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Ground Water Resources

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Abstract

Groundwater is the most preferred source of water in various user sectors in India on account of its near universal availability, dependability and low capital cost. The increasing dependence on ground water as a reliable source of water has resulted in indiscriminate extraction in various parts of the country without due regard to the recharging capacities of aquifers and other environmental factors. On the other hand, there are areas in the country, where ground water development is sub-optimal in spite of the availability of sufficient resources, and canal command areas suffering from problems of water logging and soil salinity due to the gradual rise in ground water levels. As per the latest assessment, the annual replenishable ground water resource of country has been estimated as 433 billion cubic meter (bcm), out of which 399 bcm is considered to be available for development for various uses. The irrigation sector remains the major consumer of ground water, accounting for 92% of its annual withdrawal. The development of ground water in the country is highly uneven and shows considerable variations from place to place. Though the overall stage of ground water development is about 58%, the average stage of ground water development in North Western Plain States is much higher (98%) when compared to the Eastern Plain States (43%) and Central Plain States (42%). Management of ground water resources in the Indian context is an extremely complex proposition. The highly uneven distribution and its utilization make it impossible to have single management strategy for the country as a whole. Any strategy for scientific management of ground water resources should involve a combination of supply side and demand side measures depending on the regional setting.

Introduction

Water resources are under major around the world. Rivers, lakes, and underground aquifers supply fresh water for irrigation, drinking sanitation, while the oceans provide habitat for a large share of the planet’s food supply. Today, however, expansion of agriculture,damming, diversion, over-use, and pollution threaten these irreplaceable resources in many part of the globe. Scientists widely predict that global climate change will have profound impacts on the hydrologic cycle, and that in many cases these effects will make existing water challenges work . As we well see in detail in Unit 12.”Earth’s changing climate,’rising global temperatures well alter rainfall patterns, making them stronger in some regions and weaker in other, and may make storms more frequent and severe in some areas of the world. In sum, climate change is likely to make many of the water management challenges that are outlined in this unit even more complex than they are today. In order to address various issues related to ground water, keeping in view the climatic change, there is a need to prepare a comprehensive road map with identified strategies for scientific and sustainable management of the available ground water resources in the country so as to avert the looming water crisis. In addition to addressing the issues of declining water level, the strategies should also focus on the imbalances in ground water development in the country, reasons thereof and suggesting measures including accelerated development of ground water in areas with low stage of ground water development.

Water on planet Earth

The total amount of available water on the Earth amounts to some $1.5x10^9$ km^3. The dominant part of this, $1.4x10^9$ km^3, resides in the oceans. About $29x10^6$ km^3 are locked up in land ice and glaciers and some $15x10^6$ km^3 are estimated to exist as groundwater. If all land ice and glaciers were to melt the sea level would rise some 80 m (Baumgartner and Reichel 1975). $13x10^3$ km^3 of water vapour are found in the atmosphere corresponding to a global average of 26 kg m^{-2} or 26 mm m^{-2} of water for each column of air on the surface of the Earth. There are large geographical differences such as between low and high latitudes. Figure 1 shows an estimate of the global water exchange between ocean and land, an annual average in units of 10^3 km^3 (Baumgartner and Reichel 1975). An updated version can be found in Trenberth *et al* 2007 (their figure 1) showing broadly similar results

The hydrological cycle of the world's oceans interacts differently with that of the continents. Most of the water from the Pacific Ocean recirculates between different parts of the Pacific itself, as and there is little net transport towards land. The pattern of water exchange between ocean and land is different in the Atlantic and Indian Oceans. Two thirds of the total net transport of water towards the continents comes from the Atlantic Ocean, with the rest essentially from the Indian Ocean. Most of the continental water for North and South America, Europe and Africa emanates from the Atlantic and is also returned to the Atlantic by the rivers continental water for North and South America, Europe and Africa emanates from the Atlantic and is also returned to the Atlantic by the rivers There is widespread evaporation (maximum some 2 m $year^{-1}$) on each side of the inter-tropical convergence zone (ITCZ), transporting water vapor into the ITCZ and into the storm tracks of high latitudes. Conversely, in regions of net evaporation ocean salinity is increasing, leading to increased ocean vertical mixing. In the ITCZ and in the extra-tropical storm tracks ocean salinity is decreasing due to high precipitation thus reducing ocean vertical mixing. This means that moisture convergence in the atmosphere is compensated for by moisture divergence (salinity convergence) and vice versa in the oceans, which can be seen as a counterpart to the atmospheric circulation (Webster 1994)

Atmospheric water vapour is measured both from space and from *in situ* observations and analysed in detail both by the operational weather services and through different re-analysis programs (e.g. Uppala *et al* 2005, Onogi *et al* 2007). However, while data for atmospheric water vapour are generally well observed we are much less comfortable with observations of precipitation. Precipitation has a large variance on small time and space scales and current observing systems cannot sample this sufficiently

Hydrogeological Set –up of the Country:

India is a vast country with a highly diversified hydrogeologic set-up. The ground water behavior in the Indian sub-continent is highly complicated due to the occurrence of diversified geological formations with considerable lithological and chronological variations, complex tectonic framework, climatological dissimilarities and various hydrochemical conditions. The rock formations range in age from Archaean to

Quaternary-Recent period. The Archaean rocks are present in the southern states where as the recent sediments are confined to Indo-Gangetic alluvial plains. The major Geological Formations are the –

1) Consolidated formations represented by Igneous & Metamorphic rocks with major rock types consisting of granites, Charnockites, Quartzites & associated Phyllite, slate etc; basalts & associated igneous rocks.
2) The semi consolidated rock formations are represented by rocks of Mesozoic & tertiary period with major rock types represented by limestone, sandstone, pebbles & boulder conglomerates.
3) The unconsolidated formations belong to Pleistocene to recent period & represented by major rocks such as boulders, pebbles, different grade of sands, silt-clay. These rocks form the major potential aquifer zones.

The Indian sub continent is occupied by major geological rock types such as metamorphics of pre Cambrian period, Igneous rocks represented by basaltic rocks of Cretaceous-Eocene period, Gondwana & Vindhyan rocks which are overlain by quaternary to recent sedimentary deposits .The distribution of these rock types are given in geological map

Ground Water Resources Availability:

Rainfall is the major source of ground water recharge in India, which is supplemented by other sources such as recharge from canals, irrigated fields and surface water bodies. A major part of the ground water withdrawal takes place from the upper unconfined aquifers, which are also the active recharge zones and holds the replenishable ground water resource. The replenishable ground water resource in the active recharge zone in the country has been assessed by Central Ground Water Board jointly with the concerned State Government authorities. The assessment was carried out with Block/Mandal/Taluka/Watershed as the unit and as per norms recommended by the Ground Water Estimation Committee (GEC)-1997. As per the latest assessment, the annual replenishable ground water resource in this zone has been estimated as 432 billion cubic meter (bcm), out of which 399 bcm is considered to be available for development for various uses after keeping 34 bcm for natural discharge during non-monsoon period for maintaining flows in springs, rivers and streams (Central Ground Water Board, 2006).

Ground water extraction for various uses and evapotranspiration from shallow water table areas constitute the major components of ground water draft. In general, the irrigation sector remains the main consumer of ground water. The ground water draft for the country as a whole has been estimated as 231 bcm Central Ground Water Board, 2006), about 92 percent of which is utilized for irrigation and the remaining 8 percent for domestic and industrial uses. Hence, the stage of ground water development, computed as the ratio of ground water draft to total replenishable resource, works out as about 58 percent for the country as a whole. However, the development of ground water in the country is highly uneven and shows considerable variations from place to place. As a part of the resource estimation following the GEC norms, the assessment units have been categorized based on the stage of ground water development and long term declining trend of ground water levels. As per the assessment, out of the total of 5723 assessment units in the country, ground water development was found to exceed more than 100 % of the natural replenishment in 839 units (14.7 %) which have been categorized as ‘Over-exploited’. Ground water development was found to be to the extent of 90 to 100 percent of the utilizable resources in 226 assessment units (3.9 %), which have been categorized as ‘Critical’. 550 assessment units with stage of ground water development in the range of 70 to 100 % and long-term decline of water levels either during pre- or post-monsoon period have been categorized as ‘Semi-Critical’ and 4078 assessment units with stage of ground water development below 70% have been categorized as ‘Safe’. 30 assessment units have been excluded from the assessment due to the salinity of ground water in the aquifers in the replenishable zone. Salient details of ground water resource availability, utilization, stage of development and categorization of assessment units for the above Regions of the country is given in geographic distribution of various categories of assessment units is shown in **.** In addition to the resources available in the zone of water level fluctuation, extensive ground water resources have been proven to occur in the deeper confined aquifers in the country, a major chunk of which is in the Ganga-Brahmaputra alluvial plains (Romani, 2006). Such resources are also available in the deltaic and coastal aquifers to a lesser extent. These aquifers have their recharge zones in the upper reaches of the basins. The resources in these deep-seated aquifers are termed ‘In-storage ground water resources’. The quantum of these resources has been tentatively estimated as ~10,800 bcm. Though the ground water resources in these aquifers are being exploited to a limited extent in parts of Punjab, Haryana and western Uttar Pradesh, detailed studies are to be taken up to fully understand the yield potentials and characteristics of these aquifers.

Sr. No	Regions	Annual Replenishable Ground Water Resource (bcm)	Natural Discharge during non-monsoon season (bcm)	Net Annual Ground Water Available (bcm)	Annual Ground Water Draft (bcm)	Stage of Ground Water Developmen t (%)	Categorization of Assessment Units (Blocks / Mandals)		
							Total Assessment Units	Over Exploited, Nos / %	Critical Nos / %
	2	3	4	5	6	7	8	9	10
1	NorthernHimalayan states	5.4	0.48	4.92	1.84	37	30	2 / 6.67	0
2	North Eastern Hilly States	33.99	3.02	30.98	5.63	18	118	0/0	0
3	Eastern Plain States	111.63	9.03	102.5	43.97	43	1895	1/ .05	2/.11
4	North Western Plain States	80.78	6.92	73.85	72.17	98	277	201/72.56	28/10.11
5	Western aridRegion	27.38	1.97	25.4	24.48	96	462	172/37.23	62/13.42
6	Central Plateau States	90.723	5.19	85.53	36.11	42	985	31/3.15	6/.61
7	Southern Peninsular States	82.78	7.14	75.65	46.4	61	1946	432/22.2	128/6.58
8	Islands	0.34	0.01	0.32	0.01	4	10	0	0
Country Total		**433.02**	**33.77**	**399.26**	**230.63**	**58**	**5723**	**839**	**226**

Dynamic Fresh Ground Water Resources

As per the 2017 assessment of Dynamic Ground water resources, the Total Annual Ground Water Recharge for the entire country has been assessed as 432 billion cubic meter (bcm) and Total natural discharges works out to be 39 bcm. Hence, Annual extractable

Ground Water Resources for the entire country is 393 bcm Major source of ground water recharge is the monsoon rainfall, which is about 58% of the total annual ground water recharge i.e. 252 bcm (Fig.6.1). The overall contribution of rainfall (both monsoon & non-monsoon) to country's total annual Ground water recharge is 67% and the share of other sources viz. canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures taken together is 33%. The contribution in Annual Ground Water Recharge from rainfall during monsoon season is more than 70% in the states/UT of Assam, Goa, Gujarat, Jharkhand, Madhya Pradesh, Meghalaya, Mizoram, Nagaland, Rajasthan, Sikkim, Andaman & Nicobar, Dadra & Nagar Haveli Daman & Diu and Lakshadweep. State-wise Ground Water Resources of India (as on 31st March 2017) are given in **Annexure I** and the district-wise figures for each State are given in **Annexure II**. The over-all scenario of ground water resource and extraction in the country is given .

Conclusion

Volumetric estimates are dependent on the areal extent of the assessment units. In order to compare the ground water resource of different assessment units, the volumetric estimates of annual ground water recharge have been converted to depth units (m) by dividing the annual groundwater recharge by the area of the respective assessment units (km^2). Spatial variation in annual ground water recharge (m) is shown in**.** Annual Groundwater recharge is significantly high in the Indus-Ganga-Brahmaputra alluvial belt in the North, East and North East India covering the states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and valley areas of North Eastern States, where rainfall is plenty and thick piles of unconsolidated alluvial formations are conducive for recharge. Annual Ground Water Recharge in these regions varies from 0.25 to more than 0.5 m. The coastal alluvial belt particularly Eastern Coast also has relatively high annual ground water recharge, in the range 0.25 to more than 0.5 m. In western India, particularly Rajasthan and parts of northern Gujarat that have arid climate, the annual ground water recharge is scanty, mostly up to 0.025 m. Similarly, in major parts of the southern peninsula covered with hard rock terrains, annual ground water recharge mostly ranges from 0.10 to 0.15m. This is primarily because of comparatively low infiltration and storage capacity of the rock formations prevailing in the region. The remaining part of Central India is mostly characterized by moderate recharge in the range of 0.10 to 0.25 m. The overall estimate of Annual Ground Water Recharge for the entire country shows a decrease of 15 bcm in the present estimate as compared to the last assessment i.e. 2013. The Annual Ground water extraction for irrigation, domestic and Industrial uses has also decreased by 4.35bcm. The main reasons for these variations is attributed to changes in methodology, refinement of parameters for resources estimation, refinement in well census data and changing ground water regime.

REFERENCES

- Central Ground Water Board (1995) Ground Water Resource of India. Ministry of Water Resources, Govt. of India, Faridabad.
- Central Ground Water Board (2015) Report of the Ground Water Resource Estimation Committee Ministry of Water Resources, Govt. of India. http://cgwb.gov.in/Documents/GEC2015_Report_Final%2030.10.2017.pdf

- Jha B.M.. (2007) , Management of Ground water resources for Ensuring Food Security in India, National Ground Water Congress, New Delhi
- Llamas, M. Ramon, Mukherjee, Aditi and Shah, Tushaar (2006), Guest editors' preface on the theme issue "Social and economic aspects of groundwater governance. Hydrogeology Journal, vol. 14(3), pp. 269-274.

