JEB®

Journal of Environmental Biology

p-ISSN: 0254-8704 • e-ISSN: 2394-0379 • CODEN: JEBIDP

Journal website : www.jeb.co.in ★ **E-mail :** editor@jeb.co.in

Triveni Enterprises
(Educational Services Set-up)

Editorial

DOI : http://doi.org/10.22438/jeb/43/3/Editorial

Innovative ecological approaches to ensure clean and adequate water for all

T.V. Ramachandra

Associate Editor, Journal of Environmental Biology, Lucknow, India

Co-ordinator, Energy & Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore-560 012, India

Email : tvr@iisc.ac.in; envis.ces@iisc.ac.in; **Web:** http://wgbis.ces.iisc.ernet.in/energy

The Western Ghats, a range of ancient hills extends between 8° N and 21° N latitude, and 73° E and 77° E longitude(from the tip of peninsular India at Kanyakumari to Gujarat). The Western Ghats runs parallel to the west coast of India, covering approximately 160,000 sq. km, which constitutes less than 5% of India's geographical extent. Numerous streams originate in the Western Ghats, which drain millions of hectares, ensuring water and food security for 245 million people and hence are aptly known as the water tower of peninsular India(Ramachandra and Bharath, 2019; Bharath et al., 2021). The region is endowed with diverse ecological regions depending on altitude, latitude, rainfall, and soil characteristics. The Western Ghats are among the eight hottest hotspots of biodiversity and 36 global biodiversity hotspots with exceptional endemic flora and fauna. Natural forests of Western Ghats have been providing various goods and services and are endowed with species of 4,600+ flowering plants (38% endemics), 330 butterflies (11% endemics), 156 reptiles (62% endemics), 508 birds (4% endemics), 120 mammals (12% endemics), 289 fishes (41% endemics) and 135 amphibians (75% endemics).

The Western Ghats, gifted with enormous natural resource potential, and the mandate of sustainable development based on the foundation of prudent management of ecosystems, is yet a reality. Various unplanned developmental programs, which are proclaimed to be functioning on sustainability principles, have only been disrupting the complex web of life, impacting ecosystems, and causing a decline in overall productivity, including four major sectors: forestry, fisheries, agriculture, and water (Ramachandra and Bharath, 2019).The prevalence of barren hilltops, conversion of perennial streams to intermittent or seasonal streams, frequent floods and droughts, changes in water quality, soil erosion and sedimentation, the decline of endemic flora, and fauna, etc. highlights the consequences of unplanned developmental activities with a huge loss to the regional economy during the last century. The development goals need to be ecologically, economically, and socially sustainable, which can be achieved through the conservation and prudent management of ecosystems. Sustainability implies the equilibrium between society, ecosystem integrity, and sustenance of natural resources.

Water sustenance in streams and rivers depends on the integrity of the catchment (watershed), as vegetation helps in retarding the velocity of water by allowing impoundment and recharging of groundwater through infiltration (Ramachandra *et al.*, 2020). As water moves in the terrestrial ecosystem, part of it is percolated (recharging groundwater resources and contributing to sub-surface flow during post-monsoon seasons), while another fraction gets back to the atmosphere through evaporation and transpiration. Forests with native vegetation act as a sponge by retaining and regulating water transfer between land and the atmosphere. The mechanism by which vegetation controls flow regime is dependent on various bio-physiographic characteristics, namely, type of vegetation, species composition, maturity, density, root density and depth, hydro-climatic condition, etc. Roots of vegetation help (i) in binding soil, ii) improve soil structure by enhancing the stability of aggregates, which provide habitat for diverse microfauna and flora, leading to higher porosity of the soil, thereby creating the conduit for infiltration through the soil. An undisturbed native forest has a consistent hydrologic regime with sustained flows during lean seasons. Native species of vegetation with the assemblage of diverse native species help in recharging the groundwater, mitigating floods, and other hydro-ecological processes (Ramachandra *et al*., 2020; Bharath *et al*., 2021). Hence, it necessitates safeguarding and maintaining native forest patches and restoring existing degraded lands to sustain the hydrological regime, which caters to biotic (ecological and societal) demands.

A comparative assessment of people's livelihood with soil water properties and water availability in sub-catchments of four major river basins in the Western Ghats reveals that streams in catchments with > 60% vegetation of native species are perennial with higher soil moisture (Ramachandra *et al*., 2020). The higher soil moisture due to water availability during all seasons facilitates farming of commercial crops with higher economic returns to the farmers, unlike the farmers who face water crises during the lean season. In contrast, streams are intermittent (6-8 months of water) in catchments dominated by monoculture plantations and seasonal (4 months, monsoon period) in catchments with vegetation cover lower than 30%. The study highlights the need to maintain ecosystem integrity to sustain water. Also, lower instances of COVID 19 in villages with native forests emphasize ecosystems' role in maintaining the health of biota.The need to maintain native vegetation in the catchment and its potential to support people's livelihood with water availability at local and regional levels

is evident from the revenue of Rs. Rs.2,74,658 ha^{-1} yr^{-1} (in villages with perennial streams and farmers growing cash crops or three crops a year due to water availability), Rs. 1,50,679 ha^{-1} yr^{-1} (in villages with intermittent streams) and Rs. 80000 ha^{-1} yr^{-1} (in villages with seasonal streams). Also, the crop yield (at least 1.5 to 1.8 times) is higher in agriculture fields due to efficient pollination with the prevalence of diverse pollinators in the vicinity of native forests. The study emphasizes the need for maintaining the natural flow regime and prudent management of watershed to i) sustain higher faunal diversity, ii) maintain the health of water body, and iii) sustain people's livelihood with higher revenues. Hence, the premium should be on conserving the forests with native species to sustain water and biotic diversity in the water bodies, vital for food security. There still exists a chance to restore the lost natural ecosystems through appropriate ecological restoration approaches, with location-specific conservation and management practices to ensure adequate and clean water for all.

GDP (Gross Domestic Product), a measure of the current economic well-being of a population, based on the market exchange of material well-being, will indicate resource depletion/degradation only through a positive gain in the economy and will not represent the decline in these assets (wealth) at all. Thus, the existing GDP growth percentages used as yardsticks to measure the development and well-being of citizens in decision-making processes are substantially misleading, yet they are being used. The traditional national accounts need to include resource depletion or degradation due to developmental activities and climate change. The country should move toward adopting Green GDP by accounting for the environmental consequences of the growth in the conventional GDP, which entails monetizing the services provided by ecosystems, the degradation cost of ecosystems, and accounts for costs caused by climate change.

The forest ecosystems are under severe threat due to anthropogenic pressures, which are mostly related to the GDP.The appraisal of forest ecosystem services and biodiversity can help clarify trade-offs among conflicting environmental, social, and economic goals in the development and implementation of policies and to improve the management in order biodiversity.Natural capital accounting and valuation of ecosystem services reveal that forest ecosystems provide (i) provisioning services (timber, fuelwood, food, NTFP, medicines, genetic materials) of Rs 2,19,494 ha^{-1} yr^{-1}, (ii) regulating services (global climate regulation - carbon sequestration, soil conservation, and soil fertility, water regulation and groundwater recharge, water purification, pollination, waste treatment, air filtration, local climate regulation) of Rs 3,31,216 ha^{-1} yr^{-1} and (iii) cultural services (aesthetic, spiritual, tourism and recreation, education and scientific research) of Rs.1,04,561 ha^{-1} yr^{-1}. Total ecosystem supply value (TESV), an aggregation of provisioning, regulating, and cultural services, amounts to Rs. 6,56,172 ha^{-1} yr^{-1}, and the Net Present Value (NPV) of one hectare of forests amounts to 16.88 million rupees ha^{-1}. NPV helps in estimating ecological compensation while diverting forest lands for other purposes. The recovery of an ecosystem with respect to its health, integrity, and sustainability is evident from an initiative of planting (500 saplings of 49 native species) in a degraded landscape (dominated by invasive species) of two hectares in the early 1990s at the Indian Institute of Science campus (Ramachandra *et al.*, 2016),and the region has now transformed into a mini forest with numerous benefits such as improvements in groundwater at 3-6 m (compared to 30-40 m in 1990), moderated microclimate (with lower temperature) and numerous fauna (including four families of Slender Loris). While confirming the linkages of hydrology, ecology, and biodiversity, the experiment advocates the need for integrated watershed approaches based on sound ecological and engineering protocols to sustain water and ensure adequate water for all.

A well-known and successful model of integrated wetlands ecosystem (Secondary treatment plant integrated with constructed wetlands and algae pond) at Jakkur Lake in Bangalore (Ramachandra *et al.*, 2018) provides insights into the optimal treatment of wastewater and mitigation of pollution. Complete removal of nutrients and chemical contaminants happens when partially treated sewage (secondary treated) passes through constructed wetlands and algae pond (sedimentation pond), undergoes bio-physical and chemical processes. The water in the lake is almost potable with minimal nutrients and microbial counts. This model has been functioning successfully for the last ten years after interventions to rejuvenate the lake. This system is one of the self-sustainable ways of lake management while benefitting all stakeholders - washing, fishing, irrigation, and local people. Wells in the buffer zone (500 m), now have higher water levels and are without any nutrients (nitrate). Groundwater quality assessment in 25 wells in the same region during 2005 (before the rejuvenation of Jakkur Lake) had higher nitrate values. Adopting this model ensures optimal sewage treatment at decentralized levels, and letting treated water to the lake also provides nutrient-free and clean groundwater.

The Jal Shakti ministry,the Government of India, through Jal Jeevan Mission, has embarked on the noble and novel mission of providing tap water supply to all rural households and public institutions in villages such as schools, health centers, panchayat buildings, etc. The success of this program depends on the availability of water. The imminent threat of acute water scarcity due to climate changes with global warming necessitates implementing integrated watershed development (planting of native species in the watershed of water bodies), rainwater harvesting (rooftop harvesting at individual household levels, and retaining rainwater in rejuvenated lakes, which also helps in recharge of groundwater) and reuse of wastewater through treatment at decentralized levels (a model similar to Jakkur lake at Bangalore). These prudent management initiatives at decentralized levels throughout the country aid in achieving the goals of providing clean and adequate water to the local community.

References

Ramachandra, T.V. and S. Bharath: Carbon sequestration potential of the forest ecosystems in the Western Ghats, a global biodiversity hotspot, *Nat. Resour. Res.*, **29**, 2753–2771 (2020).

Ramachandra, T. V., S. Vinay, S. Bharath, M.D. Subash Chandran and H.A. Bharath: Insights into riverscape dynamics with the hydrological, ecological and social dimensions for water sustenance, *Curr. Sci.*, **118,** 1379-1393 (2020).

Bharath S., K.S. Rajan and T.V. Ramachandra:Modeling Forest Landscape Dynamics. Nova Science Publishers, New York, 248 pages (2021).

Ramachandra, T. V.,K. Gouri, H.A. Bharath, S.Bharath, S. Vinay, and R.B. Harish: Mini forest at Indian Institute of Science: The Success Model for Rejuvenating Ecology and Hydrology in Rapidly Urbanizing Landscapes, Sahyadri Conservation Series 58, ENVIS Technical Report 110, Energy & Wetlands Research Group, CES, IISc, Bangalore, India, 82 pages (2016). http://wgbis.ces.iisc.ernet.in/energy/water/paper/ETR110/index.html

Ramachandra, T. V., V.Sincy, K.S. Asulabha, D.M. Mahapatra, P.B. Sudarshan and H.A. Bharath: Optimal treatment of domestic wastewater through constructed wetlands, *J. Biodivers.,* **9,** 81-102 (2018).