



SUSTAINABLE DEVELOPMENT: FUTURE OF GROUNDWATER MANAGEMENT

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Abstract:

Groundwater is the most important asset of Planet Earth for sustaining life and the environment. The rampant use in all spheres led to its fast depletion, so sustainable resource management become necessary. Groundwater water resource Management becomes important not only in India but also all over the planet earth. The sustainable ground water resources are Major challenge across nations, especially those located in the arid regions. In our paper we will define sustainable water resource as a flux of water that is managed to maintain quantity and quality of water. The role of water is too basic that we cannot depend only on single institution but demand collaborative approach. To address the problem of groundwater is immediate concern not only for present generation but for future as well. Water management include area with linkages multiple sectors of the Indian economy like industrial, agriculture, household, the power, environment, fisheries, and transportation sector. This management approach will be helpful to overcome the water stressed demand and help to increase he water supply. This paper acknowledges suitable measures for the management of ground water in India. The role of many factors that govern the utilization of water resources by looking at increasing water demand, so it become indispensable people centric approach for the ground water management.

Keywords: Sustainable Development, Groundwater, water resources.

Introduction

Groundwater constitutes 89% of all freshwater on the planet earth. With rising demands of groundwater and the unpredictable nature of rainy seasons, there has been an exhaustion of groundwater all around the world. Exhaustion of groundwater has reached that stage where it is difficult or near impossible to get the water table back to its earlier stage. Whereas it is possible to recharge the groundwater from different regions, the cycle is exceptionally slow and it may require a year to recharge one meter. Considering this authority of groundwater management has become one of the main issues in recent times. Additionally, there are ecological issues, such as water for mining, saltwater intrusion, stream base flow reduction, etc. This paper momentarily examines the idea of maintainability of groundwater management, principles affecting groundwater Accessibility, various

methodologies towards creating and utilizing accessible groundwater without adversely disturbing the hydro-geographical equilibrium. Moreover, the paper describes techniques for maintainable groundwater management, including the advancement of groundwater, rainwater irrigation, and artificial regeneration methods. This paper gives some applicable strategy suggestions for proper groundwater management in India.

Hydrogeological Setup of the Country

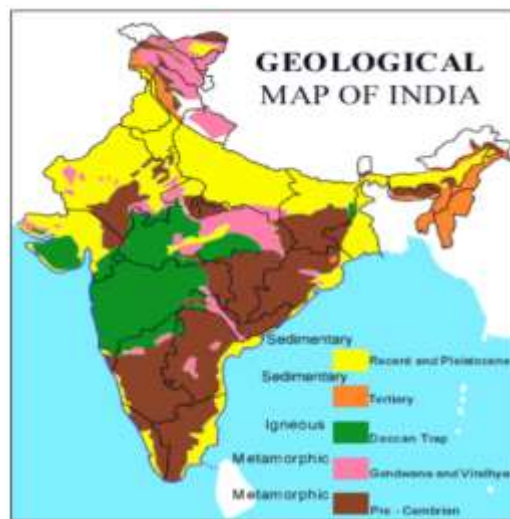
India is a country with a profoundly broadened hydrogeological setup. The groundwater conduct in the Indian sub-landmass is profoundly muddled because of the event of enhanced geographical arrangements with significant lithological and sequential varieties, complex structural systems, climatological variations, and different hydro chemical conditions [8]. The rock arrangements span in age from

Archaean to Quaternary-Recent period. The Archaean rocks are available in the southern states whereas the new residue is bound to Indo-Gangetic alluvial fields. The major Topographical Formations are the:

1. Consolidated developments addressed by Igneous and Metamorphic rocks with significant stone types comprising of stones, Charnockites, Quartzite, and related Phyllites, slate, and so on; basalts & related igneous rocks.
2. The semi consolidated stone developments are addressed by rocks of the Mesozoic and tertiary period with significant stone sorts addressed by limestone, sandstone, rocks, and rock aggregates.

3. The unconsolidated developments have taken place from the Pleistocene period till the recent period and have been addressed by some special rocks, such as boulders, pebbles, sands, and silt-clay. These stones structure the significant potential at aquifer zones [8].

The Indian sub mainland is having been formed by large geographical rocks varieties, for example, metamorphic rocks of the pre-Cambrian period, Igneous rocks addressed by basaltic rocks of the Cretaceous-Eocene period, Vindhyan and Gondwana rocks are overlain by quaternary to late sedimentary stores. The classification of these rock types is given in the geological map [4].

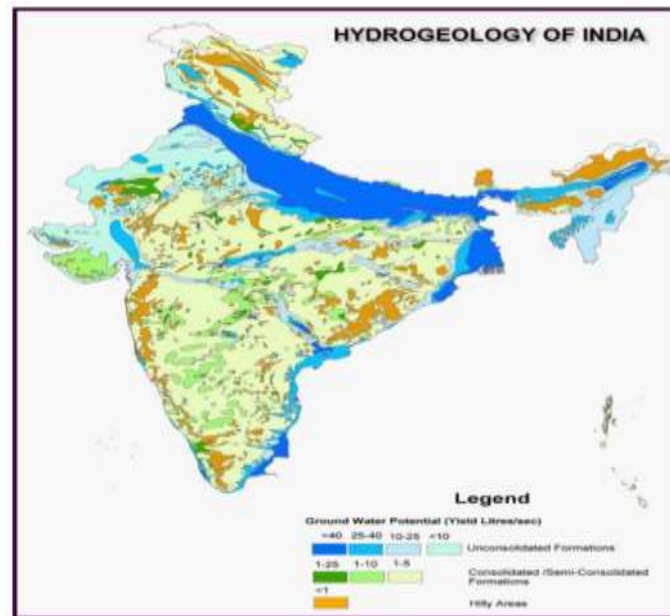


The Representative figure shows the distribution of various rocks in India with different Geological periods. (Source GSI).

In light of the development qualities and pressure-driven properties to store and maintain groundwater hydrogeological system, all the litho units can be sent under two main gatherings of water-bearing developments Viz [8]. Porous Formations can also be arranged into unconsolidated and semi solidified developments having the essential porosity and Fissured Formation or Consolidated developments which have for the most part the auxiliary or determined

porosity. The Hydrogeological map appearing the general gathering of solidified and unconsolidated water-bearing developments alongside their capitulate possibilities are displayed [7].

Physiographic and geomorphologic settings are some of the most significant variables which control the movement and conveyance of Freshwater [8]. In light of these elements, the nation has been comprehensively partitioned into five distinct areas as below:



The Representative figure showing the hydrogeology pattern in India (Hydrogeological department of India)

Groundwater Management in India: Major Problems

Groundwater and its significant usage give the utmost importance to a country like India. But there is no exact overview of groundwater assets as indicated or estimated by the National Commission of Agriculture, India's groundwater assets can be around 433 billion cubic meters or 10 times the yearly rainfall [3]. The yearly usage potential is around 145 billion cubic meters. With coming up with the new agricultural policy in the early 1960s, there was a rapid growth in the usage of power pumps and tube wells. Whereas, in 1960, only around near to 1.1 percent of the net agricultural land have got a tube-well water supply system, by 1988 around 27.8% of the net agricultural region have got the advantage of the tube-well water supply system. By 2001, the demand for industrial water has also raised around 160 billion liters each day [3]. The public authority's actions to extrapolate deep water wells for getting more water has led to water tables going down, and similarly, there was no interest and effort was made for recharging the groundwater. Groundwater being a dynamic and replenishable asset must be assessed founded on the part of yearly regeneration of groundwater which could be exposed to improvement through appropriate designs and which may also depend upon the hydro-land and

environmental conditions. In India, information on groundwater levels is not broadly distributed or made accessible outside government associations [3]. As a result, conversations on groundwater consumption are constantly founded on unreasonable information. However, it's undeniably true that decreasing the level of water tables and exhaustion of financially open groundwater saves have genuine financial results in an agricultural nation like India. Usage among village and cities people is increasing and taking us towards the struggle over groundwater utilization. Decreasing water levels also increase division among different societies [1]. Lower-class farmers are forced to give away agriculture as decreasing water tables have limited access to the people who can bear to deepen their wells. Deep tube wells need high power and hence lead to an increase in financial expense too. More exhaustion of water levels will lead us to danger to food safety [4]. A guaranteed water system is required for significant food development. As the water level decreases helpless/low-level farmers find it hard to compete for the energy necessary for developing deeper wells which at last leads to a decrease in food production. Therefore it is not unnecessary to bring up an earnest requirement for the protection of this vital asset for the safeguarding of natural

Akshay Raj Manocha Ajay Kumar Bhart Singh

security and reasonable agricultural development [2].

Overexploitation impact of groundwater

The main impact of overexploitation of groundwater exhaust of the base stream. If the base stream is diminished, different crucial extra effects happen. some are described below

- Dry up of shallow aquifer
- Reduction of vegetation cover and decrease in wetland area
- Changes in drainage pattern
- Speed up in the land degradation
- Frequent conditions of dryland areas
- Scarcity of flora and fauna
- Well interference

Different effects of groundwater exhaustion are serious emergencies safe drinking water and irrigated water.

Techniques to deal with groundwater Management

The problem of groundwater is that the department is multidirectional, connected with solid evaluation of accessible water, its usage, and purpose for expansion, scattering and decrease overexploitation, However, similar to surface water assets executives, very little effort has been made by the management board for water assets. The two generally accepted methodologies for groundwater executives are the discussed below:

Manage safe yield: This strategy considers the conscious to control on utilization of capacity through re-charging occasions.

Stop overexploitation: This helps that some long-lasting consumption might be important to advance socioeconomic improvement where regenerating is restricted.

The administration choices of groundwater in developed regions depend on pattern of water usage, and the obligation generally with supply and utilities, also similar to people. Village people take out groundwater through tube wells which they have built and own [5]. Whereas, huge scope, publicly financed tube-well advancement will increase the supply outcome; lawful and administrative arrangements at the public level can't be controlled enough; and, increase of indirect re-charge may work for the shallow level groundwater movements, also the

regeneration of the deeper level of frameworks requires clear infusion and elective wellsprings of good quality water. [3] in this context, two wide kinds of executive's come up with for groundwater arise: (I) approaches enveloping instruments, for example, power estimating, subsidies for effective advancements, economic arrangements that support less water bearing crops, and (ii) approaches managing explicit aquifers based on order and control the executives through an asset controller [6]. Whichever approach is taken, the advancement and the board of these assets should be founded on a piece of sufficient information on a reasonable total status/circumstance of the groundwater aquifer system and its renewal. With regards to the effect of environment fluctuation and spatial inconstancy in dryland areas, two significant variations gaps in groundwater the board arise, with critical results for exact usage (I) inability to adapt to the speed of increase of degradation of groundwater system by over-deliberation, and effective asset consumption from the quality differs (contamination, salinity), and (ii) unable to explore the groundwater resources administrations on multiple usage and ecological externalities [9].

Methods of Recharging

Getting significant resources of water and rising interest to develop more resources for the coming generation we have to put efforts for increase in groundwater level by looking for compelling methods [9]. For a successful administration, it is important to have full information on groundwater scenario that administer the production and movement of groundwater resources under deliberation stress, the cooperation of land and groundwater with stream base movement, and changes in stream of river and regenerating dates because of their overuse. Groundwater the executive's policies therefore should address a large number of issues including:

- The executives of provisions to further develop water accessibility in existence
- The executives of requests including the effectiveness of water use, sectoral connection with monetary exercises, and so on

- Adjusting contending requests and protection of the honesty of water subordinate eco-environment.

The popular side administration's financial aspect assumes a significant part including dealing with the people using the water and land. Simple administrative mediations like water usage freedom and licenses and monetary devices of water valuing and so forth can't be useful until the different areas people are completely involved [11]. For proper care of groundwater assets, there is a need to make people aware of the different societies using water and exercise region explicit designs for supportable development [15]. Consequently, groundwater board members not just require appropriate evaluation of accessible assets and comprehension of interconnection among surface and groundwater systems, yet additionally activities expected for proper resources allocation and avoidance of the unfriendly impacts of overexploitation of groundwater. Maintainable improvement and the executive's members of water management requires to follow the certain techniques:

1. Logical Advancement of Groundwater

Logical advancement of groundwater includes a legitimate comprehension of the nearby groundwater accessibility, its conduct, and request-driven advancement with logical arranging [23]. The requirement for logical advancement of water resource includes are as:

Advancement of multiple aquifers: In most regions of our country many springs are not completely used or created it leads to the underuse of reachable groundwater assets [20]. The unused water from deep tube well/springs are very common in some portion of the areas including Panjab, Haryana and Utter Pradesh, which has brought about close to still conditions at a deep level and gave the essential time for the finishing the quality of groundwater. It is obvious that the extended aquifer of the permeable soil is not completely exhaustible in upper ranges and the unused groundwater in restricted springs, is now shift to the saline springs nearby the bowl limit [22]. This improvement of profound springs is

significant for the advancement and the improvement of groundwater for proper use.

Improvement of groundwater in under-develop regions: Scheme creators regularly pay consideration regarding the districts where groundwater improvement has extraordinary potential and disregard different regions with stowed away potential. In India, the eastern and northeastern locale is still to create groundwater tube wells. The majority of poor farmers find it hard to increase irrigation creation because of the non-accessibility of groundwater [23]. Here is a huge degree of improvement of groundwater here floods frequently during monsoon.

Improvement of water logging areas: The water logging fields are great supplies of groundwater. Subsequently, the economic administration of flood area aquifers gives amazing options for its improvement and extra necessity of water. The improvement of groundwater in the flood plain of Yamuna in Delhi is an illustration of the technical administration of groundwater assets. Improvement of shallow level springs in flood field areas makes the essential sub-surface area for expansion of groundwater from the stream excess in the rainy season [25]. Spontaneous administration is a successful administration tool to get to the hole of requirement and deliver in regions near streams with dynamic flood fields. Subsequently, appropriate improvement of flood plain aquifer is essential for groundwater advancement and the executives [23].

Improvement of groundwater in the waterlogged regions: The waterlogged regions in channels order tells degrees for underground water improvement of water lever by five meter or more. The substandard nature of water can be blended in with channel water to an extent adequate for the water system. Hence extra water used for agriculture can be made and the lower water table will be used to bring up the monsoon season and recharging in the regions that will be used to improve land and groundwater quality [25].

Improvement of water in Catchment area: it is the compelling systems for reasonable groundwater for the executives is to involve water resources for region and use

the re-charge by improvement of water resources in regions adjoining the catchment area. consequently, not just in legitimate usage of accessible water assets yet in addition in bringing the groundwater from surface groundwater capacity will give underground drainage to the regions, which are probably going to be blocked or waterlogged [28].

Aside from these huge improvement of groundwater in waterfront regions likewise should be tended for the judicial use of water resources [18].

2. Artificial Recharge of the Groundwater

One more successful technique is an expansion of accessible groundwater assets through different modes like rainwater harvesting and artificial regeneration. It is assessed that yearly around 40.8BCM of excess surface runover can be re-charged to increase the groundwater [17]. In rural regions, strategies of artificial re-generation by alteration of local development of water from appropriate common designs like collecting tanks, small tanks, ditches, furrows, nala bunds and so on is seen as practical. The rooftop topwater collecting structure is normally practical both by increasing the groundwater storage also by putting away it in uniquely assembled tanks [14].

3. Guideline of groundwater Development

The significant methodologies for feasible administration of groundwater are the guideline of groundwater improvement in basic regions and local regions. More and more improvement of groundwater assets is progressively coming up and being recognized as a significant issue. The propensity to look towards over advancement of groundwater assets is established in the quick response of empowered pumping technics, resources attributes, segment movements, and government strategies [19]. There are very few efforts to take a look at the overexploitation and guideline of groundwater assets. Now in recent times, the main real administration is by restricting National bank for agriculture and rural development. funds in blocks that are classified as grey and dark. Gujarat Government approved the groundwater

executives Act for managing and controlling the utilization of groundwater [27]. Anyway, it isn't simple to execute the regulations without local consent and proper demonstration camps various regions.

4. Guaranteeing water resource for Farming

Most important threat is the judicial utilization of resources in areas short of disturbing the water level and farming productions. So, any maintainable technique depends on the evaluation of the real water level to be designated for local homes to use, horticulture, and keeping up with ecosystem balance [23]. All the more specifically, it should have more focus on the cost-adequate investigation involving water for various use, skilled and improved water level development, agricultural productivity, and post-seeding handling [22]. A portion of the successful methodologies, that is much prevalent in country include:

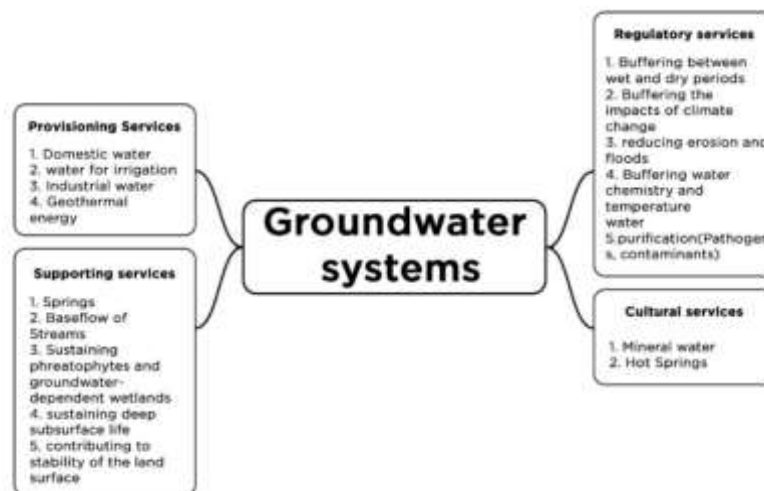
1. Support the non-delicate groundwater using people to change from exhaustion of great quality of water level to normal quality of groundwater for the most important groundwater use.
2. Proper comeback of deliberation freedoms from ventures where poor people introduced water-proficient innovations.
3. Give subsidies to working people for improvement in the water level used by the peri-urban regions in return for water resources exploitation.

5. Understanding quality of Water resources

An important requirement is to understand the contamination of water resources and its recovery from contamination can be guaranteed in multiple methods including:

1. Planning weakness maps, in light of appropriation of travel times, synthetic boundaries, kinds of dirt, subsoil, and landcover.
2. Identify and focusing on potential zone of water resource.
3. Low lying areas are more prone to groundwater weakness
4. Confining private advancement is served by inducing disinfection.
5. Confining the removal of modern releases to the ground in weak regions through the presentation of release allows proper

charging to energize reusing and decrease.



Groundwater services and Functions

Shortcomings in Existing Approaches

However there exist different systems for an economical administration of groundwater assets, it frequently neglects to make any sure effect on the manageable use because of several reasons. Because of the nonappearance of any valuing system and severe guidelines, unpredictable water resources, its inefficient use and soil removal waste material continued. work on groundwater use in the financial setting is somewhat little, the exceptionally specialized information on the aquifers systems is of somewhat very less use for proper practical management reasons. The vast majority of the groundwater land and hydro-land improvement technology has been divided, technocratic, and connected with the groundwater movement and damages. The functional administration rehearses, it is irrelevant to look at all user's indigenous adaptive methodologies, environmental change reactions, and so on. Anyway, in recent times' situation, less consideration has been given to these regions. For the understanding of groundwater, the most important components that might be important to consider are as follows: (I) the most essential worth of the groundwater situated close to 'high-value' uses like urban areas or prime farming regions, rather than springs situated in less essential areas and (ii) water bearing rock with excellent water that is not polluted with waste and the kinds of people using it.

Necessity for the Sustainable Approach

Akshay Raj Manocha Ajay Kumar Bhart Singh

The guaranty for food and ecological security are the main worldwide problem of the 21st century. With respect to the sensational advantage made in irrigation development, we have few areas of our country where food production has not kept tempo with the increment in the populace or have scarcely stayed up with the increment in the populace. Even though slowdown in agriculture production due to environmental implications, alteration of land use and absence of suitable innovation to area the fundamental problem of asset activation and the board members might be the essential variables liable for less farm production. Water shortage and bad water quality are the central issues in various nations, which primarily depend upon agriculture for the job of individuals. New water accessibility is as of now the main consideration in the feasible utilization of assets. The water, shortage is additionally highlighted by underground and surface water contamination. UNDP tells about the world land and soils assets critically affect are likely to bring up the greenhouse impact. As it is inappropriate to give the note that proper water usage planning plays an important part in social security and natural security in the current time described by expanding clashes due to scarcity water resources.

As different techniques on groundwater, the executive member clearly tells that effective management of groundwater needs to be a cross-cutting and holistic methodology consolidating all partners, technocrats,

hydro-land conditions, nearby explicit ecological issues, native techniques for water preservation and consume, etc. The suitable use of groundwater there should be a proper strategy taking into account every one of the multi-faceted parts of these issues of freshwater shortage and over-usage. There is a requirement for appropriate regulation to make rainwater gathering compulsory in all private and public structures, particularly in developed regions. There should also be awareness creation camps about the importance of re-charging and reusing groundwater among the locals through different media. The people using freshwater should always conduct a water review to check how much freshwater can also be saved and utilized. The unused wastewater can also be recycled and also reused in working with natural exercises. At last, any plan won't work without the support of individuals, and the local state running administrations are inspired what's more prepared. With people, group investment and embracing locally accessible methods for water conservation designs can change the existences of millions. In this way taking requirements connected people with appropriate management and security of groundwater source versus the move should have been made at various ranges, a multipronged coordinated approach has thoroughly thought-out blend of expert, specialized managerial and legitimate steps and local area interest might give the way for accomplishing the requirement for laying a solid natural establishment for guaranteeing practical management of groundwater assets.

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