Surface and ground water studies in India during 2019-2022

V.M. Tiwari* and N. Srinivas
CSIR-National Geophysical Research Institute, Uppal Road, Hyderabad-500007, India
*Corresponding Author: virendra.m.tiwari@gmail.com

ABSTRACT

The present work documents a concise overview of research and development activities in the areas of surface and ground water and a short note on the national programs initiated to provide the potable water for public in India. Data from Web of Science for the four calendar years (2019 - 2022), indicate that about ~ 1600 peer-reviewed papers authored by at least one researcher affiliated to Indian institution, were published on the topic related to the surface water and ground water (both quantity and quality), which suggests the breadth of research being carried out in the country. The research activities conducted during the period 2019 - 2022 in India have contributed significantly to deepening the understanding of surface hydrological processes, aquifer mapping, water quality monitoring, water resources management, and climate change impacts. The government programs are focused to implement projects to recharge/conserve the water resources and recycle/reuse of the treated wastewater, for meeting the water demand and providing enough clean water to every rural/urban family in India.

WATER RESOURCES OF INDIA AND THEIR MONITORING

Annual rainfall over the Indian territorial region is ~ 3,830 Billion Cubic Metre (BCM) and utilizable water resource is about 1,122 BCM, which includes 432 BCM of ground water and 690 BCM of surface water (MoSPI, 2009). These estimates change from time to time depending upon the amount of rainfall during the specific year. As per a recent report, the total water requirement of the country for the years 2025 and 2050 are 843 BCM and 1180 BCM respectively, which are in the order of the annual water availability. However, the uneven distribution of water, poses future challenge of its adequate availability. India’s water requirement is mostly met from the twenty river basins and hydro-meteorological related data to all the river basins is recorded in a systematic manner by the relevant government departments and institutes for monitoring, planning and development of water resource projects, and research purposes. The surface water levels, discharge, water quality and silt are recorded in the all twenty river basins by the Central Water Commission (CWC) through a well distributed network of 1543 hydrological observation (HO) stations and 187 meteorological observation stations. Snowfall observations are also recorded at some crucial stations. Glacial lakes, stored glacial ice melts sometimes lead to flash floods in the downstream reaches. Therefore, CWC also monitors about 475 glacial lakes and water bodies in higher reaches of the Himalaya, having dimension of more than 50 Ha water spread area. Similarly, the ground water levels of 22835 ground water observation wells (Dug Wells: 16271, Piezometers: 6394, Hand Pump: 129, spring: 41) spread across India in a network, are being monitored by the Central Ground Water Board (CGWB). The same wells are utilized to collect ground water samples which are analysed to determine the chemical quality of ground water and its variation over the time. A review of knowledge of hydrology and water resources engineering in ancient India has been reported earlier by Singh et al. (2020).

Total annual ground water recharge over the entire country is ~ 438 BCM, which is estimated based on a standard methodology (GEC-2015) of rainfall and recharge relation, including other related parameters (CGWB, 2022). Satellite based data from the GRACE and GRACE-FO missions, also allow to quantify the water storage changes and spatio-temporal variabilities. Satellite derived Terrestrial Water Storage (TWS) data are widely analysed and studied (e.g. Munagapati et al., 2021). In India, presently, ~ 83 per cent of the water resources are used for irrigation and the rest are utilized for drinking, domestic, industrial and recreational purposes. Since 1960’s, the water demand has increased in many ways due to the rapidly growing population, urbanization, industrialization and irrigation demands. Figure 1 shows the assessment of recharge versus exploitation. It is obvious from the Figure 1 that a considerable part of the country is classified as ground water overexploited, critical and semi-critical, which is also reflected in satellite-based estimates of decreasing ground water storage (Munagapati et al., 2021; Panda et al., 2022).

A continuous declining trend of TWS and ground water over exploited regions in northern India, are probably caused by a combination of climatic and anthropogenic factors, whereas, a substantial increase in TWS over the Narmada river basin region appears to be mainly caused by the water storage rise in the surface reservoir (Munagapati et al., 2021; Dangar et al., 2021). During the period of 2002-2016, the Ganga basin lost ~225 km$^3$ of ground water, which is equivalent to approximately 20 times the storage capacity of India's largest reservoir, Indira Sagar. An alarming 95% of India's ground water loss (498 km$^3$) occurred between 2002 and 2022 in the northern region of the country, a global hotspot for ground water depletion (Dangar and Mishra, 2021).