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Editorial: The impacts of climate change and human activities on the structure and function of wetland/grassland ecosystems

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Editorial on the Research Topic
The impacts of climate change and human activities on the structure and function of wetland/grassland ecosystems

Wetland/grassland ecosystems play a crucial role in providing numerous ecosystem services, including water purification, flood prevention, carbon (C) sequestration, and habitat provision. However, these ecosystems are highly vulnerable to environmental changes. In recent years, climate change and human activities have put these ecosystems at risk of degradation or transformation (Cloern et al., 2016). This could lead to the release of C, exacerbating global warming and causing habitat loss, water pollution, and the introduction of invasive species (Gibbons et al., 2000; Jaureguiberry et al., 2022). As a result, there has been a decline in biodiversity and ecosystem service functions (Sharma and Singh, 2021; Martínez-Megías and Rico, 2022). On the one hand, wetland/grassland ecosystems support rich biodiversity, and studying their responses to climate change and human disturbances helps identify conservation priorities and provides information for implementing effective management practices. Conducting such research enables us to gain a deeper understanding of the ecological interactions and dependencies within these ecosystems. This knowledge empowers us to make well-informed decisions regarding their protection and restoration. On the other hand, wetland/grassland ecosystems are often interconnected with surrounding landscapes, making them susceptible to land use changes and habitat fragmentation caused by climate change and human activities. By studying the impacts of these disturbances, we can develop sustainable land-use practices, minimize negative effects, and promote their long-term viability. Therefore, the related research is crucial for understanding their vulnerability, protecting ecosystem services, preserving biodiversity, and providing information for sustainable management practices.

This Research Topic focuses on the impacts of climate change and human activities on various components, such as plants and soil, as well as ecological functions like C fixation and biodiversity maintenance, within wetland and grassland ecosystems including regional

or specific site scales. It utilizes a range of methods, such as manipulation experiments, remote sensing, ecological models, and machine learning techniques.

Climate change or human activities' effects on wetland/grassland plants

This thematic section contains eight papers on the study of climate change and human activities' effects on wetland/grassland plants. Based on a variety of research methods, these studies present several significant findings and new perspectives on vegetation coverage, aboveground biomass, plant stoichiometry and stable isotopes. Wang et al. based on the Global Database (CMCC-BioClimInd), identified the key bioclimatic indicators that indicate forage growth in the northeastern Qinghai-Tibet Plateau and revealed the physiological and ecological mechanisms behind forage growth in this region. In terms of stoichiometric ratios and stable isotope feature of plant issues, the findings of Wang et al. support the idea that shrubs in permafrost peatlands expand due to competition for nutrients under conditions of climate warming, which helps enhance our understanding of how various plant tissues in permafrost peatlands respond to climate change. Chen et al. utilized the Break for Additive Seasonal and Trend (BFAST) algorithm to detect abrupt changes in the monthly Normalized Difference Vegetation Index in wetlands and revealed a significant turning point in the greening of wetlands in the new century. The time-lag effect of alpine vegetation on climate variables is further discussed in the study. Based on the long-term altitude asymmetric warming experiment, Han et al. proposed that uneven warming at different altitudes could balance out plant α-diversity and aboveground net primary production in the northern alpine steppe of Qinghai-Tibetan Plateau. Lv et al. focused on Kobresia pygmaea, a dwarf sedge in the alpine meadow on the Qinghai-Tibet Plateau. They used the BIOMOD niche model to determine the potential distribution of its community and revealed the spatial distribution and driving factors from the perspectives of human activities and climate change. Feng et al. utilized the residual analysis method to simulate the potential net primary productivity (NPPp) of marsh wetland vegetation in the source region of the Yellow River. They employed the Zhou Guangsheng model to simulate NPPp and calculated the net primary production (NPP) influenced by human activities by comparing the results with the MOD17A3HGF product. The problem of quantifying the relative contribution of climate change and human activities to changes in NPPa in marsh wetland vegetation has been solved.

In addition, based on an investigation of vegetation communities in inland salt marsh wetlands, Kang et al. utilized meteorological, hydrological, and Landsat remote sensing image data, as well as a binary pixel model, to analyze the spatio-temporal distribution characteristics of vegetation coverage in inland salt marsh lake wetlands in Sugen. They also quantitatively analyzed the response of vegetation coverage to hydrometeorological factors, which is beneficial for preventing vegetation degradation in fragile ecosystems. Liu et al. utilized high-resolution remote sensing images from Sentinel-1 and Sentinel-2, as well as environmental and topographic data, along with remote sensing algorithms including traditional regression, machine learning, and deep learning models, to estimate the aboveground biomass (AGB) of mountain grasslands in southwest China. This method provides a high spatial resolution simulation solution for estimating the AGB of grassland with complex terrain, fragmented landscape, and interleaved vegetation distribution. Furthermore, Tao et al. conducted a study on the composition of the plankton community and its influencing factors. They found that an increase in biodiversity and improved resource use efficiency resulted in a more stable plankton community. Their research will contribute to the restoration of damaged wetlands and provide a valuable reference for the protection of urban wetland ecosystems.

Climate change or human activities' effects on wetland/grassland soil biogeochemical cycles

In this thematic issue, the main factors considered to affect soil element cycling in wetland/grassland are warming, precipitation changes (including timing and intensity), and external nitrogen (N) input. Ma et al. conducted a laboratory experiment to investigate the changes in carbon dioxide emissions and soil enzyme activity under warming in a boreal peatland. They also examined the litter positions in the soil and the response mechanism of climate warming on litter decomposition. Tong et al. conducted a greenhouse experiment to investigate the effects of warming and drought on the C, N, and phosphorus cycles in the soil of alpine meadows. The study proposed an interesting finding that microorganisms did not directly benefit significantly from the increased nutrient availability under the prevailing conditions. Furthermore, in the Inner Mongolia steppe, Chen et al. investigated the biotic and abiotic factors that influence methane (CH_4) uptake through a manipulated experiment involving warming and precipitation addition. Zheng et al. investigated the co-regulatory effects of timing and plant composition on CH_4 uptake under heavy rainfall using a manipulative experiment and a mixed-effect model. At the same time, the study highlights that climate-driven changes in dominant species are highly likely to alter ecosystem feedback. Based on field investigations, Cong et al. conducted an in-depth study on the stability of C pools under climate change and human activities. They assessed the effects of climate factors and human activities on C pools in natural and degraded peatlands, and highlighted the sensitivity and vulnerability of C pools in shrub peatlands under anthropogenic interference. Through a field N input experiment and high-throughput sequencing technology, Huang et al. found that the response of the soil bacterial phylogenetic community to short-term N input was more sensitive than that of the species community. This finding emphasizes the importance of considering the phylogenetic level in research on the response of soil bacterial communities to short-term N input. Song et al. monitored the long-

term net ecosystem exchange (NEE) flux using an open-path eddy covariance system and identified a pattern in which NEE responds to the size of rainfall events. This study contributes to a deeper understanding of the C cycle and its regulatory mechanisms in the temperate desert steppe. More significantly, it also provides valuable long-term continuous field monitoring data for the validation of ecological models.

In addition, there is one paper that mainly focuses on wetland degradation. Sun et al. utilized an expert scoring method and analytic hierarchy process, along with networks and administrative units, to examine wetland degradation at a regional scale in Northeast China. Their findings clearly indicate that human activities, such as construction, overgrazing, deforestation, and reclamation, were the primary causes of wetland degradation, which could provide a new perspective for the index selection and model construction of comprehensive evaluation of wetland degradation in other cold areas.

In summary, this Research Topic explores a range of wetland and grassland ecosystems, with a specific focus on the impact of climate change and human activities on their vegetation and soil biogeochemical cycles. These papers can provide valuable insights for addressing the challenges brought about by environmental changes and ensuring the continued health and functionality of these vital ecosystems.

Author contributions

KZ: Writing – original draft. ZY: Writing – review & editing.

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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.

Publisher's note

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