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Understanding and enabling variability in wetlands

Max Finlayson[1] and Peter Gell[2]

Given changes due to the direct drivers of change in wetlands and the absence of suitable reference conditions, we recommend that the Ramsar Convention on Wetlands develops guidance for managers to better understand the nature and trajectory of change in wetlands, and to identify preferred ecological conditions.

The state of wetlands

The Ramsar Convention on Wetlands (see ramsar.org and Gell 2017 for background on the Convention) has reported that national governments are having difficulty in meeting their obligation to maintain the ecological character of internationally important wetlands (Ramsar sites) and other wetlands in their territory (Ramsar Convention on Wetlands 2018; Convention on Wetlands 2021). This indicates a need to better understand the drivers of change in wetlands to inform management decisions, and to identify the trajectories of ecological change.

Key obligations accepted by national governments under the Ramsar Convention are to maintain the ecological character of wetlands they designate as internationally important (known as Ramsar sites), and to make wise use of other wetlands in their territory (Finlayson et al. 2011; Pritchard 2021). These concepts are defined as follows: (1) the ecological character of a wetland is the combination of the ecosystem components, processes, and benefits/services that characterize the wetland at a given point in time; (2) wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development (Finlayson et al. 2011, page 185). Hence, national governments commit to maintaining or restoring wetland ecosystems, their biodiversity, ecological processes, and ecosystem services.

Ecological character of wetlands

The ecological character of wetlands is a consequence of their history, and the ecological trajectories that have been set in place through natural succession and the influence of humans. The former may have occurred over millennia, with more recent human impact arising from pollutants and changes in land and water use within wetlands, and their catchments.

As the maintenance of the ecological character of each Ramsar-listed wetland is judged against an agreed baseline, it is necessary to identify and describe that baseline in sufficient detail for managers to use as a reference, including accommodating natural variability and ecological succession (Pritchard 2021). In some cases, managers have accepted that the ecological character at the time of listing as a Ramsar site was the appropriate baseline. However, many wetlands were in long-term ecological decline long before listing as Ramsar sites, including those documented by Gell et al. (2016). This points to a need to provide information about the nature of change in wetlands, over a range of time-scales, and to improve understanding about their present condition and the importance of anthropogenic drivers. This includes understanding whether paleoecological approaches could be combined with other approaches to understand benchmarks of change, as well as the rates and direction of change, both historic and anthropogenic.

Wetland wise use and long-term change

Guidance for the wise use of wetlands has been developed through the Convention to provide wetland managers with technical knowledge for making decisions for managing and restoring wetlands, including for restoring water regimes and limiting the spread of invasive species. This guidance has not hitherto included how to establish baselines for determining change in ecological character, nor how to respond to variations and change due to climate change (Finlayson 2013). The examples outlined below illustrate how investigations of past change and trajectories can be important for managers.

(1) Loch Ruthven, Scotland

Loch Ruthven (Fig. 1) was listed as a Ramsar site in 1996 for its role in maintaining biodiversity in a biogeographic region. Its Ramsar Information Sheet[1] (2006) identified it as a mesotrophic lake, and identified its role in supporting breeding pairs of the waterbird, the Slavonian Grebe. Short sediment cores spanning almost 200 years revealed changes in the lake (Brooks et al. 2012). Diatom-inferred total phosphorus revealed the lake to have been oligo-mesotrophic before the 1920s; it is now approaching eutrophic levels. Preserved chironomid (midges) head capsules (a measure frequently used in palaeoecological and palaeoclimate studies) showed that an increase in productivity drove increases in food resources for grebe chicks. This eutrophication trend, attributed to increased cattle stocking, has increased the security of a key bird species, central to the listing of the Ramsar site. Care will be needed to avoid a critical transition that may impact the grebes and other biota.

(2) Lake Urmia, Iran

Lake Urmia (Fig. 2), listed as a Ramsar site[2] in 1975, was the world's second largest hypersaline lake until 1995 when the water level and area started to decline; it is now almost desiccated (Alizadeh-Choobari et al.

Figure 1: Loch Ruthven has undergone eutrophication, attributed to increased cattle stocking (photo credit: S. Elliot).

Figure 2: Lake Urmia in Iran is undergoing change in response to drying conditions (photo credit: M. Moser).

2016). This led to the loss of amenity values (Schmidt et al. 2020), exposure of island refugia for waterbirds, and reduced productivity of *Artemia*, the main food for migratory flamingos (Schulz et al. 2020). Lake levels have fluctuated greatly with several high lake phases occurring through the Late Holocene (Haghipour et al. 2020); however, the present trend appears to be the result of a drying climate (Schulz et al. 2020; Alizadeh-Choobari et al. 2016) and the use of the catchment's water sources. While the drying of the lake was reported to the Ramsar Secretariat in 2011, such multi-faceted drivers of change challenge restoration efforts owing to the broad bounds of past ecological states revealed through paleoclimate records and the challenge of attributing the change to climate versus human forcing, and local- versus global-scale influences.

(3) Gippsland Lakes, Australia

The Gippsland Lakes (Fig. 3) in southeast Australia were listed as a Ramsar site in 1982. Its Ramsar Information Sheet[3] (1999) reveals changes in water quality attributable to the construction of a permanent opening to the sea in 1889 to allow for navigation and access for ocean fisheries, as well as through farming in the catchment. Hazardous algal blooms have impacted the amenity of the system, yet pigment and isotope analyses from sediment cores show that these were also naturally prevalent prior to opening, owing to nutrient releases under stratified conditions (Cook et al. 2016). In fact, the increased inflow of marine waters acted to suppress blooms owing to higher salinities, at least until the 1940s when nutrient releases from the hinterland increased lake productivity. Recent deepening of the opening has seen an increase of tidal water in the estuary and is resulting in ecological conditions that have hitherto not been previously recorded (Boon et al. 2016), with the death of fringing vegetation and sea-grass, increases in marine biota, and unprecedented cyanobacteria blooms. The system has experienced ongoing change, since well before its listing as a Ramsar site. Future sea-level rise, reduced effective rainfall, the diversion of river flows, and the further intensification of irrigated agriculture may drive the system into novel states that comprise new combinations of species, and are self-sustaining.

Supporting analyses of the trajectories of change in wetlands

These examples raise questions about the adequacy of recent baseline conditions at the time of Ramsar listing for assessing change in the described ecological character. The examples and lessons are highly pertinent to managers, given the expected onset of further change as a consequence of global forces and the inadequacy of many past baselines (see discussion in Kopf et al. 2015). Given that many baseline, or past reference conditions, may not be suitable for future management purposes, it is recommended that the Convention develops guidance to enable managers to better understand the nature and trajectory of change in wetlands and for determining preferred ecological conditions.

Figure 3: Ocean entrance to Gippsland Lakes has enabled increased inflow of marine water (photo credit: P. Gell).

AFFILIATIONS

[1]School of Biological, Earth and Environmental Sciences, University of New South Wales, Australia

[2]School of Science, Psychology and Sport, Federation University Australia, Ballarat, Australia

CONTACT

Max Finlayson: colin_maxwell.finlayson@unsw.edu.au

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LINKS

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[3]rsis.ramsar.org/RISapp/files/RISrep/AU269RIS.pdf