Kaabar Tal, Bihar's first Ramsar site: status, challenges and recommendations

The Kaabar Tal, a large floodplain wetland in the East Ganga Plains (EGPs), a bird sanctuary in Bihar, India, had been considered for long as a potential Ramsar site. It has now been accorded the status of Bihar's first and India's 39th Ramsar site on 12 November 2020 by the Ministry of Environment, Forest and Climate Change, Government of India[1]. While it is a matter of pride for the country to have another Ramsar site, it is equally important to identify the challenges that lie ahead in maintaining and managing it.

The Kaabar Tal, once a single waterbody, is now highly fragmented and appears like a mosaic of small wetlands with variable hydroperiods. Its present status points to the dire need of monitoring, managing and restoration. Based on several years of research by different workers[2–8], we present an up-to-date summary of the status of the wetland, the associated problems, and provide certain recommendations which may be useful for the restoration and management of this wetland.

The Kaabar wetland is an assemblage of different fluvio-geomorphic features such as oxbows, meander scrolls, and abandoned channels (Figure 1). The erosional and depositional processes over time have modified the fluvio-geomorphic features, giving rise to the present-day morphology[7]. Internal morphology of the wetland should be considered in any management plan. Significant changes in the inflows to Kaabar Tal wetland have taken place during the past. Before the 1950s, the nearby Burhi Gandak river was not embanked, and provided water to the wetland in the monsoon season. Also, a canal was constructed to drain the wetland for agricultural purpose, which although still exists, is completely choked with sediments. Currently, rainfall is the primary source of water for the Kaabar Tal, and the water-spread area of the wetland generally corresponds with the amount of monsoon rainfall. Since rainfall alone is not sufficient to sustain hydrological functions of a wetland, efforts to restore its original connection to the Burhi Gandak are necessary to manage the wetland.

The Kaabar Tal has ~200 sq. km of catchment area, of which 70% is agricultural land. The run-off from agricultural fields bring nutrients, pesticides and sediments into the wetland, degrading its water quality[3,5]. This warrants implementation of management of agricultural effluents not only in the wetland and its proximity, but in the entire catchment area. A regulated land-use practice in the catchment is therefore essential for good health of the wetland.

A critical issue in wetland restoration is to maintain its 'connectivity'. This requires understanding of the inflow and outflow pathways of material fluxes such as water, sediments, and biota. Seasonal assessment of geomorphic connectivity has indicated that the wetland has a better connectivity potential during the water-stressed pre-monsoon season compared to the water-surplus post-monsoon season[6]. Higher vegetation density during the post-monsoon, the growing season, brings down the potential connectivity. This is not ideal for a wetland, which is dependent on monsoon rainfall as the prime water source. Under the dynamic land-use/land-cover (LULC) scenario, during the past three decades, the potential connectivity of the wetland with its catchment has changed significantly[8]. The regions with high connectivity potential are diminishing in size, and those with low connectivity potential are increasing. This implies that the overall hydrological connectivity of the wetland is diminishing, and hence the potential

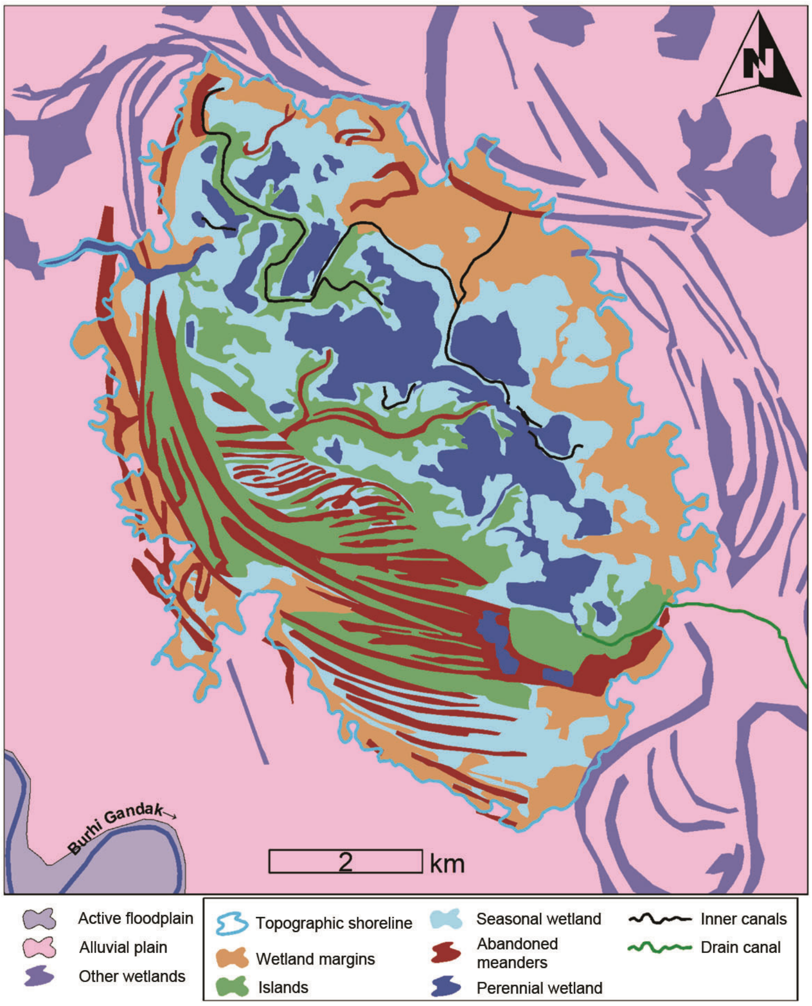

Figure 1. Major geomorphic units and features in and around Kaabar Tal, Bihar, India.

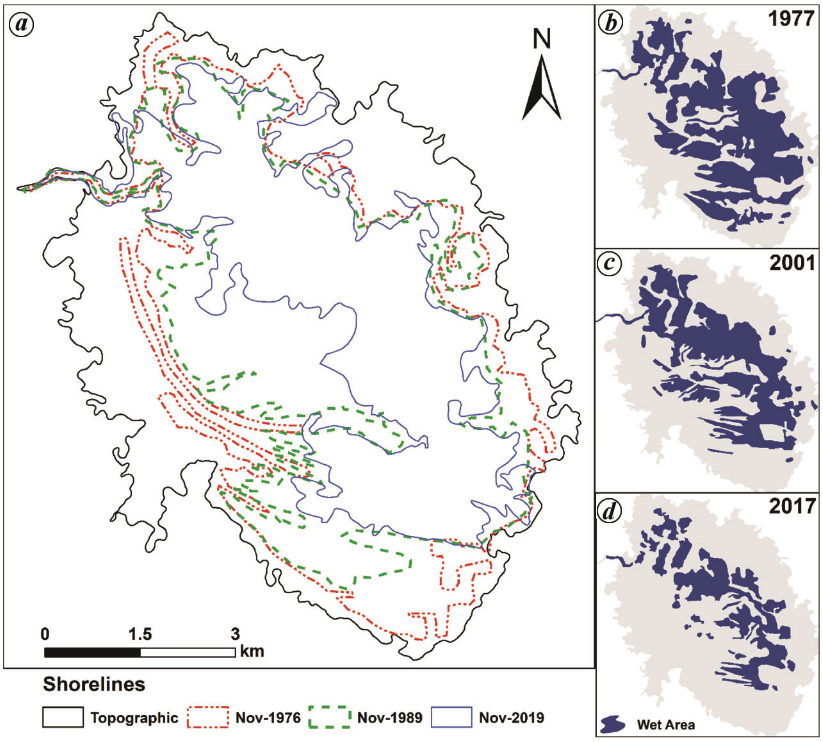

Figure 2. Shrinkage and fragmentation of Kaabar Tal. ***a***, Shorelines of Kaabar Tal in the post-monsoon season. ***b–d***, Wet area in the pre-monsoon season depicting fragmentation and shrinkage over the years.

Table 1. Kaabar Tal – factsheet

Other names	Kanwar Lake, Kabartal, Kabar Taal (A taal locally refers to large lakes/wetlands)
Ramsar site number	2436
Ramsar site designation date	21 July 2020
Location	25.62°N, 86.14°E (Begusarai, Bihar, India)
Area	51 sq. km (based on the topographic shoreline)
Water-spread area (October–November)	In 1976–33.6 sq. km, In 2019 – 23.6 sq. km Post-monsoon area, from Landsat imagery
Water-spread area (May)	In 1977–24.6 sq. km, In 2020–9.6 sq. km (Pre-monsoon area, from Landsat imagery)
Catchment	~200 sq. km Based on SRTM DEM and geomorphic mapping

for monsoon run-off reaching the wetland is also diminishing, aggravating its hydrological stress. Field visits show that changing LULC pattern, mostly due to agriculture, is the primary reason for diminishing connectivity. Dynamic connectivity analysis shows that the connectivity potential is high and even increasing in the proximal parts of the catchment. The catchment is witnessing extensive agricultural activity and therefore generates high volume of sediments. A well-connected proximal catchment with high flux of loose sediments can potentially increase fragmentation within the wetland through siltation. Therefore, management efforts should focus on increasing the hydrological connectivity with the medial and distal parts of the catchment and decreasing the sediment connectivity of the wetland from the proximal catchment areas.

Another major factor leading to fragmentation of the wetland is drying. When a waterbody starts drying from the outside, it witnesses a shoreline shrinkage; but when it dries from the inside, it starts fragmenting. Temporal analysis of 40 years of data between 1976 and 2019 of wetland dynamics has shown that the shorelines are shrinking both from inside and outside. As a result, the wetland is getting more (Figure 2), and the patches are increasingly getting less connected. We have documented 12.3 m/year of shoreline loss between 1976 and 2016 and recorded maximum shoreline loss rate ~28 m/year in the western and northwestern parts of the wetland region. Onan average, the wetland showed a drying rate of 3 ha/day during 1976–77 between October and May. This increased to 4.8 ha/day in 1989–90 and 7.8 ha/day in 2016–17. These data on spatio-temporal dynamics of the wetland and their causal factors provide the basis for planning restoration strategies for Kaabar Tal.

The present analysis of temporal data also shows that vegetation density is increasing, and the wetness is decreasing since 1988 in the wetland. There are some regions in the marginal parts where wetness is shows an increasing trend. However, in these latter marginal zones, vegetation is also increasing – implying that the wetness increment is not natural, buta result of irrigation practices. In the core regions of the wetland, vegetation growth trend is increasing, implying increasing eutrophication of the open water areas. From a wetland health point of view, terrestrial farming within the topographic shoreline of the wetland should always be discouraged because it imposes hydrological stress on the wetland by water abstraction for irrigation, increases siltation and results in eutrophication owing to nutrient-loading. Aquaculture instead of agriculture could be a better option for livelihood of the local community and should be explored.

Scientific studies on the Kaabar Tal so far call for a multidisciplinary approach to designing sustainable strategies for its restoration and management. It is essential to understand the forcing functions and feedbacks from different processes. For example, intensive agricultural practices have affected its hydrology due to high rates of groundwater and surface-water abstraction; its geomorphology has been affected by generating loose sediments leading to siltation. Geomorphologically, a wetland can be diverse and may show variable responses to forcing functions, as is the case with Kaabar Tal. Diverse and complex geomorphic characteristics of the wetland have enhanced fragmentation. Therefore, the heterogeneity and complexity of the geomorphic units of the wetland and the long-term LULC patterns of the catchment should be considered in designing any management and restoration plan.

A drying and fragmenting wetland is neither good for fishery nor for agriculture. While the loss for fisheries is obvious, damage to the farmers is subtle. The wetlands can sustain water table in dry seasons, and a dry wetland translates into lowering groundwater table in the region. Reduced wetland–catchment connectivity also hampers farming by waterlogging. The water which is supposed to reach the wetland gets trapped in the agricultural fields because of poor hydrological connectivity. It is essential to understand these multidimensional issues for evolving successful management and restoration strategies.

In summary, wetland management approach for Kaabar Tal should (i) account for the restoration of hydrological connectivity with particular focus on catchment areas which are shows ‘diminishing’ connectivity; (ii) consider reducing sediment and nutrient connectivity from the proximal catchment areas and from within the wetland and (iii) account for heterogenous hydrogeomorphology of the wetland which arises due to its polygenetic origin.

A few specific recommendations for restoration of Kaabar Tal: (a) restore hydrological connectivity by reconnecting the wetland with the Burhi Gandak; (b) keep the natural drainage network intact by construction of culverts across roads within the catchment; (c) close the drain canal; (d) monitor groundwater abstraction within the catchment and encourage canal irrigation fed by the Burhi Gandak; (e) restrict agricultural practices and encourage pisciculture within and in the proximity of the wetland; (f) discourage use of inorganic fertilizers and pesticides in the catchment, and (g) minimize siltation of the wetland, possibly through vegetative buffers around its margins.

1. https://rsis.ramsar.org/RISapp/files/RISrep/IN2436RIS_2010_en.pdf (access on 16 November 2020).
2. Ambastha, K., Hussain, S. A. and Badola, R., *Environ. Syst. Decis*., 2007, **27**, 261–273.
3. Shardendu, S., Sayantan, D., Sharma, D. and Irfan, S., *ISRN Soil Sci.*, 2012, **2012**, 9; https://doi.org/10.5402/2012/516947.
4. Ranjan, R. K., Sinha, A. K., Gupta, D., Sappal, S. M., Kumar, A. and Ramanathan, A., *J. Appl. Geochem*., 2016, **18**, 414–429.
5. Singh, A. K. and Jayakumar, S., *Imp. J. Interdiscip Res.*, 2016, **2**, 793–803.
6. Singh, M., Tandon, S. K. and Sinha, R., *Earth Surf Process. Landf.*, 2017, **42**, 1982–1996; https://doi.org/10.1002/esp.4156.
7. Singh, M. and Sinha, R., *Geomorphology*, 2020, **351**, 106960; https://doi.org/10.1016/j.geomorph.2019.106960.
8. Singh, M. and Sinha, R., *Sci. Total Environ.*, 2019, **651**, 2473–2488; https://doi.org/10.1016/j.scitotenv.2018.10.139.

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