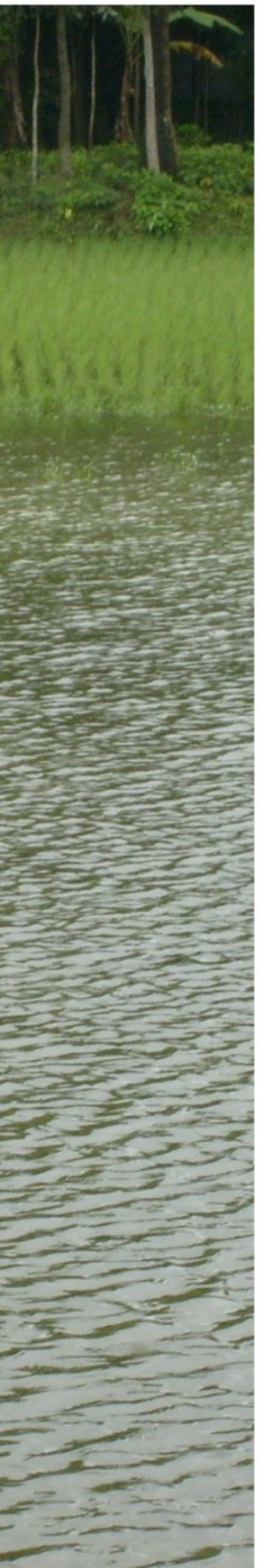





IWMI International Water Management Institute

CPWF-IWMI Basin Focal Project for Indus-Gangetic Basin
Research Brief- Series I

CGIAR Challenge Program on WATER & FOOD



Water Resources of Indus-Gangetic Basin: Continuing Threats and Emerging Challenges

Water resources in Indus-Gangetic basin serve as a powerful tool for development and for overcoming poverty in the region. Rapid agriculture expansion and subsequent utilization of available water resources of the basin has placed the basin at risk with water scarcity issues on one hand, and flooding problems on the other, the scales of which are further exacerbated by impacts of climate change. The transboundary nature of the basin adds more complexity to the water resource challenges confronted.

Water Rich or Water Scarce?

Indo-Gangetic basin region experiences two facets of water scarcity; regions with physical scarcity of water and those with an economic water scarcity. The total drainage area of 110 Mha in Indus basin contributes an average annual flow of upto 230 BCM (41 years average, 1957-1997). Even with this flow, Indus basin is faced with physical scarcity of water, with net runoff of only about 10% of total precipitation input and the rest appropriated by various uses of rainfed and irrigated agriculture, grasslands, domestic and industrial use. The basin also has a high level of groundwater use (105% developed). On the other hand, Gangetic basin having an average annual flow of upto 459 BCM (at Farakka barrage) is confronted with issues of economic water scarcity, where only 18% of the total resource is developed for irrigated agriculture due to inadequate human and financial capacity in the region. Increased efforts on development of unutilised surface and groundwater resources and a general improvement of the rural infrastructure can have a positive impact on agricultural productivity and poverty alleviation of Ganges basin. The scarcity issue becomes much more severe with the added impacts of climate change. A reduction in dry-season flows in the basin region is predicted by the retreat of glaciers and a reduction in snow cover in the Himalayas, the major contributor to the flows in Indus and Ganges.

Water resources development in the basin exhibits a stark contrast, with Western region having high levels of regional development, mainly attributed to infrastructure development in irrigation, which allowed maximum utilization of inputs. Indus basin houses the largest contiguous irrigation network in the world, the Indus Basin Irrigation System (IBIS), serving 17 Mha. The system diverts almost 75% of the annual river flows into the Indus basin. On the other hand, eastern IGB still have considerable undeveloped resource base and lack of infrastructure and enabling environment prevents this region from harnessing the true potential of the available

Groundwater availability and its use in the Indus-Gangetic Basin

Basin Name	Groundwater Available (BCM)	Annual Groundwater Draft (BCM)			Stage of GW Development (%)
		Irrigation	Domestic, Industrial & Other	Total	
Ganga Basin					
India	168.7	94.4	8.2	102.4	61
Nepal	11.5	0.8	0.3	1.1	10
Bangladesh	64.6	25.2	4.1	29.3	45
Indus Basin					
India	30.2	36.4	1.6	38.0	126
Pakistan	55.1	46.2	5.1	51.3	93
	85.3	82.6	6.7	89.3	105

resources. Major challenge faced by water managers working in this region is to find suitable instruments to bridge this gap in development, possible to an extent by increasing the productivity of water and land. There is also a need to address the problem of generating political environment and regional cooperation among the basin countries conducive to such developmental activities. Targeting investment in the least developed areas of eastern IGB, where rural poverty is also at its highest, could offer the rural poor a way out of poverty.

Growing Population and Urbanization: Drivers of Resource Degradation

With rapid population growth, water allocation among competing sectors remains a big challenge. The per capita water availability in the Indo-Gangetic basin under the projected water demand by 2025 is going to be reduced to the level that it will become a water stressed area In addition to the rise in water demand, land-use changes contributed by population growth is also adding to the pressure on water resources. Sub-basin scale analysis of Gorai-Madhumati sub-basin in Bangladesh has shown that outlet runoff is affected by land use within the catchment as well as the inflow coming from the Ganges.

Though Ganges basin is relatively underdeveloped with more than 40% of the total resources as net flows to the sea, the river in most part of its flows in the plains (downstream of Haridwar) is highly polluted in spite of it being declared as the National River of India and a much publicized Ganga Action Plan to reduce the pollution load in the river. Ganges and its tributary, Yamuna have turned into stinking sewers from industries and population on its banks. Studies show that 75% of the pollution in Ganges is from untreated municipal sewage, 88% of which is from 25 Class 1 towns situated on the banks of the river.

Quality degradation of groundwater is observed in Punjab, Sindh and Haryana states of Indus basin. Around 41% of the net draft in Punjab, Haryana, Rajasthan and Uttar Pradesh is predicted to be of marginal and poor quality. Almost 65% of the agricultural area of Haryana is confronted with groundwater quality problems; especially in central and western districts. A tremendous reduction in cereal yield could be the result of irrigation using marginal quality water. Studies have reported a 68% decrease in wheat yield in moderately saline land and 84% decrease in wheat yields in highly saline land.

Future pressure on water resources by urban and industrial uses advocates the need for suitable strategies to combat reduced water availability for irrigation based on whether the water available would be enough to grow enough food to meet the requirements of the population.

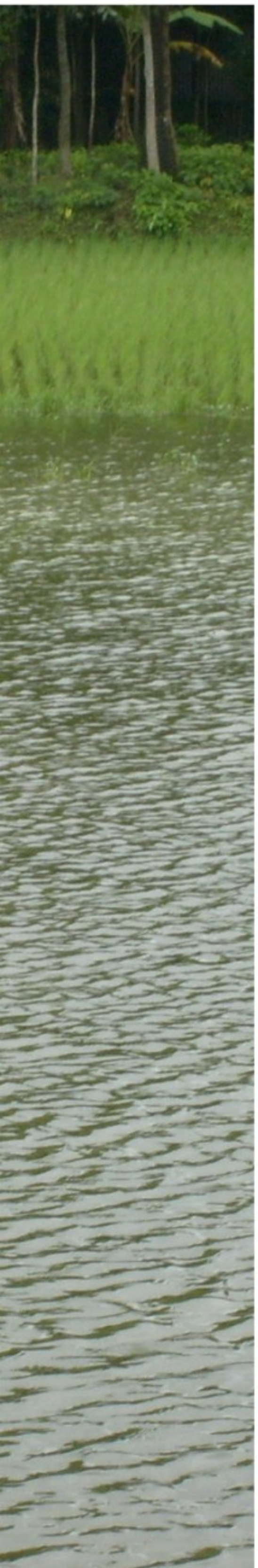
Total renewable water resources (TRWR) and per capita water resources in the Indus and Gangetic regions of India and Pakistan

IG Basins	TRWR (km^3)	Per capita water resources (m^3/person)			
		1990	2000	2025	2050
Indus- India	97	2487	2109	1590	1732
Indus- Pakistan	190	1713	1332	761	545
Ganga - India	663	1831	1490	969	773

Over extraction of water for industrial and domestic purposes leave less flows available for environmental requirements. Intensified agriculture to feed the growing population steps up the use of chemical fertilizers, pesticides, herbicides etc. polluting much of the watercourses in the Ganges. This coupled with the alarming levels of industrial waste loads dumped to water bodies and sewage disposal in turn reduces the amount of utilizable flows. Challenges lie in checking sewage discharges from an ever-increasing population as well as effective implementation of policies to control industrial wastewater discharges.

Adding to the Threat: Climate Change Impacts

Water resources of IGB are at risk from changes in temperature, glacier retreat, floods and droughts and sea level rises. Predictions on alarming rate of retreat of glaciers, as for example the Gangotri glacier, signal the



Country-wise climate risks for the Indus-Gangetic basin countries

Climate risks	India	Pakistan	Nepal	Bangladesh
Temperature rise	High	High	Very high	High
Glacier retreat	High	High	High	---
Frequent floods	High	Low	High	Very high
Frequent droughts	High	High	High in some areas	High in some areas
Sea-level rise	Modest	Modest	---	Very high

Adapted from Heatherman et al. (2009)

reduction of river flows and their impact on food production. Average annual rate of retreat of Gangotri glacier, the source of Ganges, has increased from 14.6m during 1934-1976 to 35.4m during 1962-2000 (142% increase) and has retreated around 2 km since 1780.
In contrast, another study reports that glaciers in Central Karakoram, source of Indus river, is actually advancing, surveys done between 1997 and 2002 have shown 13 glaciers of intermediate size to be advancing.

The runoff potential of the Ganges and the Indus Rivers are on decline trajectory due to fast melting of the glaciers and ice and higher evaporative demands. Indus Basin Irrigation System (IBIS), relying heavily on summer flows contributed by winter snow and ice in Himalayas and Karakoram, will be faced with new challenges with the change in snow and ice potential.

Frequent droughts in dry western region and recurrent floods in eastern IGB, mostly in Bihar state of India and Bangladesh, cause huge economic losses, which gets much more severe with climate change. Studies suggest increase in the frequency and intensity of extreme events in most of the sub-basins of Ganga basin under the changed scenario. Farming systems and water use still has to find effective ways to adjust to such uncertainties in climate. Such adjustments has to be tapered to the regional needs as the level of adaptation needed for rural poor communities, especially in Bihar and Uttar Pradesh, to the impacts of climate change being different from those in urban settings. Technology aimed at developing and disseminating new varieties that can survive floods and drought spells are the need of the hour to build climate change adaptation.

Concerns about the Role of Groundwater

The well-developed surface irrigation system in Indus basin does not deter it from being one of the biggest

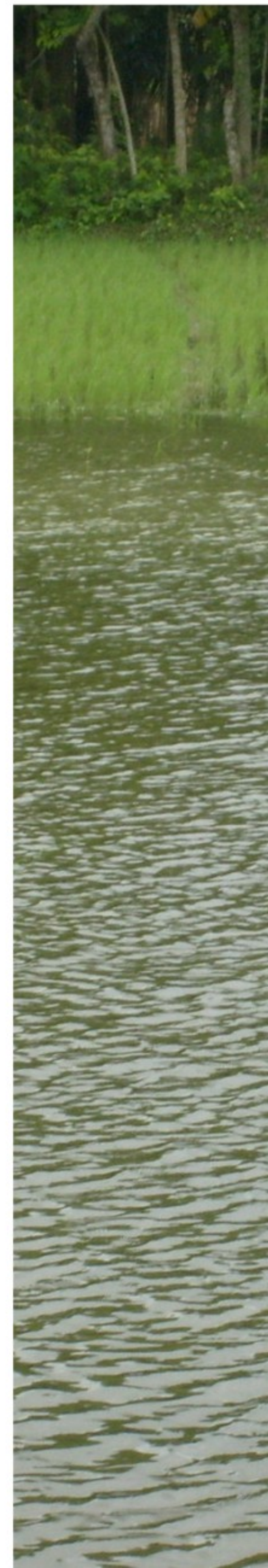
The share of groundwater in the water footprint of IGB is considerably large and is increasing at a rapid pace.

groundwater usage regions in the world. This is partly due to the aging and less actively managed canal irrigation systems. Over the last decade, share of area irrigated by groundwater has increased by 33% in IG basin countries. Continuous and increased agricultural groundwater extraction contributed much to the regional development of Punjab and Haryana in western IGB, but these came at a cost of environmental degradation in the form of depleting water levels. More than three fourth of Indian Punjab is experiencing issues on water table decline. On the other hand, seepage and percolation from canals leave Sindh and parts of Punjab provinces in Pakistan, with issues on waterlogging and salinity.

Eastern IGB has a rich endowment of groundwater resources, which is largely underdeveloped at present.





Lack of human, financial and political capital as well as poor infrastructure act as major impediments in groundwater development of the region. Presently, most of the poor farmers access groundwater through diesel-operated pumps, which are expensive to operate and manage. More than 50% of the farmers do not have their own pumps and depend upon alternate mechanisms to have access to the groundwater at a high cost. Large investment on rural electrification and devising of low-cost pumping technologies can help a long way in improving the current situation. Groundwater markets, with suitable pricing and contractual mechanisms, need to be established and encouraged to assure access to resource poor farmers.

Unsustainable levels of groundwater development in most areas of western IGB is favoured by inappropriate policy and energy subsidies, that often fail to regulate over-exploitation of this valuable resource. Politics play a substantial role in this and reforms aimed at eliminating subsidies would be politically difficult. Although regulations exist on limiting groundwater extraction from dark and grey zones, governance is not efficient enough for their effective implementation. The real challenge lies in defining a groundwater policy framework, which allows for its future sustainability, but at the same time acceptable to all the stakeholders. The framework should also be able to address the nexus existing between water, energy and food security in the basin. Policy-makers also need to understand and establish tradeoffs between sustainability and economic development.

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This note forms part of the Challenge Program on Water and Food (CPWF) sponsored Basin Focal Project for the Indus-Gangetic Basin (BFP-IGB). For detailed project report, log on to http://bfp-indogangetic.iwmi.org:8080 or write to:

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