6 Global Warming, Changes in Hydrological Cycle and Availability of Water in South Asia

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1. INTRODUCTION

Various regions of South Asia experience high climate variability, both spatially and temporally. The hydrological regime of major parts of the region is predominantly influenced by monsoon, which brings 70-80% of total annual rainfall during early June to September. The post-monsoon months become dry and there is hardly any appreciable rainfall during winter months (December to February). Moreover, the western parts of Bangladesh and India generally receive significantly lower amounts of rainfall compared to the eastern parts of both the countries, which is a manifestation of high spatial distribution of rainfall. Rainfall in Nepal is also higher in the eastern part compared to the western region. Topographically, in the Terai region with flatter topography along the Indian border, rainfall is very high. In Pakistan, the Punjab and Kashmir regions in the north experience the highest precipitation whereas in the southern region it is one-fifth of the north. In a warmer climate in future, the overall pattern of rainfall/precipitation is expected to change spatially as well as temporally. Water resources of the South Asia region, however, are highly sensitive to climate variability and change. Therefore, an anticipated change in climate system – as a consequence of global warming and subsequent sea level rise – could considerably affect both the hydrological cycle as well as distribution, which in turn would affect the lives and livelihoods of hundreds of millions of inhabitants.

2. MONSOON VARIABILITY AND HYDROLOGICAL CYCLE IN SOUTH ASIA

Monsoon is the most important climatic phenomenon in South Asia. Economic, social and cultural lives of hundreds of millions of South Asians

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are intertwined with the onset and departure of monsoon. Until recently, South Asian economy has always been dependent on subsistent agricultural practices, where rainfed cropping played a significant role. While a monsoon with normal rainfall brings joy to the South Asians, especially to the farming communities, an abnormal monsoon (either dry or extremely) can cause destruction of crops and hardships and may lead to nutritional hazards and famine. Onset and retreat dates of monsoon (Fig. 1) and the amount of rainfall it brings in, determine crop calendar, river characteristics, sediment supply and moisture availability in South Asia.

Munot and Kothawale (2000) identified a large scale temporal variability and intensity of daily rainfall variations during monsoon over India. It was found that, on an average, the monsoon was active for 103 days over northeast (NE-India) India, for 75-78 days over central-northeast (CNE-India) India and so on for all the regions. Pant (2003) identified temporal scale of monsoon variability and associated hydrological features (Table 1). Floods and droughts and their frequencies are associated with interannual and decadal and century scale variability, respectively. Average daily normal rainfall (ADNRF) is at a maximum of 14.7 mm over NE-India and at a minimum of 4.6 mm over NW-India (Munot and Kothawale, 2000). Increase of greenhouse gas concentrations would likely to intensify the Asian summer monsoon and its variability. The intensification of monsoon resulted mainly from an enhanced land-sea contrast and a northward shift of the convergence zone. They simulated gradual increase of the monsoon variability from the year 2030 onwards. The intensification seemed to be connected with the corresponding

Table 1: Temporal scales of monsoon variability

Scale	*Intraseasonal*	*Interannual*	*Decadal and century*	*Millennium and longer*
Features	Active and break-monsoon phases; 30-50 day oscillations	Droughts and floods	Changes in the frequency of droughts and floods	Changes in the areal extents of monsoons
Factors	Atmospheric variability; tropical-midlatitude interactions; soil moisture; sea-surface temperatures	Atmospheric interactions; El Nino Southern Oscillation; Top layers of tropical oceans; snow cover; Land surface characteristics	Monsoon circulation variations; Deep ocean involvement; Greenhouse gases increase; Human activities; Biospheric changes; Volcanic dust	Global climate excursions; Ice ages; Warm episode; Sun-earth geometry

Source: Pant, 2003.