by sensitizing users at various levels to the need for judicious use and scientific management of groundwater would ensure successful implementation of the notifications. The impact of the regulatory actions on depletion in the region's groundwater resources should be assessed on a regular basis through micro-level studies in these areas. The stakeholders must be aware about changes in situations in groundwater due to the regulatory process. Local people may also help to increase the area's groundwater resources in the implementation and administrative processes as social volunteers.

TECHNOLOGICAL STRATEGIES

Until it reaches the user, the introduction and evolution of new technologies is of little relevance. This takes a couple of years to reach the end user of a new technology. The invention of new irrigated farm techniques is particularly important in the semi-arid region, for example in the study area. For example, the development and implementation of new water saving irrigation techniques is considered to be one of the successful strategies. Modern devices to save water are the increasing demand in this region as the Central Groundwater Board's survey shows a decline in the spurt of tubewells, as the withdrawal exceeds the average annual fee. In terms of water availability, groundwater irrigation is a critical factor for the study area. Centrifugal pumps for water level have also been found in this region to be superseded with dipping pumps. Submersible pump installation calls for heavy investment that is beyond the grasp of most farmers. Various methods of improved irrigation, such as sprinklers, drop irrigation could be useful in the area studied.

1. **Augmentation of Sprinkler Device:** Irrigation with sprinklers is somewhat like precipitation. This method sprays water into the air and allows it to drop as rain on the ground. Water is uniformly distributed to the root area in this irrigation system at a rate sufficient for the soil infiltration. Efficient irrigation with less water could be achieved with this method. Therefore, in regions like the area where water is scarce, this method is becoming popular. Almost all plants (except rice) can be successfully used with this process. By adopting appropriate crop patterns, more area can be irrigated with the sprinkler. For plants like wheat, sarson, gram, bajra and fodder, this procedure has been very effective. The crop pattern for most of the study area is therefore suitable for irrigation of sprinklers. This technique should therefore be spread to more and more areas in order to minimize the burden of groundwater resources without jeopardizing farmers ' economies in the region.

2. **Augmentation of Drip Irrigation:** The irrigation by drop or drop-by-drop is a new irrigation method. The plants are frequently watered at the same rate as their consumption by this technique. Up to 50 percent can be saved with this irrigation strategy in addition to traditional irrigation methods. Water losses could be greatly

reduced by the introduction of a drip irrigation system because of deep percolation, surfacto exhaust and soil water evaporation of any conventional irrigation method. It is also estimated that the yield of crops by this technique can be increased by between 50 and 200 percent. The initial cost of equipment and other infrastructure for drip irrigation however is relatively high and is beyond most farmers ' reach. Thus the economic factors usually limited the application of this technique to a limited field. For this technique, the crop design and soil characteristics of the area of study are suitable. Therefore, the need for highly subsidized drop irrigation equipment is great to enable the farmers in the field to boom this method.

3. **Augmentation of Deep Tubewell Technology:** Tubewells are installed at higher levels (> 500 feet) under Deep Tubewell irrigation technology (DTIT). This technology was used as a community facility for a group of farmers. Marginalized and small-scale farmers who can not afford private tubewells can take the tubewell network. As deeper aquifers are taped by the DTIT, higher release potentials are therefore available. As such, the supply of DTIT water is regarded as more reliable and safe in comparison with the shallow tubewells. In this technology, farmers in the chak area receive water on the basis of equity rotation under normal circumstances. Growing chak covers an area of approximately 300-400 acres. The benefit of the DTIT is that its impact on the table is small. The system is recognized as an important method in groundwater management. As a powerful tool in water management DTIT therefore provides a means of managing and regulating waste and reducing the rate of water tables decrease. Also in the sweet water zone not controlled by canal irrigation deep tubewells could be installed. decades ago, the Minor Irrigation and Tubewells Corporation (MITC) constructed large-scale deep pipes in the City. The state government closed the business in 2003, however, but the DTIT remains fruitful in the region. In the areas in which irrigation water is inadequate, such as the study area, the water extracted from the deep aquifers via DTIT was carried through canal networks. This could easily increase irrigation intensity in the study area to a certain degree.

4. **Augmentation of Scientific Knowledge:** Farmers must be taught some technology to save water and they also need to trust their profitable return. Therefore the planners need to prove the value and profitability of these new techniques in order to change farmers to an increasingly scientific and modern water saving method. Institutional capacity for productive irrigation scheme planning, designing, construction, service, management and maintenance must be improved. Only by improving our professional qualification in all irrigation technology areas can we achieve this, to enhance crop production and therefore farmers ' incomes without jeopardizing environmental damage.

5. **Augmentation of Availability of Rivers Water:** Haryana is currently receiving its share of the rivers Yamuna and Satluj. The State is also entitled to water from the rivers Ravi and Beas. Different agreements on the sharing of Haryana's share in Ravi-Beas and Satluj waters have been made from time to time. The latest in the series was an agreement signed by Rajiv-Longowal on 24 July 1985. According to this agreement, 3,83 million acre (MAF) of water was allocated to Haryana. Furthermore, the share of Haryana in the Ravi-Beas system shall be increased or decreased accordingly in the event that the available water fluctuates in a given year. This agreement's recommendation is still to be implemented. Haryana currently draws about 1.61 MAF from the Bhakhra system, however. Through the Satluj-Yamuna (SYL) channel, Haryana is still not receiving about 2.22MAF of its allotted share. In the Honorable Supreme Court of India, the whole issue of building SYL and allocating the share of Haryana's water is still pending. The state government is called upon to make a concerted effort to procure its legal water content from the Ravi-Beas and Satluj rivers so that water is available to farmers. Similarly, under the 1994 Yamuna Agreement between different States, Haryana has a share of about 4.66 MAF in Yamuna River Water. It is shared by the State via the Western Jamuna Canal (WJC) and Agra Canal. Under the 1994 Yamuna Agreement, the Indian Government will build three dams in the Upper Yamuna Basin (UYB) in collaboration with other nations. For Yamuna water storage that run out during the mountain season otherwise. These three dams, Renuka, Kishau and Lakhwar-Vyasi, should be built in Yamuna's or its tributary upper reaches. The supply of water and power in the countries concerned will be improved after these projects are completed. After the implementation of these national projects Haryana will also earn increased water share. But these programs have been pending for a long time and the work continues to be very slow. The efforts for the sustainable development of agriculture, in particular in the field of study, are therefore urgently needed to be further developed.

AUGMENTATION OF POLLUTION FREE TECHNOLOGY

There were twofold issues in the study area with respect to emissions. One is excessive fluoride and other soluble salts used for drinking and other applications in groundwater. The highly polluted water in the study area flows across the Agra canal is also a problem. It is recognized to be a serious health problem if polluted water is used to either drink or irrigate. Nevertheless, legislation restricts the existence, but often overlooks, of undesirable materials which pollute the water. Although much attention has been paid to clean the Yamuna River by the Indian Government. The desired results are, however, still awaited. Cohesive efforts to clean up the river are therefore necessary. Before releasing it to its sub-agents and outlets, government can also take measures to clean the polluted water of the Agra Canal. The dirty water of the rivers and dams can be filtered by technologies. Various methods are available before being supplied for consumption to eliminate fluoride and other harmful components. All-round efforts need to be made with modern technology to solve the problem of water pollution. This can reduce the pressure on the area of fresh water.

CONCLUSION

The highly diverse hydrogeological conditions and differences in groundwater supplies accessibility from one part of the country to the other call for a holistic approach to the development of effective management strategies. The emphasis on management requirements does not mean full development of groundwater resources in India. An integrated approach, integrating supply and demand sides, includes effective management of available groundwater resources. In the Indo Gangetic alluvial plain, a vast area is located in which the development of groundwater is suboptimal and enough scope for future development. In the water stressed areas, immediate action is also required in order to increase ground water. However, development efforts should now be focused on through management mechanisms in order to achieve a sustainable use of ground water resources. Soil water constitutes in the gangetic plains, including the three States, the most important source of irrigation water. Punjab, West Bengal and Bihar. Agricultural productivity in Bihar and West Bengal is relatively low in comparison with Punjab. While in these areas ground water production can be carried out on the basis of hydrogeological and environmental factors, the mainly small and marginal farmers also face major economic obstacles. There have been a multitude of mechanisms developed or developed to allow farmers to take advantage of groundwater in those areas. Assured supply of electricity is one of the most important factors, which determines the rate, access and availability of soil water to a large extent. As the demand-led production of groundwater is mostly guided, it may be adjusted with the formation of suitable markets by means of proper agricultural, credit, subsidy and energy policies. The flood plains along the country's major stretches offer good opportunities for the development of groundwater. Similarly, artesian zones can be mapped and appropriate development plans drafted in the country. Methodologies for determining the development potential of deeper water sources must be established in alluvial areas, where multi-aquifer systems exist. Coordinated efforts are urgent for the developing and implementing of appropriate ground water management strategies in the country from various central and State government agencies, NGO's and social services organisations, academic institutions and stakeholders.

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