from *Sūryasiddhānta*. Joisaru also provides some corrections and improvements devised by him to the procedures of *Vārṣikatantra*.

It may be noted that the term 'Graha' refers to the Sun, Moon and five planets visible to the naked eye, and also Chāyāgraha (shadow planet or imaginary points) such as Rāhu (ascending node of Moon's orbit around the Earth in the ecliptic plane) and Śīghrocca (apogee) of a planet, all of which move with respect to the background of stars in apparent orbits.

The commentary in Kannada is translated into English by Shylaja and Javagal, who also analyse each procedure, rationalize and point out areas where Joisaru has made his own innovative contribution, and often compare with other well-known works. The analysis is made using current notations and methods of arithmetic, spherical trigonometry, series expansions, etc. The book flows smoothly through the Sanskrit verses from *Vārṣikatantra*, Kannada commentary of *Gaṇitagannaḍi* and authors' English translation with analysis. While it does not aim to critically edit *Vārṣikatantra*, a comparison is made with *Tantradarpaṇa*, Sanskrit commentary of the same work written by Joisaru before the Kannada commentary and additional verses found are incorporated at appropriate locations.

As the authors point out, *Gaṇitagannaḍi* is not a primer: it assumes sufficient knowledge of terminology and methodology of Siddhantic astronomy. Likewise, the book under review also requires some prior knowledge of the both the Siddhantic and modern concepts in positional astronomy. The book stems from earlier research publications, and hence it is a reference work for advanced students and scholars. On the other hand, the first 35 pages of the book are easy to read and informative. Following a short foreword on behalf of the Kulapati of the family, Javagal's Preface explains Jyotiṣa as a Vedānga (part of Vedic studies), and briefs on Siddhānta Jyotiṣa, Śṛngeri Jyotiṣka lineage, the manuscripts in its possession and status of preservation and publication. This is followed by a brief on *Gaṇitagannaḍi* apparently by both the authors, and Shylaja's independent brief in Kannada. While a reader with the knowledge of Kannada would enjoy Shylaja's beautiful prose as well as the original work of Joisaru, others can skip the Kannada part and study the English translation and analysis. Those who are familiar with Sanskrit and Devanāgari script will enjoy the original verses of Viddanācārya (Chandas name is provided against each verse) and Sanskrit quotes. Those who wish to delve deeper will find the bibliography at the end to guide them; most of the works listed are referred in the book. A glossary of Sanskrit terms with their meaning in English is compiled, which contains a few words in English to Sanskrit order probably by oversight.

The Bhūtasankhya system of enumerating integers to help versifying numbers according to desired metres is explained with examples used in the original manuscript. All the Bhūtasankhyas used in the text are listed along with their numeral equivalent in the appendix. The alternative method of Kaṭapayādi numerals widely used in South India is referred in the text, but not fully explained since it is not relevant to the book. There is a verse index for the 127 verses of *Vārṣikatantra.* This is followed by a general index that provides the chapter numbers of where a technical term (Sanskrit or English) appears. It would have helped to add page numbers too, since some chapters are long counting all pages of translation and discussion.

The language and the fonts used make this book an easy read. One quibble I have is about the spaces between words that are at times missing and often too long, especially when fonts change. The diacritical marks used in the transliteration of Sanskrit words need a check. The low cost of the book offsets these minor editorial errors, and readers will be grateful to the authors and publishers for making this important historical document accessible to all.

The book is recommended for the astronomy and Indian heritage sections of all libraries. I encourage everyone interested in the historical development of science in India to read the book. It will whet the appetite of novice students who may then move on to read other works by a few researchers in the country who are bringing to light Indian heritage through evidence-based studies.

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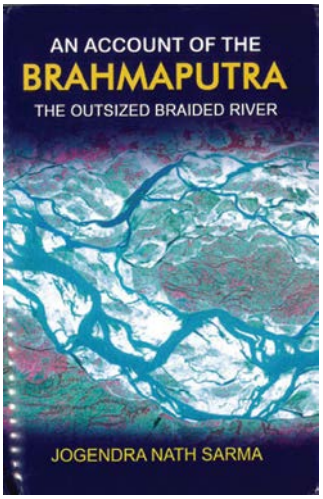

An Account of the Brahmaputra: The Outsized Braided River. Jogendra Nath Sarma. Purbanchal Prakash, H. No. 2, Sewjee Path, Dr B. N. Saikia Path, Wireless, Guwahati 781 006. 2022. 356 pages. Price: Rs 700.

Rivers with their freshwater resources constitute one of the most significant natural systems that are required for the sustenance of human populations, as well as for several other species that occur in the terrestrial biosphere. River basins occupy almost 70% of the land area such as the Amazon, Nile, Congo, Mississippi, Murray-Darling and Lena amongst others, and the Asian large rivers such as the Indus, Ganga, Brahmaputra, Godavari and the Yangtze. The large river systems and their complex networks are responsible for sculpting and creating the topography of extensive swathes of land that constitute the terrestrial ecosystems, and continue to be increasingly populated by human beings. Many of these large river systems are transboundary, and research on them is driven by their economic importance as borne out by the major developmental activities in riverscapes related to power generation, irrigation and inland waterways for navigation. Another aspect that commands attention is the understanding and mitigation of natural hazards that are associated with large river basins. We have to minimize the losses that accrue year after year because of floods, bank erosion and channel shifting.

It is noteworthy that river basins are home to about 40% of the world population, which essentially makes them coupled social–environmental systems that have come under considerable anthropogenic pressure. These systems in several parts of the world are stressed. The unprecedented population

pressure in the past 100 years on the resources of these large river basins has led to a corresponding increase in demand on their water resources, wetlands, alluvial soils and vegetation systems. Significant anthropogenic stress on the large river basins of the world has resulted from: (a) interventions related to the construction of large dams and their reservoirs; (b) the interlinking of rivers; (c) construction of embankments as a flood control measure; (d) irrigation canals; (e) sand mining, and (f) the introduction of invasive species, besides the stress imposed on wetlands and soil health through the expansion of agriculture.

As the title of the book under review emphasizes, the Brahmaputra is an outsized braided river. Let us reflect on the word 'outsized', and look at a quantitative description of the river in terms of its length, width, basin area, and the water and sediment discharge at its outlet. As pointed out by the author, the width of Brahmaputra River Valley in Assam, North East India, varies between 35 and 90 km, while the Brahmaputra channel belt varies from 1.1 to 18.6 km. The river originates in Tibet, flows for about 1600 km in an easterly direction, and then takes a sharp bend and flows southwards cutting across the Himalayan lithotectonic provinces before entering the plains of Assam near Pasighat. This 600 m wide reach becomes 10 km wide about 12 km downstream of Pasighat. The total length of the Brahmaputra is about 2900 km and the contributing drainage area up to its confluence with the Ganga in Bangladesh is ~580,000 km^2. The Ganga-Brahmaputra is the fourth largest river globally with a discharge of 19,830 m^3/s. Among the large river systems of the world, Ganga-Brahmaputra is ranked second carrying 1 billion tonnes of sediment and 100 million tonnes of dissolved load annually. These numbers serve to highlight, only to a limited extent, the complexity of this large drainage network and its hinterland; but do effectively convey a sense of the magnitude of the processes that have led to the evolution of this 2900 km long fluvial system through geologic time.

So, what are these processes and how long does it take for a large river system like the Brahmaputra to evolve. The growth and development of this large river system is related to: (i) tectonic processes such as orogenesis, domal/plateau uplifts accompanied by continental tilt, development of fracture zones and faults at many scales, and (ii) long-term climatic variability, particularly the persistence of orographic precipitation through time. In this context, coupled tectonic–erosion studies from the Bengal/Surma Basin have shown the antiquity of the Brahmaputra river system to be extending back to the Early Miocene, approximately 20 million years ago.

This book consists of 12 chapters, the first of which is introductory and includes a brief account of River Brahmaputra in ancient Indian literature such as the *Mahabharata*, the *Puranas*, and the *Brihat Samhita*. The next few chapters deal with the physical aspects of the river system, including the physiographic aspects, the geology and geomorphology of the basin, as well as climate of the basin. Chapters 5 and 6 deal with the hydrology of the Brahmaputra and its tributaries, the sediment transport data and the geohydrology of the aquifers along with a description of the natural springs. The next chapter highlights the most significant aspect of any basin, that is the resource aspect, in terms of its soils, wetlands, mineral resources, metal extraction and pottery industries, flora and fauna. It also includes a short section on the people of the Brahmaputra basin. Chapters 9 and 10 are focused on natural disasters and river channel changes along with a description of the management of such disasters. The loss and damage due to floods in this region of India is enormous; for instance, as pointed out by the author, the Brahmaputra Valley in Assam accounts for 95% of the total flood-prone area in the North East region and almost 10% of the country as a whole. Table 9.1 provides an interesting comparison of the damage caused by floods between 1991 and 2017 in Assam. The 2004 flood stands out as the most catastrophic event in Assam during this period. During the 2004 flood, 354 breaches occurred in the embankments on the rivers, thereby pointing to the flaws in the flood protection measures. Another important aspect that has been dealt with in this chapter is that of bank erosion, shifting of the bank lines and river channel changes in relation to the ancient course of the Brahmaputra. Interestingly, this chapter concludes with a report on the impact of the 1950 earthquake on River Lohit. Chapter 10 provides a detailed account of the management strategies adopted for flood control, including the construction of embankments, dredging for improving channel capacity, flood and erosion control that are aimed at prevention of bank erosion. Chapter 11 is a mix of how the water resources of the Brahmaputra were used in the past and how they are used for hydel power generation and irrigation in more recent times. The concluding chapter is on the sedimentology of the recent river deposits of the Brahmaputra. It would have been better to present the contents in an earlier chapter along with the geomorphology of the basin, say chapter 4.

The book has a useful bibliography as well as an Index that enhances the ease of access to various topics that are dealt with in the text. The accompanying tables and figures are indeed useful. Some of the figures need improvement; for example, figure 2.2 – the drainage map of the Brahmaputra Basin (p. 62) has poor legibility. Many of the field photographs (e.g. figure 9.14) should be improved in any future edition of the book.

Large river basins sustain civilizations through millennia, and hence need to be the focus of study from the viewpoint of water resources, nutrient cycling and soil health, wetlands and their management, as well as flood risk and management strategies. Therefore, this book is a welcome addition to the growing literature on the large river systems and their basins in South Asia. It is based on a career-long engagement of the author with the Brahmaputra basin, and is especially useful for the reaches of the Brahmaputra River that flow through NE India. The book should receive due attention and recognition from geologists, hydrologists and geomorphologists who are interested in ensuring a resilient terrestrial hydrosphere in South Asia now and in the future decades to come.

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