BOOK REVIEW

GROUNDWATER SYSTEMS ANALYSIS OF INDIAN COASTAL DELTAS.

I. Radhakrishna, D.S. Publications, Hyderabad, 2013, 590p. Price: Rs.6995.

Deltas are triangular, generally fanshaped areas formed by the river branching off into distributaries before joining the sea. Being discharge areas of rivers, freshwater is available aplenty. These are the areas which are most densely inhabited, with intensive agricultural and economic activities. The distributaries with their ever changing courses deposit the sediments to form the deltas. A complex set of levees, flood plains, beaches, dunes, tidal flats, creeks, lagoons etc constitutes the major environments overlapping each other in space and time and controlling the sedimentation in a sinking basin as the deltas grow by progradation and the continental fluviatile regime grades into estuarine and marine regimes (Das, 1991; Mahalik, 2000; Vaidyanathan, 1991, 2006). The sediments of varying texture and composition reflect the interplay of seawater and freshwater regimes. This depositional history has been punctuated by cooling and warming periods, and sealevel oscillations in the geological past. In India the eastern coasts are mainly built up of deltas, while the western coasts are not with the sole excetion of the estuarine delta of Gujarat. The aquifers occurring in this coastal sedimentary pile contain a large reserve of fresh water useful for drinking, agriculture and other purposes. The aquifers occur in layers, but invaded by seawater in the coastal areas to varied extent. But uncontrolled development of coastal aquifers, the valuable source of freshwater has led to overexploitation, seawater ingress and salinisation of aquifers. The dynamic equilibrium between saltwater and freshwater is rather complex and delicately poised especially in the eastern deltas. Further, cyclones, super cyclones, tsunami, storm surges are regular visitors bringing about enormous miseries, wreaking havocs which too affect the freshwater regime. Hence to manage the development activities an in-depth understanding of the coastal and deltaic environs, ecosystem and resources is essential. In short, the broad framework of coastal groundwater management is as below:

1. Saltwater-freshwater distribution, their hydrodynamic and hydrochemical interactions.
2. Groundwater development and management without upsetting saltwater-freshwater equilibrium.
3. Protection against overexploitation, pollution, seawater ingress or upconing.

Since independence Indian subcontinent has seen intensive exploration by CGWB, GSI, State Agencies, supported by Foreign aided Projects (UNDP 1972, 1989, SIDA 1991, DANIDA 1992 etc) which have revealed the complex hydrogeological set up of the coastal, mainly deltaic areas. It is thus imperative that the exploratory and related scientific data are compiled and analysed for planning and scientific management of the resource. With this objective plethora of publications have been brought out in the last four decades mainly by CGWB and its scientists e.g., Pathak (CGWB 1981), Raju (CGWB 1983), Varadaraj (Bhujal News1988), Das (*JGSI* 2006) etc, apart from the research scientists of other organisations. Das (Mem. GSI 1991) was pioneer in presenting comprehensive account of the hydrogeology of Deltas in Indian subcontinent. Recently a much updated version has been published by CGWB as a Special Publication (Dhiman ed., Coastal Aquifer Systems of India, CGWB, 2011) giving in-depth analysis of coastal hydrogeology based on up to date exploration and surveys.

The latest in the series is "Groundwater Systems Analysis of Indian Coasts," authored by I. Radhakrishna (2013), which has also focussed on the occurrence, quality and management of coastal deltaic aquifer systems. The author has made laudable effort to present a compendium of valuable exploratory data in exhaustive details. This voluminous book written in lucid language covers a vast range of topics related to aquifer systems, potentials, quality, outlining management aspects and running into 590 pages in six chapters. A welcome addition in the book is location wise summarised borehole data. Other important topics in the book are theoretical background or basics of saltwater-freshwater dynamics, pumping tests, multivariate statistical analysis in quality study, which will surely help the freshers and uninitiated. The chapters on geophysics and borehole logging, and groundwater modelling as indispensable tools in coastal groundwater exploration and management also merit special mention. The subchapter on 'Global climate change and sealevel rise' is also highly informative.This hard bound book published by B.S. Publications, Hyderabad, with a good get up, printed in art paper, nicely drawn illustrations and data tables have automatically captured the market of coastal researchers. The author has surely made praiseworthy effort. But voluminous data only when

compiled with objective and systematic analysis render the publication a worthwhile addition to knowledge. However, in all such compilations from wide ranging sources some shortcomings are inherent or unavoidable. This book too being the first edition has its share of errors or omissions. Printing and grammatical errors apart, technical omissions too have marred the quality of the book to some extent. The following are some of the missing links or omissions.

While relevance of space technology and geomorphology in the occurrence of freshwater, both surface and subsurface, in the saline tract has been left incomplete or treated in a sketchy manner, sedimentary facies variations vis a vis fluctuating depositional environments and sea level oscillations impacting past and present flow and quality regimes which have primary control over fresh and saline water distribution is not borne out in the narrative. Further, the shallow aquifers (within 70 m depth) constituting the most vital and the maximum developed zone as source of drinking water and even irrigation deserved a more detailed sector wise description of its distribution which could help the planners. Also, the interaction of water table with sea water is vital aspect of coastal hydrogeology. Seasonal/diurnal fluctuations of water level vis a vis sea level rise and fall, tidal stages, storm surges, effects of full moon and new moon are all skipped in the book.

Similarly, detailed geochemistry of interactive/reactive processes and controls vis a vis host sediments/environs like quality evolution in transgressive and regressive seas, tidal stages, storm surges, marine depositional influences etc., are either untreated or as cursory reference only. Isotopic studies, role of iodide/bromide as valuable indicators of salinity source do not find their worth in the book. Also missing is the sector wise detailed picture of quality variation i.e., salt water-freshwater distribution in the shallow aquifers which is highly non-uniform, rather bizarre, being a window to the happenings in the geological past explaining many riddles of saltwater hazards.

Widespread arsenic pollution in the lower Ganga delta as also contamination with high nitrate, iron, fluoride etc., are conspicuous by absence in the book.

Contrary to expectation, the book does not present delta wise specific development and management strategies or plans keeping in mind conservation and protection issues which form the crux of coastal groundwater management. Figures with legends incomplete or not matching with the map, and Fence diagrams or hydrogeological sections without layout marked on the map hinder comprehension. Depiction of groundwater flow or depth to water without mention of the period/year renders them useless. Special coastal features like autoflowing conditions, over-exploitation, land subsidence, canal irrigation and its impact, conjunctive use, artificial recharge, impact of long-term pumping, well spacing, drought, cyclone or tsunami, use of saltwater, desalination and remedial treatments of contaminated water, salt industry, prawn cultivation which need brine water, cultivation of salt tolerant crops could add value to the book.

Lastly, the data sources in tables, figures and even in the text are generally wanting, thus leaving the data unauthenticated. This is a serious infraction of universally adopted practices and ethics of scientific publication, failing which readers are compelled to refer to this book and the author as the primary source which in reality is a secondary source. Hopefully that was not the objective of the author.

However, inspite of the above deficiencies, the book does present much of valuable basic information compiled at one place which may serve as a very good ready reckoner/reference source for the uninitiated, freshers and all those interested in coastal groundwater including managers and planners. It is hoped that the shortcomings will be addressed in future prints or editions turning it to a priceless treatise. Undoubtedly compilation of this nature requires painstaking work, patience, peer reviewing. I am sure that with his experience, and grit this will be possible.

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