# CLIMATE CHANGE-FORCING OF GROUNDWATER RECHARGE IN ARID-SEMI-ARID REGIONS: AN INSIGHT FROM RAJASTHAN

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## ABSTRACT

The term climate change has become synonymous with modern global warming, but from hydrologic standpoint possible increase of mean surface temperature on century-scale is of secondary importance because the scope of hydrologic work is to measure and analyse hydrologic fluxes, and to make meaningful inferences and predictions about them at relevant spatial scales. The climate models simulate various climate change-forcing variables of hydrologic interest at land-atmosphere interface, The variables of regional climate models (RCM) include precipitation, surface air temperature, wind speed etc. that constitute the forcing input variables of hydrologic models.

Natural groundwater recharge occurs by two main mechanisms, namely, first spatially distributed recharge to the aquifer from the vadose zones (diffuse recharge), and second, seepage from the streams and lakes into the underlying aquifer (focussed recharge) (Stone et al, 2001). Stream recharge is possible in sections of the stream channels that are hydraulically connected to the underlying water table. If impermeable strata isolate the aquifer from the surface hydrological cycle no diffuse recharge can take place. Such recharge hydrology plays an important role in climate change scenario for groundwater replenishment in arid-semi-arid regions like Rajasthan, because these regions are sensitive to changes in climate, landcover-landuse, and human interventions.

The Aravalli hill range is a major water divide in Rajasthan. It separates two distinct climatic zones, namely, the western arid zone (Thar desert) (200-500

mm annual rainfall) and the eastern semi-arid zone (500-700 mm annual rainfall). 500 mm isohyet follows the hill range that acts as a barrier to SW monsoon. Evapotranspiration (ET) in the western and the eastern zones is around 200 mm and 140 mm, respectively (Resource Atlas of Rajasthan, 1994). This climatic situation makes groundwater recharge of shallow aquifers in western Rajasthan extremely limited and erratic. This supports the study results in arid and semi-arid regions of Africa where areas with annual rainfall of <200 mm little or no recharge takes place while in areas with annual rainfall in the range 200-500 mm up to 5% (25 mm/yr) contribute to groundwater recharge (Ellers et al, 2007, Edmunds et al, 2000).. Similarly, in India average recharge rates in semi-arid regions range from 46 to 161 mm/yr representing 9-20% of local average seasonal precipitation . The restricted groundwater recharge scenario in arid and semi-arid Rajasthan is caused not only by poor precipitation, but also by the impact of Quaternary climatic and geomorphic factors.

Palaeoclimatic record in Rajasthan shows that the climate fluctuated between arid and humid in the Quaternary period. In the Holocene a wet phase has been recorded at 10-6 ka which was followed by an arid phase during 6-3 ka. The aridity peaked at ca. 3 ka causing the disorganization of the drainage system including the demise of the Vedic Saraswati and disappearance of the Indus valley civilization, Subsequently, the climate became semi-arid in eastern Rajasthan while in western Rajasthan arid condition persists. One of the impacts of Holocene climate change to increased aridity is the production of groundwater calcrete and gypcrete horizons that occur at variable depths both in the vadose and phreatic zones. These hard pan layers act as impermeable seals restricting diffuse groundwater recharge of shallow aquifers while in major drainage basins (e.g. Banas basin) focused recharge is aided by fault-controlled streams that have entrenched the calcrete/gypcrete layers. Post-monsoon rise of 2-5 m of the water table in eastern Rajasthan is spatially non-uniform and is restricted to focussed recharge areas (Sinha-Roy, 2008). While there is little or no diffuse recharge in calcretised alluvial peneplain at low elevations, the Aravalli hill range and the intermontane basins contain bedrock aquifers that are recharged both by diffuse and fault/fracture controlled focussed infiltration.