frontiers | Frontiers in Water

TYPE Editorial
PUBLISHED 15 May 2024
DOI 10.3389/frwa.2024.1415097

Check for updates

OPEN ACCESS

EDITED BY
Subimal Ghosh,
Indian Institute of Technology Bombay, India

REVIEWED BY
Amey Pathak,
Indian Institute of Technology Kharagpur, India
Saran Aadhar,
Indian Institute of Technology Jodhpur, India

*CORRESPONDENCE
Mohammad Shamsudduha
m.shamsudduha@ucl.ac.uk

RECEIVED 09 April 2024
ACCEPTED 06 May 2024
PUBLISHED 15 May 2024

CITATION
Shamsudduha M, Bhanja SN and Nowreen S (2024) Editorial: Water supply sustainability and challenges in Asian megadeltas under global change. *Front. Water* 6:1415097.
doi: 10.3389/frwa.2024.1415097

Editorial: Water supply sustainability and challenges in Asian megadeltas under global change

Mohammad Shamsudduha[1,2]*, Soumendra N. Bhanja[3] and Sara Nowreen[4]

[1]Institute for Risk and Disaster Reduction, University College London, London, United Kingdom, [2]School of Global Studies, University of Sussex, Brighton, United Kingdom, [3]Environmental Sciences Division, Oak Ridge National Laboratory (DOE), Oak Ridge, TN, United States, [4]Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

KEYWORDS

salinization risk, sustainable development, sea level rise (SLR), freshwater, coastal environment, groundwater

Editorial on the Research Topic
Water supply sustainability and challenges in Asian megadeltas under global change

Globally, riverine deltas comprise barely 1% of land area, but they support the livelihoods of more than 500 million people (Moorhouse et al., 2021). The Asian megadeltas (e.g., Indus, Bengal, Mekong, Red River, and Yangtze) and their riverine floodplains are the most dynamic economic and environmental systems in the world. These low-lying coastal landforms support surface water bodies and highly productive aquifer systems. However, water resources of the Asian megadeltas are extremely vulnerable to geogenic (e.g., arsenic) and anthropogenic (e.g., bacteria) contamination, increased water salinisation from rising sea levels (Figure 1), and chemicals (e.g., fertilizers, pesticides) from land-use practices (Mukherjee et al., 2024) – all of which are threatening the sustainability of water supply and food security in the region. This Research Topic collection features five original articles that explore water chemistry including arsenic and bacteriological contamination, water salinisation, water-energy-food nexus in irrigated agriculture, and groundwater depletion resulting from irrigation, rapid urbanization, and climate change. Although the Research Topic collection does not include case studies from all the Asian Megadeltas shown in Figure 1, the relevance of multi-hazard driven water risks to all deltaic and river floodplain environments around the world is well-illustrated.

Acharya et al. studied water chemistry in the Mahanadi River Delta – the 8th largest river basin in India (area: 141,600 km^2), which ultimately flows into the Bay of Bengal. The study involves collection and chemical analysis of river water and groundwater samples during the pre-monsoon, monsoon, and post-monsoon seasons between 2017 and 2018. This study provides the first estimates of the radiogenic Strontium flux of the Mahanadi River to the Bay of Bengal. The groundwater composition of the Lower Mahanadi Basin was found to be modulated by the mixing of four endmembers such as weathering of silicate and carbonate rocks, the mixing of Bay of Bengal seawater and fertilizer inputs. It also finds high concentrations of nitrates and phosphates in water samples during the monsoon season that derive from fertilizers – raising the concerns of surface water and groundwater contamination.

Dey et al. studied groundwater contamination by bacteria in the Churni River floodplains in the western Bengal Basin, West Bengal of India. The study collected 56 groundwater and surface water samples in January 2018 (post-monsoon), May–June 2018 (pre-monsoon), and August–September 2018 (monsoon). Water salinity measured as electrical conductivity is found to be the highest in the post-monsoon season compared to the monsoon and pre-monsoon seasons with a range of 406 to 1,894 μS/cm. Groundwater is found to be contaminated with total (TC) and fecal (FC) coliform bacteria with the highest concentrations of TC found in the monsoon season (78%) compared to pre-monsoon (48%) and post-monsoon (29%) seasons. These findings raise concerns about shallow groundwater contamination with pathogens – affecting human health due to exposure to poor-quality public water supply.

Sikdar et al. explored the impacts of groundwater development in the southern Bengal Delta that hosts populous Kolkata and Howrah cities. Demand of drinking water for 4.6 million permanent and 6 million floating populations in Kolkata city is 1,262 million liters per day (ml/day) against an almost equal amount of supply of 1,210 ml/day of which 90% of water supply is sourced from surface water the remaining 10% comes from groundwater. Groundwater levels dropped by about 14 m below ground level in the Quaternary aquifer systems of Kolkata due to decades of sustained groundwater pumping (McArthur et al., 2018). Using groundwater flow models applying MODFLOW-GUI software (Winston, 2000), this study simulates groundwater levels in the study area. The results suggest a drawdown of 22 m with respect to the predevelopment condition in about 20 to 25 years. The model predicts another ∼2 m drops of groundwater levels by 2030 if current level of pumping continues. This study raises concerns of depletion of groundwater storage and contamination of arsenic and pathogens from wastewater due to rapid urbanization and increased dependency on groundwater resources.

Siyal and Gerbens-Leenes estimates irrigation water use, energy requirements and carbon footprints associated with the freshwater supply from irrigation for major crops such as wheat, rice, sugarcane, and cotton at the national scale in Pakistan. Although this is a national-scale analysis in Pakistan, the study area covers the Indus Delta – one of the Asian megadeltas located within the southern parts of Balochistan and Sindh provinces. This study focuses on the trade-offs between the Sustainable Development Goals (SDG 2: food security, SDG 6: water security and SDG 7: clean energy and SDG 13: climate action) within the framework of water–energy–food nexus in irrigated agriculture to improve water and energy resources management. The study finds that 10 "hotspot" districts in Pakistan contribute 42% to the national share of energy footprint of the major crops that has increased by 21% in the last 14 years. Information on surface water and groundwater from a conjunctive source is not available at the district level. However, the study estimates that approximately

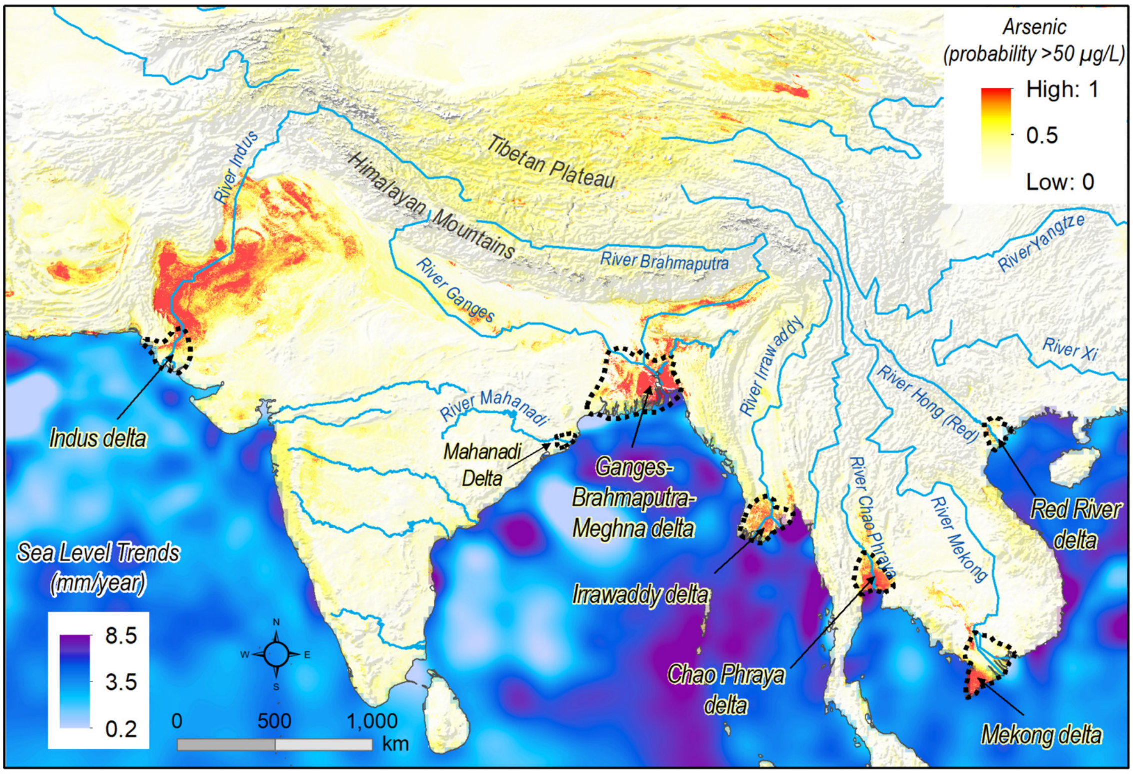

FIGURE 1
Location of the study areas that include major river and associate deltas in South and Southeast Asia. The map also features spatiotemporal trends in sea levels (1993 to 2022) from the AVISO global sea surface height dataset (Guérou et al., 2022) and the probability of predicted groundwater arsenic concentrations exceeding the WHO standard of 50 μg/L (Podgorski and Berg, 2020).

51 km^3 of freshwater was pumped in Pakistan for irrigation from surface water and groundwater combined to produce major crops (i.e., wheat, rice, sugarcane, and cotton) in the 2016–2017 season.

Haq et al. examined time-series data of surface (i.e., river) water salinity in the coastal part of the Ganges-Brahmaputra-Meghna (GBM) or the Bengal Delta of Bangladesh for the period of 1990 to 2019. Using statistical and geospatial mapping techniques this study characterizes spatiotemporal dynamics and trends in surface water salinity and identifies the key drivers of change in water salinity in rivers. This study employs parametric (linear regression) and non-parametric (Sen's slope estimator) trends as well as the Seasonal-Trend decomposition using Loess (STL) technique (Cleveland et al., 1990), and cluster analysis to characterize decadal patterns in water salinity in coastal rivers at 86 monitoring locations in southern Bangladesh. The spatiotemporal patterns in surface water salinity are primarily controlled by the magnitude and seasonality of river discharge entering the GBM Delta. In the moribund delta, just north of the Sundarbans, the contour between fresh and brackish water migrates seasonally between ∼20 and ∼40 km northward between dry and wet season indicating a strong influence of local monsoon rainfall and river discharge in the area. Other drivers of long-term changes in surface water salinity in the Bengal Delta of Bangladesh are episodic storm surges from tropical cyclones, slowly rising sea levels and anthropogenic land-use practices (e.g., polders). One of the interesting insights revealed in this study is that the effects of tropical cyclones on river-water salinity depend on the timing of the events as salinity generally peaks during the pre-monsoon season. Other findings are that the impacts of tropical cyclones and associated inundation on river-water salinity can be short-lived. Nonetheless, the impact of tropical cyclones on inland, closed water bodies (e.g., freshwater ponds, water-logged wetlands) can be substantial and prolonged.

In the background of slowly rising sea levels, frequent tropical cyclones, and changing patterns in monsoon rainfall, freshwater resources of these low-lying populous deltas in South and Southeast Asia are already facing serious threats of seasonal water scarcity, groundwater depletion, and water quality deterioration from increased salinization. Future research should emphasize on better understanding of the impacts of climate change on surface water and groundwater interactions, water quality and changes to aquifer recharge pathways. Respective governments in these deltaic countries should invest in monitoring water quality and quantity for facilitating data-driven decision making for water adaptation and sustainability in the face of accelerating climate change and development demands in the Asian megadeltas.

Author contributions

MS: Writing—original draft, Visualization, Project administration, Conceptualization. SB: Writing—review & editing, Project administration, Conceptualization. SN: Writing—review & editing, Project administration, Conceptualization.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

References

Cleveland, R. B., Cleveland, W. S., McRae, J. E., and Terpenning, I. (1990). STL: a seasonal-trend decomposition procedure based on loess (with discussion). *J. Off. Stat.* 6, 3–73.

Guérou, A., Meyssignac, B., Prandi, P., Ablain, M., Ribes, A., and Bignalet-Cazalet, F. (2022). Current observed global mean sea level rise and acceleration estimated from satellite altimetry and the associated uncertainty. *Ocean Sci.* 19, 431–451. doi: 10.5194/os-19-431-2023

McArthur, J. M., Sikdar, P. K., Leng, M. J., Ghosal, U., and Sen, I. (2018). Groundwater quality beneath an Asian megacity on a delta: Kolkata's (Calcutta's) disappearing arsenic and present manganese. *Environ. Sci. Technol.* 52, 5161–5172. doi: 10.1021/acs.est.7b04996

Moorhouse, H. L., Roberts, L. R., McGowan, S., Panizzo, V. N., Barker, P., Salehin, M., et al. (2021). Tropical Asian mega-delta ponds: Important and threatened socio-ecological systems. *Geo Geograph. Environ.* 8:e103. doi: 10.1002/geo2.103

Mukherjee, A., Coomar, P., Sarkar, S., Johannesson, K. H., Fryar, A. E., Schreiber, M. E., et al. (2024). Arsenic and other geogenic contaminants in global groundwater. *Nat. Rev. Earth Environ.* 12, 1–17. doi: 10.1038/s43017-024-00519-z

Podgorski, J., and Berg, M. (2020). Global threat of arsenic in groundwater. *Science* 368, 845–850, doi: 10.1126/science.aba1510

Winston, R. B. (2000). *Graphical User Interface for MODFLOW, Version 4. Open File Report.* Reston, VI: U.S. Geological Survey.