Environmental sciences

Extent and drivers of global wetland loss

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An impressive combination of modelling and data analysis has enabled a new estimate of the extent of wetland losses over the past few centuries – and reveals that an area about the size of India has been lost since 1700. **See p.281**

Wetland ecosystems provide essential services that have supported human communities worldwide for thousands of years. Yet, owing to their proximity to reliable water sources, rich soils and typically flat topographies, wetlands have often been drained or repurposed so that the land can be used for human objectives[1] (Fig. 1) – most notably, in pursuit of productive agricultural land and to accommodate growing urban populations[2]. The history of these environmentally devastating transformations is so long that developing an accurate global picture of the long-term extent of wetland loss has been exceptionally difficult. On page 281, Fluet-Chouinard *et al.*[3] provide a comprehensive estimate.

Conventional measures of global wetland loss are typically stated in highly approximate terms such as 'more than half', although estimates[1,2,4,5] developed using different approaches range from around 28% to 87% for the period since 1700. Many of these have involved the compilation of wetland-loss estimates from a variety of published local sources, which were then extrapolated globally[2]. However, this approach suffers from the varied definitions of wetlands used in the referenced materials. The question of what to include in efforts to estimate global wetland loss has been eloquently summed up[5] as, "How wet is wet enough?"

Furthermore, compilations can have severe data gaps for areas where no reliable estimates of wetland change have been made. This leads to biased estimates with unreliable measures of uncertainty[5]. Crucially, compilations also lack spatial data sets, making it difficult to develop analyses that could help to reveal geographical patterns in wetland change. Such patterns are essential for purposes including wetland management[6], planning conservation and restoration activities, assessing progress towards global conservation targets and understanding the various drivers of wetland loss[7].

Drawing on a large number of data sources, Fluet-Chouinard *et al.* address many of these issues, and reconstruct the extent of the world's wetland losses since 1700. The authors reveal that around 3.4 million square kilometres – equivalent to about 2% of Earth's land surface area – have been lost

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Figure 1 | A rice field at Tonlé Sap Lake, Cambodia. Conversion of wetland to rice fields is contributing to extensive loss of natural wetland ecosystems in the Tonlé Sap region.

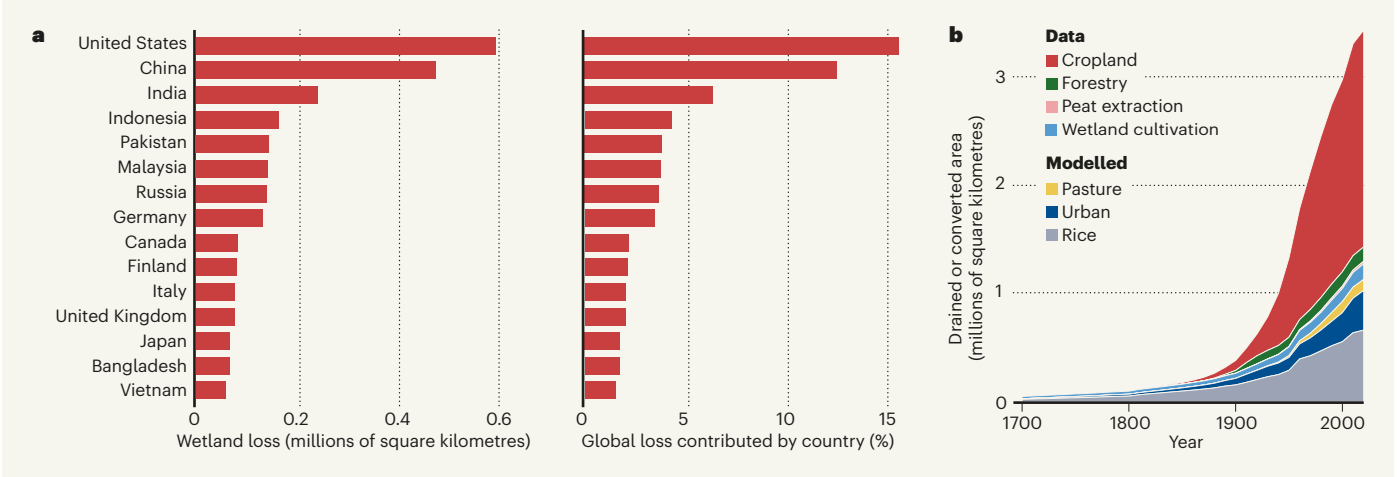

Figure 2 | Major areas and causes of wetland loss since 1700. a, These charts show the 15 countries in which the greatest percentage of global wetland loss has occurred, according to an analysis by Fluet-Chouinard and colleagues[3]. **b**, The analysis also quantifies the land uses that have contributed most to wetland loss over time.

owing to a broad range of drivers over the past three centuries[8]. This equates to the loss of about one-fifth (21%) of the wetlands that existed in 1700.

The authors put considerable effort into developing a database to support their analyses. This included data for cropland conversion, forestry, peat extraction and the cultivation of wetlands obtained from 3,320 land-use and land-drainage records collected over various spatial scales. The authors used this information to develop a global time series of wetland losses resulting from these four activities. They also modelled the extent of other, more poorly documented land uses (such as rice irrigation, pasture and urban development) that have driven wetland conversion. These efforts provided a basis on which to develop a broad suite of analyses — including simulations of the probable historical extent of wetlands to fill considerable gaps in the historical record. The result is a comprehensive estimate of global wetland loss, its spatial distribution over time and an assessment of the causes of those losses (Fig. 2).

Fluet-Chouinard and colleagues' analysis enabled the drivers of wetland loss to be ranked in terms of impact. Top of the list, by far, was wetland drainage for croplands. Such drainage has transformed vast swathes of upland wetlands into areas now dominated by cultivation. It was responsible for nearly two-thirds (62%) of the wetland losses reported in the study. Conversion of wetlands to rice agriculture, urban areas and (mainly in northern Europe) forestry were also large drivers of wetland losses. The analysis showed that losses have occurred worldwide, but, strikingly, that more than 40% of global losses occurred in just five countries: the United States, China, India, Russia and Indonesia.

Researchers often struggle to balance historical records with new data sets, such as those derived from Earth observation, to develop global estimates of land-surface change. Fluet-Chouinard *et al.* have managed to integrate data from a broad range of old and new sources into a geographically comprehensive analysis. These data should support models that simulate the Earth system, improve our understanding of the long-term patterns of land-use change that influence, among other things, the persistence of wetland biodiversity, and enhance our ability to characterize the Anthropocene (the proposed name for the geological phase in which human activity is the dominant influence on the environment).

Nevertheless, several sources of uncertainty remain. The authors acknowledge that some destructive activities, particularly drainage, occurred before 1700, and point out that very different sources of data (such as pollen records) will be needed to estimate pre-1700 wetland extent. Moreover, changing rainfall patterns and increasing efforts to restore and reconnect wetland ecosystems are currently resulting in wetland gains in some places — a process acknowledged by the authors but not included in their modelling framework. Wetland gains should be addressed in future studies as the rate of losses continues to decelerate and meaningful actions to restore the world's wetlands grow. Knowledge about the types of wetland that have disappeared would also enable a better understanding of lost ecosystem services and historical changes in wetland biota, leading to a better understanding of the global status of the world's freshwater ecosystems[9].

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Spatial models that describe the occurrence of and change in major systems such as wetlands are a crucial information source that can help us to understand and manage rapid global change. The findings and resources developed by Fluet-Chouinard *et al.* will also inform global policy initiatives, including the United Nations Sustainable Development Goals, which require an understanding of the distribution of wetland change to improve the management of these ecosystems. For example, knowledge of the former spatial distribution of wetlands might enhance the planning, success rate and biodiversity benefits of wetland restorations across the world[10], thereby aiding global efforts to meet agreements such as the Kunming-Montreal Global Biodiversity Framework of the UN Convention on Biological Diversity, adopted in 2022. More broadly, this new analysis highlights the ongoing need to protect and restore the world's remaining wetland ecosystems.

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