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Review

Room for improvement: Hydroclimatic challenges to poverty-reducing development of the Brahmaputra River basin

Patrick A. Ray [a,*], Yi-Chen E. Yang [a], Sungwook Wi [a], Abedalrazq Khalil [b], Vansa Chatikavanij [b], Casey Brown [a]

[a] University of Massachusetts, Civil and Environmental Engineering, 18 Marston Hall, Amherst, MA 01003, United States
[b] The World Bank, 1818 H Street, NW Washington, DC 20433, United States

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ABSTRACT

The Brahmaputra river is the largest (by annual discharge) of the three in the Ganges-Brahmaputra-Meghna (GBM) system, and by itself carries more flow than all but 4 rivers in the world. It is the primary water source for over 130 million people, many of whom are mired in chronic poverty. The potential in the Brahmaputra River basin for poverty-reducing development of agriculture and hydropower is great. However, progress in these sectors and others has been hindered by significant natural and anthropogenic challenges. As they attempt to develop their water resources in a manner that reduces water-related vulnerabilities, the people of the Tibet Autonomous Region of China, Bhutan, Northeast India, and Bangladesh face a number of challenges, including: endemic poverty; floods; droughts; groundwater over-abstraction; political unrest; and the broader development ambitions of the member nations (leading to net import or export of resources from the basin). To those challenges have recently been added climate change and difficult decisions regarding hydropower development. A critical compounding factor in the Brahmaputra basin is the lack of an authoritative, reliable, and comprehensive network of basin-wide information on climate, streamflow, natural hazards, and economic factors, such as agricultural production, prices, and trade. Anthropocentric development in the Brahmaputra basin must balance the goal of immediate poverty reduction with the preservation of the vulnerable, rich natural heritage of the basin, in the interest both of intergenerational human equity, and biocentric egalitarianism. In the space allotted here, we provide a snapshot of the demographic and hydroclimatic characteristics of the basin of greatest concern to water system planners aiming at poverty reduction through sustainable development. We propose that the basin's hydro-climatological, economic, and political complexities are such that a basin-wide water system knowledge platform is needed to organize quantitative thinking on potential water-related investments in the basin.

1. Introduction

As explained by Grey et al. (2013), most of the world's poor are deeply water insecure and face disproportionately large water-related risks resulting from their location in regions of particularly complex hydrology. These water-related risks are exacerbated by a general lack of good publicly-available water resources data in much of the world, and the speed with which demand for limited water resources is increasing through population growth, urbanization, economic development, and climate change.

More than 1.3 billion people rely on the flow from the waters of the Tibetan plateau in a south Asian region that is undergoing rapid climate and demographic change (Eriksson et al., 2009; National Research Council, 2012). Of those, at least 630 million people live in the watershed of the Ganges-Brahmaputra-Meghna (GBM) river system (FAO, 2011). The GBM river basin (Fig. 1) is characterized by endemic poverty and is home to an estimated 40% of all the poor people of the developing world, defined as those with a daily calorie intake of less than 2200–2400 kilocalories (Biswas, 2008). Of the three rivers of the GBM system, the focus of this paper is on the Brahmaputra for 4 primary reasons. First, the Brahmaputra River is the largest (by annual discharge) of the three in the GBM system, and by itself carries more flow than all but 4 rivers in the world (FAO, 2011). Second, because of its location in a region where little development has historically occurred, the potential in the Brahmaputra River basin for poverty-reducing development of agriculture and hydropower is great, and in fact diversion of Brahmaputra water is seen as a potential partial solution to water

* Corresponding author.
E-mail address: paray@umass.edu (P.A. Ray).

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Fig. 1. Rivers of the Tibetan plateau.

stresses in the more densely populated and developed (and more studied) Ganges River basin (Rahaman and Varis, 2009). Progress in the development of the Brahmaputra's agricultural and hydropower (among other) sectors has been hindered by significant natural and anthropogenic challenges: rapid geomorphological changes, floods and droughts, the migration of channels, the erosion of land, earthquakes, intra-national political fragmentation, international disputes, and large uncertainty regarding future climate, demographic, political, and socio-economic conditions (Rao, 1975). Third, motivation remains to preserve the so-far mostly unaltered natural environment (e.g., water quality, wildlife, mangrove forest river delta) in the Brahmaputra watershed, which has already been compromised in the Ganges (Sarkar et al., 2007). And fourth, there is a great amount of current interest in developing the previously undeveloped hydropower resources (Rahaman, 2012) and flood prevention infrastructure (Haque et al., 2012,) in the Brahmaputra basin, with influxes of investment that could have long-lasting ramifications on the quality of life (human and otherwise) in the basin.

A critical hindrance to development in the Brahmaputra basin is the lack of an authoritative, reliable, and comprehensive network of basin-wide information on climate, streamflow, natural hazards, and economic factors, such as agricultural production, prices, and trade. This is made especially challenging by the ethnic fragmentation and political unrest in individual countries in the basin, and the complex international politics influencing the sharing of the Brahmaputra's transboundary waters.

In the space allotted here, we aim to lay the groundwork for such a knowledge platform by providing a snapshot of the demographic and hydroclimatic characteristics of the basin of greatest concern to water system planners aiming at poverty reduction through sustainable development. In order to do so it has been necessary to gather and organize previously disperse literature on the water-related challenges facing the region's poor across the food-water-energy nexus (Rasul, 2014). In a number of cases where the existing literature was either insufficient or in disagreement (esp., climate drivers, climate change trends and projections, irrigation water availability, glacier characteristics, hydropower plant construction activities and plans), it was necessary to supplement the literature with data analysis of our own. The paper is organized as follows: (1) the characteristics of the basin are introduced (geography, climate, surface water, groundwater, glaciers, climate change, land use, ecology and delta region); (2) agricultural water use is calculated and put in the context of available surface water; (3) water-related challenges to the people of the basin are described (hydropower development, endemic poverty, and regional geopolitics); and (4) with the perspective provided by this in-depth analysis, we propose that the basin's hydro-climatological, economic, and political complexities are such that a basin-wide water system modeling platform is needed to organize quantitative thinking on potential water-related investments in the basin.

2. Characteristics of the Brahmaputra river basin

The GBM river system is the third largest freshwater outlet to the world's oceans, exceeded only by the Amazon and the Congo river systems (Chowdhury and Ward, 2004), and when it swells to