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Hydrogeological Feasibility of Sponge Zone Implementation for Urban Flood Resilience and Groundwater Recharge in Bangalore

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Abstract

The present research scientifically assesses the feasibility of implementing sponge zones in Bengaluru as a nature-based water resource management strategy, to address shallow-aquifer depletion and flash flooding. The methodology encompasses conducting hydrological and hydrogeological investigations, around Bellandur - Varthur valley and Hebbal - Nagavara valley, considering a buffer zone of 2 kms on the either side of the valley, entailing field survey to locate and analyze urban drainage parameters, conduct well inventory, pumping - recovery tests, and gridded geophysical survey. Further, primary data mapping and its integration with Government based validated secondary data, explains the hydrogeological setup of the terrain. Well inventory analysis of 95 borewells in Bellandur Varthur wetland complex reveals a combination of pseudo aquifer conditions, due to continuous hydraulic loading over the weathered formations extending beyond 40 m, along with over-exploitation of ground water resource with water level fallen beyond 24 m, over the last 25 years. Similar analysis of 86 wells in Hebbal - Nagavara valley revealed that construction of basement structures, with excavation depth greater than the bed level of adjacent surface water bodies has developed hydraulic slopes, within the weathered formation and has led to hydrological imbalances. Also, as the seepages ingresses into the plot owing to the tangential flows, the degraded lake water, containing 95% of domestic sewage, saturates the phreatic aquifers with the contaminated water, slowly polluting the pristine ground water also. These afore-mentioned site-based scenarios limit the suitability for implementation of sponge zones. To summarize, Bengaluru's sponge-zone approach can rather be replaced with point recharge structures and inverted borehole mechanisms, designed site-specifically and positioned 2-3 m below the excavation depth of underground basement structures to account for local hydrogeological and drainage conditions, alongside urban-planning considerations.

Keywords: *groundwater recharge; hydrogeological assessment; nature-based water solutions; sponge zone; sustainable water management; urban flood resilience*