Journal of Hydrology: Regional Studies 4 (2015) 1–14

Contents lists available at ScienceDirect

Journal of Hydrology: Regional Studies

journal homepage: www.elsevier.com/locate/ejrh

Groundwater systems of the Indian Sub-Continent

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ARTICLE INFO

Article history:
Received 9 March 2015
Received in revised form 9 March 2015
Accepted 9 March 2015
Available online 17 April 2015

Keywords:
Groundwater
Indian Sub-Continent
Irrigation
Aquifer
Groundwater quality

ABSTRACT

The Indian Sub-Continent is one of the most densely populated regions of the world, hosting ~23% of the global population within only ~3% of the world's land area. It encompasses some of the world's largest fluvial systems in the world (River Brahmaputra, Ganges and Indus Basins), which hosts some of the highest yielding aquifers in the world. The distribution of usable groundwater in the region varies considerably and the continued availability of safe water from many of these aquifers (e.g. Bengal Basin) is constrained by the presence of natural contaminants. Further, the trans-boundary nature of the aquifers in the Indian Sub-Continent makes groundwater resource a potentially politically sensitive issue, particularly since this region is the largest user of groundwater resources in the world. Indeed, there is considerable concern regarding dwindling well yield and declining groundwater levels, even for the highly productive aquifers. Though irrigation already accounts for >85% of the total ground water extraction of the region, there is a mounting pressure on aquifers for food security of the region. Highly variable precipitation, hydrogeological conditions and predicted, impending climate change effects provide substantial challenges to groundwater management. The observed presence of natural groundwater contaminants together with the growing demand for irrigated food production and predicted climate change further complicate the development of strategies for using groundwater resources sustainably. We provide an introduction and overview of 11 articles, collated in this special issue, which describe the current condition of vulnerable groundwater resources across the Indian Sub-Continent.

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http://dx.doi.org/10.1016/j.ejrh.2015.03.005

1. Overview of the groundwater systems in the Indian Sub-Continent

The Indian Sub-Continent (ISC) comprises six countries: Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka (Fig. 1). The ISC occupies ~3.2% of the global land area but hosts ~23.2% of the world's population (FAO, 2013). The region is arguably the most densely populated region in the world. Precipitation varies spatially and temporally over the region, with the lowest national mean occurring in Pakistan (494 mm/year; WBA, 2015) and the highest in Bangladesh (2600 mm/year; WBA, 2015) (Fig. 1). The ISC is drained by the rivers Indus, Ganges and Brahmaputra Basins, which collectively form the Indo-Gangetic Basin (IGB) (Figs. 2 and 3) and include some of the highest yielding aquifers of the world (Figs. 2 and 3). The aquifers associated with these river basins cross international borders of the contiguous ISC countries, forming numerous transboundary aquifers, including the Indus basin aquifers (between India and Pakistan), Ganges and Brahmaputra basin aquifers (between Bangladesh and India), the aquifers of the tributaries to the Ganges (between Nepal and India), the aquifers of the tributaries to the Brahmaputra (between Bhutan and India and between India and Bangladesh) (UN-IGRAC, 2014).

At the beginning of every hydrologic year, >4000 billion cubic meters (bcm) water enters the ISC hydrological systems, of which almost half is lost by poorly understood and un-quantified processes (e.g. overland flow, surface discharge through rivers to oceans, submarine groundwater discharge, evaporation and evapo-transpiration, etc.) (Verma and Phansalkar, 2007). Annual groundwater

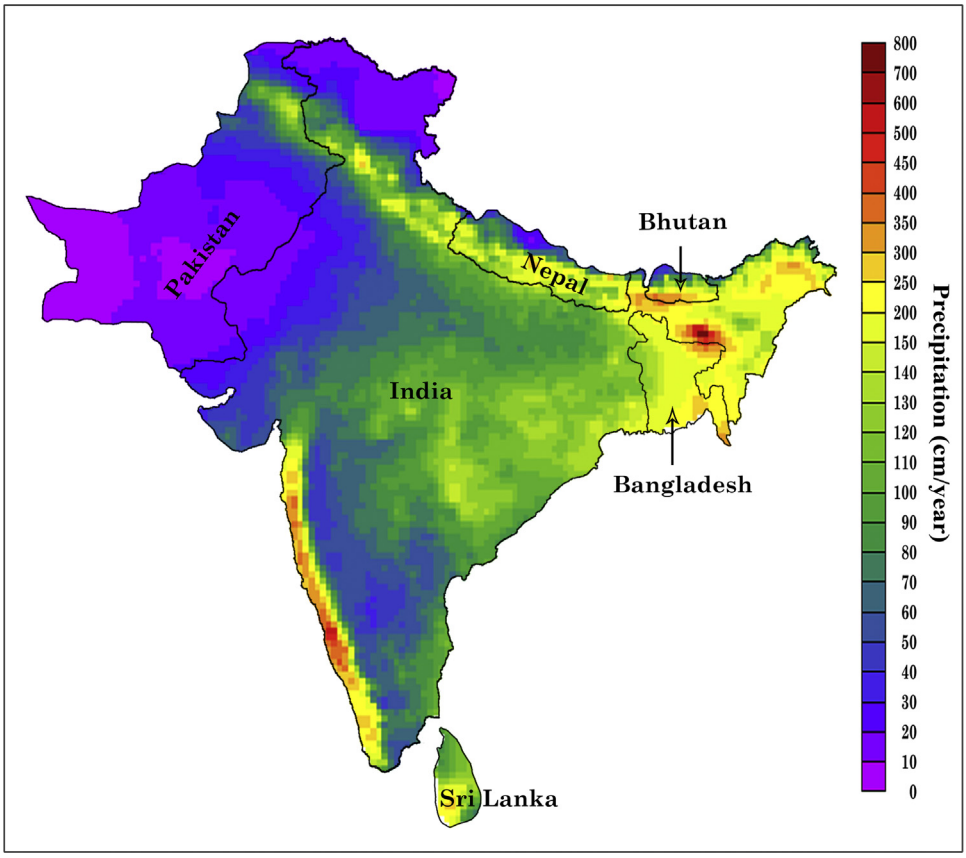

Fig. 1. Map showing mean annual precipitation distributions (1961–2007) across the Indian Sub-Continent (*source*: APHRODITE database). The figure is not to scale and the country boundaries are for illustrative purpose only.