SPRINGER BRIEFS IN EARTH SCIENCES

Alka Upadhyay
Raveendra Kumar Rai

Water Management and Public Participation

Case Studies from the Yamuna River Basin, India

Springer

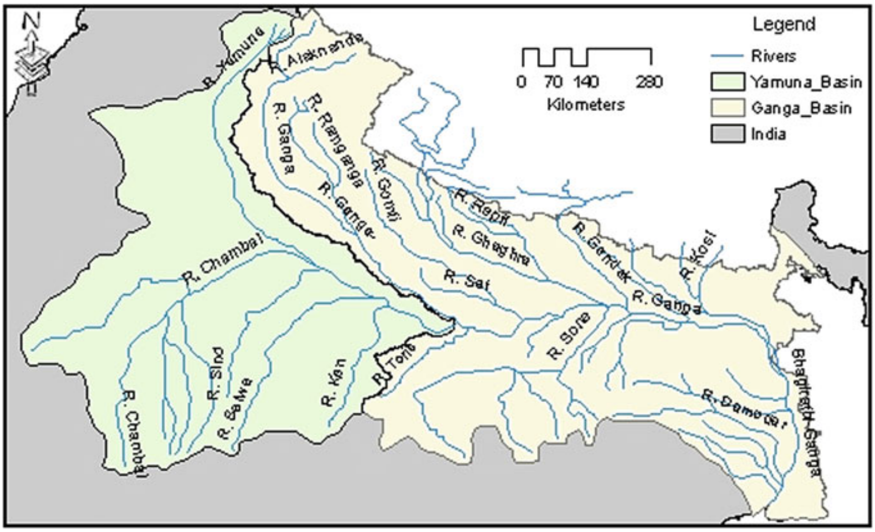
SpringerBriefs in Earth Sciences

For further volumes:
http://www.springer.com/series/8897

Alka Upadhyay · Raveendra Kumar Rai

Water Management and Public Participation

Case Studies from the Yamuna River Basin, India



Springer

Alka Upadhyay
Water Resources Division
DHI (India) Water & Environment Pvt Ltd
New Delhi
India

Raveendra Kumar Rai
Water Resources Division
DHI (India) Water & Environment Pvt Ltd
New Delhi
India

ISSN 2191-5369 ISSN 2191-5377 (electronic)
ISBN 978-94-007-5708-0 ISBN 978-94-007-5709-7 (eBook)
DOI 10.1007/978-94-007-5709-7
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2012949713

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Challenges faced by more and more countries in their struggle for economic and social development are increasingly related to water. Water shortages, quality deterioration, and flood impacts are among the problems which require greater attention and action. Globally the good quality of water for various uses has been scarce. Therefore, its management and allocation to meet out the various demand, such as domestic, agriculture, industrial, and environmental become important. However, the sustainable water resources management cannot be achieved without involvement of the stakeholders and public participation. This approach has been adequately addressed through the Integrated Water Resources Management (IWRM). Many counties have implemented this approach, but do not gain considerable success because of lack of public awareness and their involvement. In India, IWRM approach is being implemented by setting-up institution in the form of river basin organizations. For Yamuna river basin, effective management and planning of water resources accordance with geological formation, topography and climate has been investigated and linked to the public participation and awareness. The investigation was systematically planned and campaigning was made in different parts of the Yamuna river basin. Based on the analysis of information and available secondary data, necessary interpretations were made in light of the IWRM approach and documented as case studies in the present book.

This book has been presented into eleven chapters starting from the introduction to the water resources issues and brief idea of Indian water resources and principles of IWRM. Chapter 2 provides brief overview of the Yamuna River basin. The methodology adopted for the study is presented in Chap. 3. The Chaps. 4–10 presents the various case studies in different catchments of the Yamuna River basin. Finally overall, conclusion and lesson learned from the various case studies are summarized in Chap. 11.

The book will be useful to the water managers, decision makers, administrators, planners, Government, and Non-Government Organizations (NGOs) who involved in water resources management and poverty alleviation.

During the course of the campaigning, interactions was made with local people and are duly acknowledge for their timing and supports. Authors also wish to acknowledge local administration and local institutions for their co-operations and supplying available information. Authors wish to thank their colleagues for their necessary support.

Alka Upadhyay
Raveendra Kumar Rai

Contents

Chapter 1
Introduction

Abstract This chapter presents the status of water resources issue of India and the necessity of its management. The principles of integrated water resources management (IWRM) is also discussed for sustainability in the management including the role of public participation and awareness.

Water is essential for the socio-economic development and for maintaining the healthy ecosystems. It is a powerful geophysical force influencing the landscapes and climate. On a wide range of time scale, water is in everlasting movement, cycling through various reservoirs in the oceans, sky and soil. Indeed, water is abundant in the environment, but its distribution is quite uneven both in time and space. Therefore, to monitor the global water cycle with interaction among the key elements requires a comprehensive representation of the budgets and cycling of entire phases of water storages.

Reflecting on the water resources that will be available for future use, Hossain et al. (2011) have separated societal and environmentally important water resources into five categories: water food, energy, human health, and ecosystem function. These categories are inter-related and water is required for each of the remaining four categories. The water that would be available will depend on the demands or stressors placed on the water resources and the uses thereof. This principle applies on both quantity and quality of water resources. Some of the stressors may entail local human population requirements, irrigation, flood and drought, biofuel production, weather variability and long term change, land management practices, waste generation and treatment, animal and insect dynamics, vehicular and industrial emissions, natural landscapes change, natural events such as earth quakes and others. Among all, the major water stressor to the water resources is human population requirement, especially the food.

If considering the water requirement to feed the population, it is assumed that some 900 m^3 of water per person per year is required for self-sufficiency. However, Falkenmark (1997) has estimated this figure as 1,570 m^3 per person per year.

A. Upadhyay and R. K. Rai, *Water Management and Public Participation*, SpringerBriefs in Earth Sciences, DOI: 10.1007/978-94-007-5709-7_1,

Considering the current global population, the estimated water required to feed the population is 7,117.5 BCM per year. However, this figure rises to 9,964.0 BCM per year for the projected population of 2050. It means, for the year 2050, the additional water requirement to feed the population will be 2,846.5 BCM per year. This is really a big future water challenge to be faced.

Beside population growth, climate change and landuse change will further aggravate the future water challenge, which results environmental damage and water sharing conflicts. Therefore, by now it is the prime importance to pay great attention to the water resources management. The only ways give the impression to resolve this issue is water resources management.

1.1 Water Resources of India

The water resources of Indian sub-continent largely depend upon the success of Indian Monsoon, especially the South–West (SW) Monsoon, generally experience during the month of June–September. It enters from the direction of Africa, and brings heavy rainfall to the west coast and covers large part of the northern India. It contributes around 80 % rainfall or precipitation in India. Other than the SW monsoon, during winter, average contribution of rainfall due to North–East (NE) Monsoon, which sweeps down from the plateaus of Asia and the Himalayas, and brings rain and cooler weather to south–east India between October and December. In spite of seasonal variability in the rainfall pattern, Indian sub-continent has large spatial variability in the mean annual rainfall/precipitation (MAP) ranging from 100 mm in Western Rajasthan to 2,500 mm in North–east part of the India with heaviest rainfall of approximately 11,000 mm near Cherapunji. High MAP values of approximately 2,000 mm are also typical to the western slopes of the Western Ghats.

This rainfall variability when coupled with geological and topographical conditions of the river basins, a large spatial variability in the flow regimes in the rivers experiences, which ranging from perennial to ephemeral. Based on the origin and flow regime, the rivers of India are classified as Himalayan, peninsular, coastal, and inland-drainage basin rivers. Himalayan rivers are snowfed and maintain a high to medium flows throughout the year. The heavy annual rainfall due to SW monsoon in the Himalayan catchments further increases their flow and caused flooding and erosion. These rivers are also fed with considerable base flow from groundwater in alluvial plains. Approximately 80 % of the total annual flows in the Himalayan Rivers are due to rainfall. The peninsular rivers on the other hand, are rainfed and do not have any snowmelt contribution. Approximately 90 % of the annual flows of these rivers are due to rainfall. The coastal rivers are found in the western part of India are short and episodic. Rivers of the Inland system (i.e. in the semi-arid to arid regions), centered in western Rajasthan, are few and frequently disappear in years of scant rainfall. These Inland Rivers are ephemeral in nature, and almost 100 % of its annual flows are due to the rainfall during SW

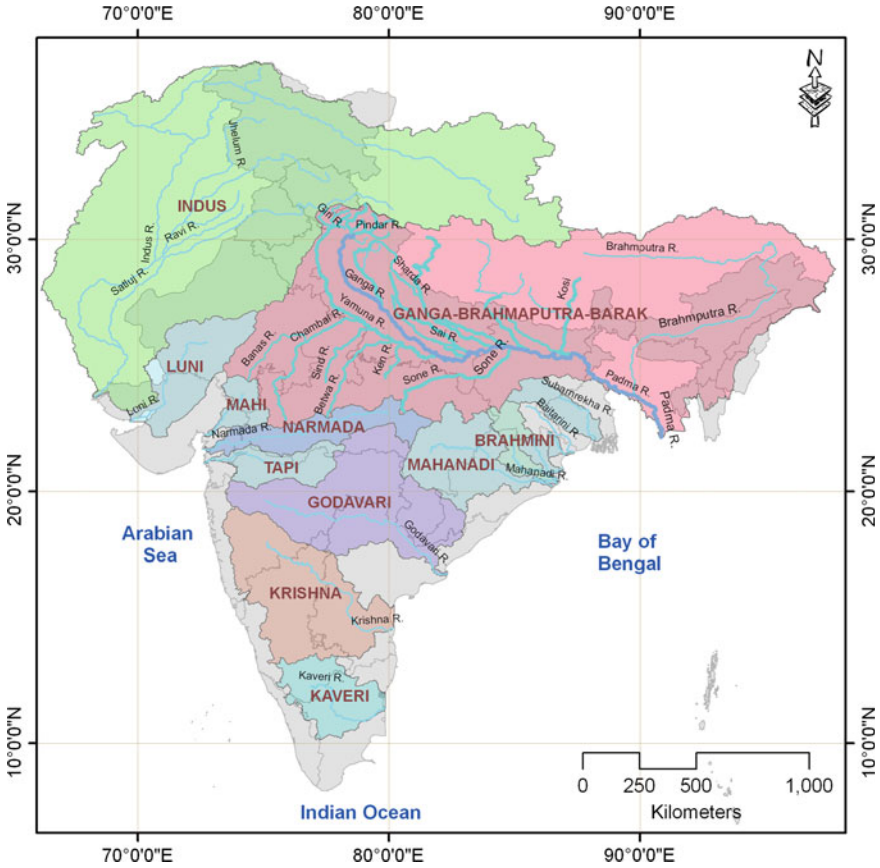


Fig. 1.1 Important river basins of India, including part of Pakistan

monsoon. The majority the rivers flow through broad, shallow valleys and drain into the Bay of Bengal. The river systems of India are shown in Fig. 1.1.

In the past, several organizations and individuals have estimated water availability for the Indian River basins. Recently, the National Commission for Integrated Water Resources Development estimated the basin-wise average annual flow in Indian River systems as 1,953.0 BCM (NCIWRD 1999). The utilizable water resource is the quantum of withdrawable water from its place of natural occurrence. Within the limitations of physiographic conditions and socio-political environment, legal and constitutional constraints and the technology of development available at present, utilizable quantity of water from surface flow has been assessed by various authorities. The utilizable annual surface water of the country is 690.0 BCM. In a majority of river basins, the percent utilization is quite high and is within the range of 50–95 % of utilizable surface resources, indicating a moderate to high availability of water for economic development, environmental conservation and social well-being.

Beside the surface water potential in the Indian basins, the annual potential natural groundwater recharge from rainfall in India is about 342.0 BCM, which is 8.56 % of the total annual rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 90.0 BCM. Thus, the total replenishable groundwater resource of the country is assessed as 432.0 BCM (CGWB). Out of which, approximately, 396.0 BCM is utilizable. The average stage groundwater developments of the Indian basins vary between 3.4 % in the Brahmaputra to 77 % in the Indus basin. Thus, total water resources of India can be assessed as 2,385.0 BCM (i.e. 1,953 + 432 = 2,385 BCM), out of which approximately 1086.0 BCM is utilizable [i.e. 690 + 396 = 1,086 BCM] (NCIWRD 1999; Kumar et al. 2005).

1.1.1 Basin-Wise Per Capita Water Resources Availability of India

In the basins, the distribution of population is uneven. The Ganga basin alone occupies about 40 % the total population in its one-quarter of the total drainage area of India. On the other hand, the five other largest single basins: Mahanadi, Brahmaputra, Krishna, Godawari cover 46 % of the drainage area but have only 30 % of the total population. The population density of India is 280 people per square kilometer, which is high as compared to most other developing countries. Six basins have population density of more than 350 persons per square kilometer.

Majority of the people in all river basins still lives in rural areas. More than 70 % of the Indian population is rural. This is substantially higher in some basins. For example more than 80 % of population is rural in Brahmaputra, Meghna, Mahanadi, Godavari and Brahmani-Baitarni basins. The livelihood of most rural population depends on agriculture. Thus the development and management of the available water resources is a crucial factor in the strategy of rural development and poverty alleviation in India.

To assess the adequacy of water resources availability, optimum limit considered is 1,700 m^3 per person per year. Based on this limit the water resources status may be categorized as: extreme scarcity: <500; scarcity: 500–1,000; stress: 1,000–1,700; adequate: 1,700–4,000; abundant: 4,000–10,000; and surplus: >10,000.

The basin-wise per capita water resources (PCWR) availability varies between 13,393 m^3 per annum for the Brahmaputra–Barak basin to about 300 m^3 per annum for the Sabarmati basin. Due to increasing population, water demand for various uses such as domestic, food, industrial and power will increase. The current national water demand is 813.0 BCM (GOI 1999). For the year 2050, NCIWRD (1999) has estimated that the total water demand in the country will be 973.0–1,180.0 BCM, whereas the utilizable surface and ground water resources are 1086.0 BCM. In spite of the spatial variability of utilizable water resources in the country, India will become a highly water stressed country, if better water management practices is not implemented at the watershed level. The PCWR

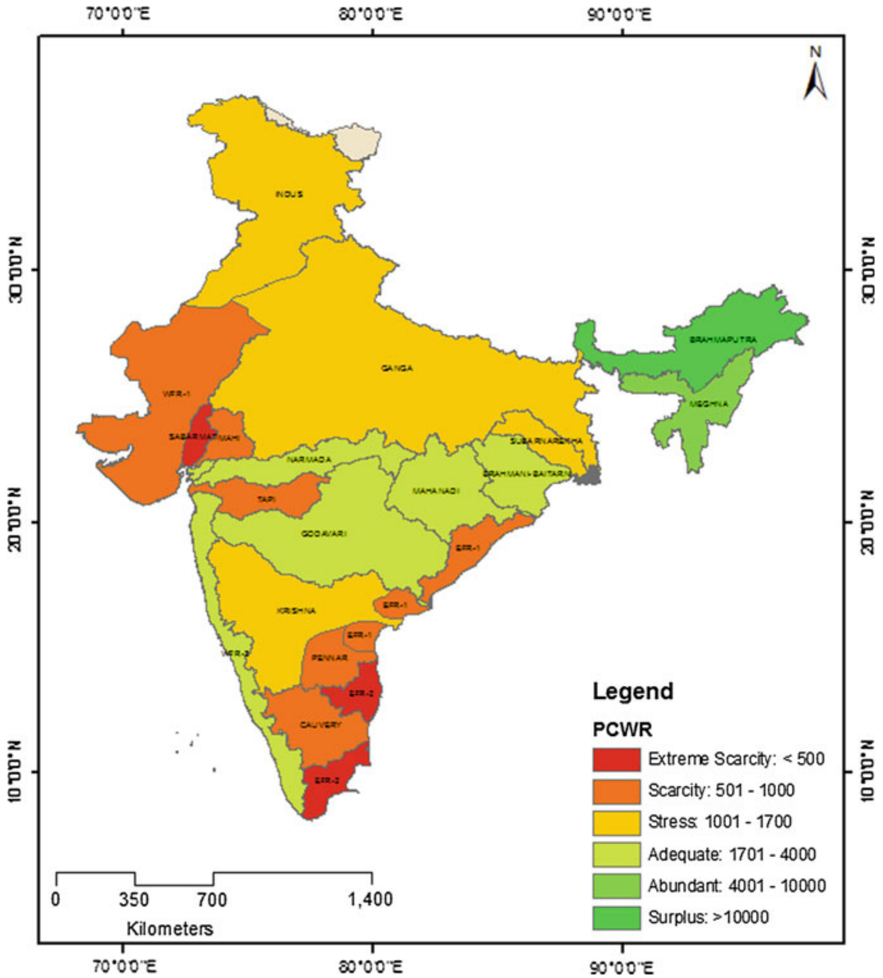


Fig. 1.2 Current per-capita surface water availability

analyses also reveal that only five basins have adequate water resources availability (Fig. 1.2). However, based on the analysis of per capita utilizable water resources potential (PUWR), currently three basins has the adequate utilization surface water potential (Fig. 1.3).

For the projected population of 2050, the per-capita surface water availability (PCWR-2050) is shown in Fig. 1.4. It is clearly apparent from Fig. 1.4 that India will face extreme water scarcity in future. Based on this analysis, it is observed that only Western Ghat Rivers, Brahmaputra and Meghna Rivers have adequate to surplus water resources availability.

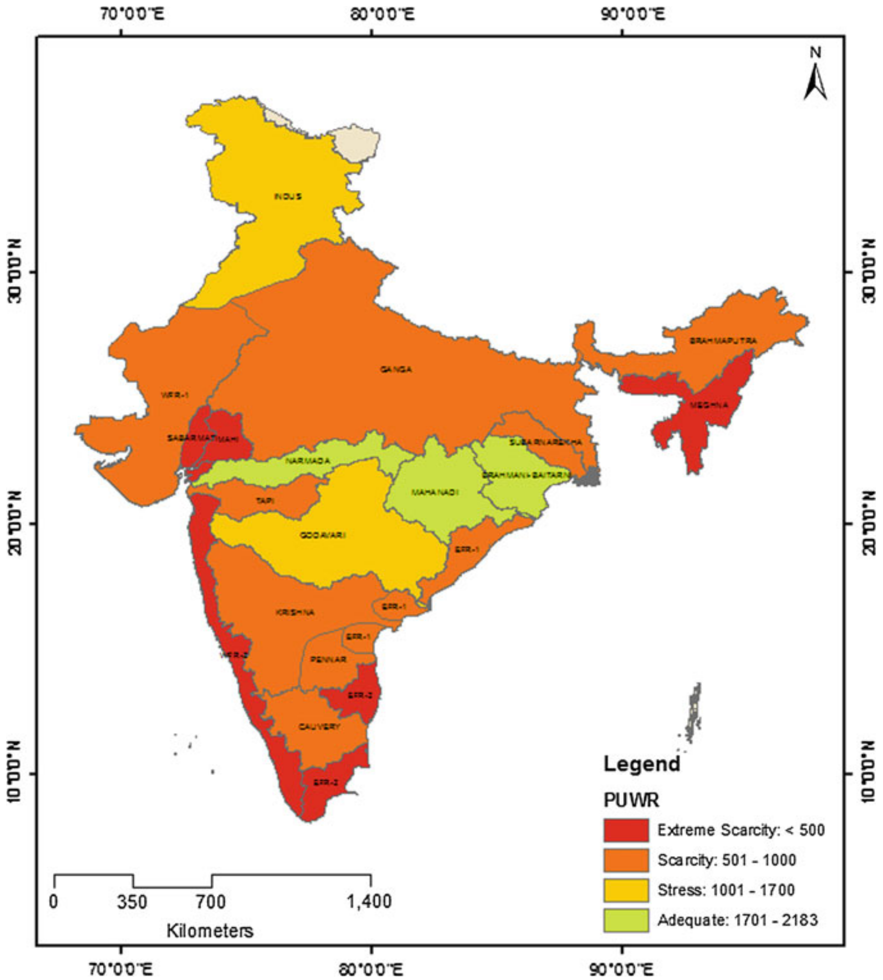


Fig. 1.3 Current per-capita utilization potential of water resources

Considering the above facts, it is necessary to manage the available water resources of India to suffice the water needs sustainably; which can be possible through integrated water resources management (IWRM).

1.2 Water Management

For sustainable water resources management, water accounting like inflows (precipitation, surface water inflow, ground water inflow), water use (evaporation, evapotranspiration, irrigation, drinking water), outflows (surface water outflow,

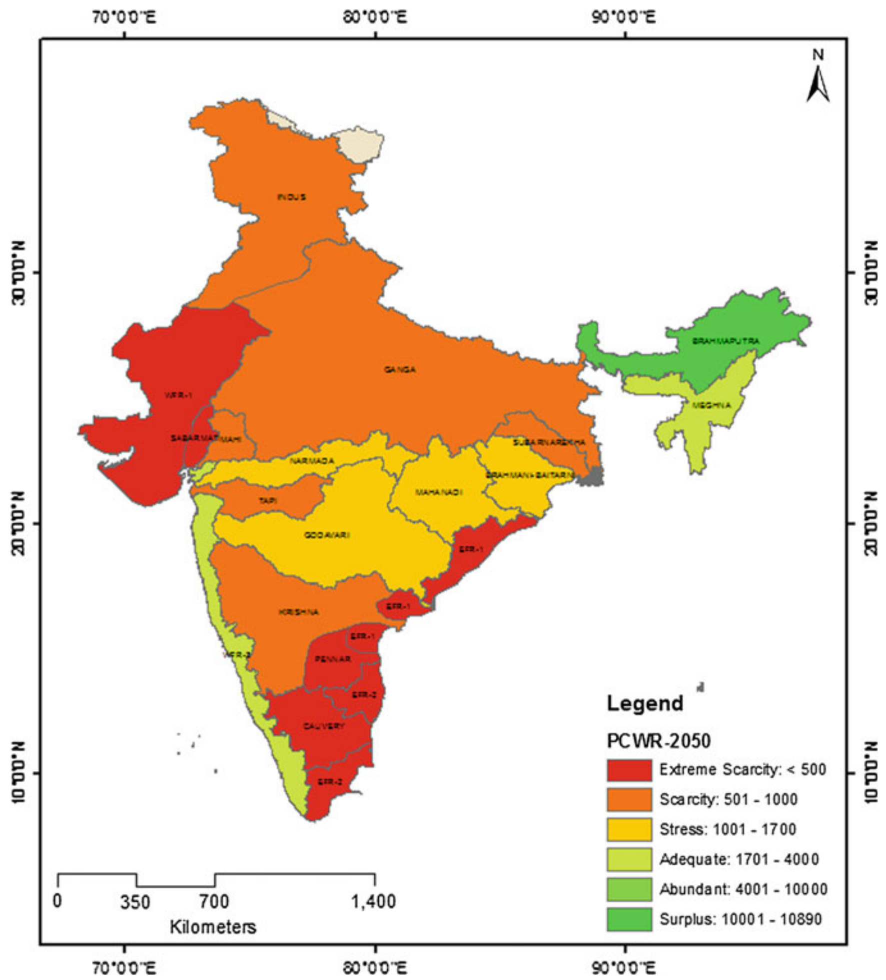


Fig. 1.4 Per capita surface water availability for the projected population

ground water out flow), and storage (surface storage, ground water storage, root zone storage) are the principal factors to be taken care of. The broad interventions for water management are: rainwater harvesting; groundwater recharge; maintenance of water balance; preventing water pollution; economic use of water; preventing various losses, etc.

For sustainable water resources management, a few important statements need to be carefully understood:

Dublin Statement on Water and Sustainable Development (ICWE 1992):

> Principle No. 4: Water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an