

The global network of cultural ecosystem services estimated from social media posts reveals increased focus on urban greenspace and self-care during the COVID-19 pandemic

Keywords: computational human ecology; large-scale social phenomena; computational methods to study cultural dynamics; human-nature interactions; cultural ecosystem services

Extended Abstract

Understanding human-nature interactions and the architecture and functions of coupled human-nature systems is one of the grand challenges of sustainability science^{1,2}. This knowledge is crucial for human activities to be sustained while keeping the planet in a habitable state for our species. One poorly understood aspect of those interactions are cultural ecosystem services (CES). CES are co-produced by people undertaking activities in nature and are generally defined as intangible benefits people obtain from nature exposure³. Recent work suggests the importance of CES as contributors to human well-being^{4,5}. However, this work also emphasizes that we have a poor understanding of how well-being benefits emerge from human-nature interactions. CES are generally studied using case studies, and it is not known which general ecosystem features are used for recreational activities and enjoyment^{3,6}. Given the overall scope of CES to contribute to the global well-being challenge associated with rapid planetary changes⁷, we crucially need to understand the drivers and resilience of the global nature features-human activities network systems (CES networks hereafter). The key hurdle to understand and estimate CES is data access. Recent developments in social media sampling have shown that user-generated data can be a useful measure of visitation at destinations offering CES^{8,9}. Beyond sampling intensity of nature use, it is possible to use text-mining approaches to retrieve the context of human-nature interactions from this data. Thus, enabling the estimation of CES networks.

Here we used social media data to gain a better understanding of the relationship between the ecosystem features and human activities underpinning human-nature interactions. We particularly aimed to assess whether the global CES network changed during the COVID-19 pandemic. Public health interventions meant that the human mobility was globally reduced, hence reducing the scope for people to access CES. At the same time there are multiple reports that people sought nature more during the pandemic for its well-being benefits. We used Reddit and Twitter to understand the contexts of human-nature interactions providing CES. It was expected that the structure of the global bipartite socioecological network, based on human-nature interactions, would change in response to the pandemic.

We used a bottom-up approach to build the repertoire of CES human activities and CES nature features. We queried Reddit to produce a complete list of nature features mentioned in nature dedicated conversations (r/EarthPorn) over the past ten years, retrieving 40 main nature features from 590 thousand posts. The same was done for conversations dedicated to outdoor activities (r/Outdoors), where 197 human activities were retrieved from 93 thousand posts. We then sampled Twitter to estimate the co-occurrence of nature features and human activities in tweets, which resulted in 41.7 million tweets post cleaning. We estimated the CES bipartite network from these tweets, where each edge was weighted by the number of times nature

features and human activities co-occurred in tweets. Due to the large number of features and activities, a second network was constructed, where features and activities were pooled into larger classes, i.e., features were grouped into 11 nature classes and activities were grouped in 16 activity classes. The resulting CES networks (full and grouped) were estimated annually for 2018 to 2022 (Figure 1). This covered tweets reporting human-nature interactions before, during, and after the COVID-19 pandemic, making it possible to assess the network's response to this global perturbation.

The global structure of the CES network did not change between years. However, higher-order single value decomposition (hosvd) of the CES tensor (CES network through time) showed that edge level changes occurred for specific nature and activity classes. More particularly, an increased prevalence was observed between urban greenspaces (garden, park, pool) and self-care activities (relaxing, meditating, thinking) during the first wave of the COVID-19 pandemic. This increased prevalence was temporary and the edge between urban greenspaces and self-care activities returned to its pre-crisis state the following year (2021), where there was instead an increased prevalence between urban greenspaces and outdoor recreation activities (fishing, hiking, camping).

An increased use of urban greenspace in relation to specific activity classes was observed in response the pandemic, however, the overall structure of the global CES network was resilient to the pandemic perturbation. This could be due to an overall resilience of nature features, i.e. nature features providing CES are constant, but during the pandemic these features were used by locals instead of tourists. Thus, indicating an overall need for CES and access to nature features providing CES in local communities.

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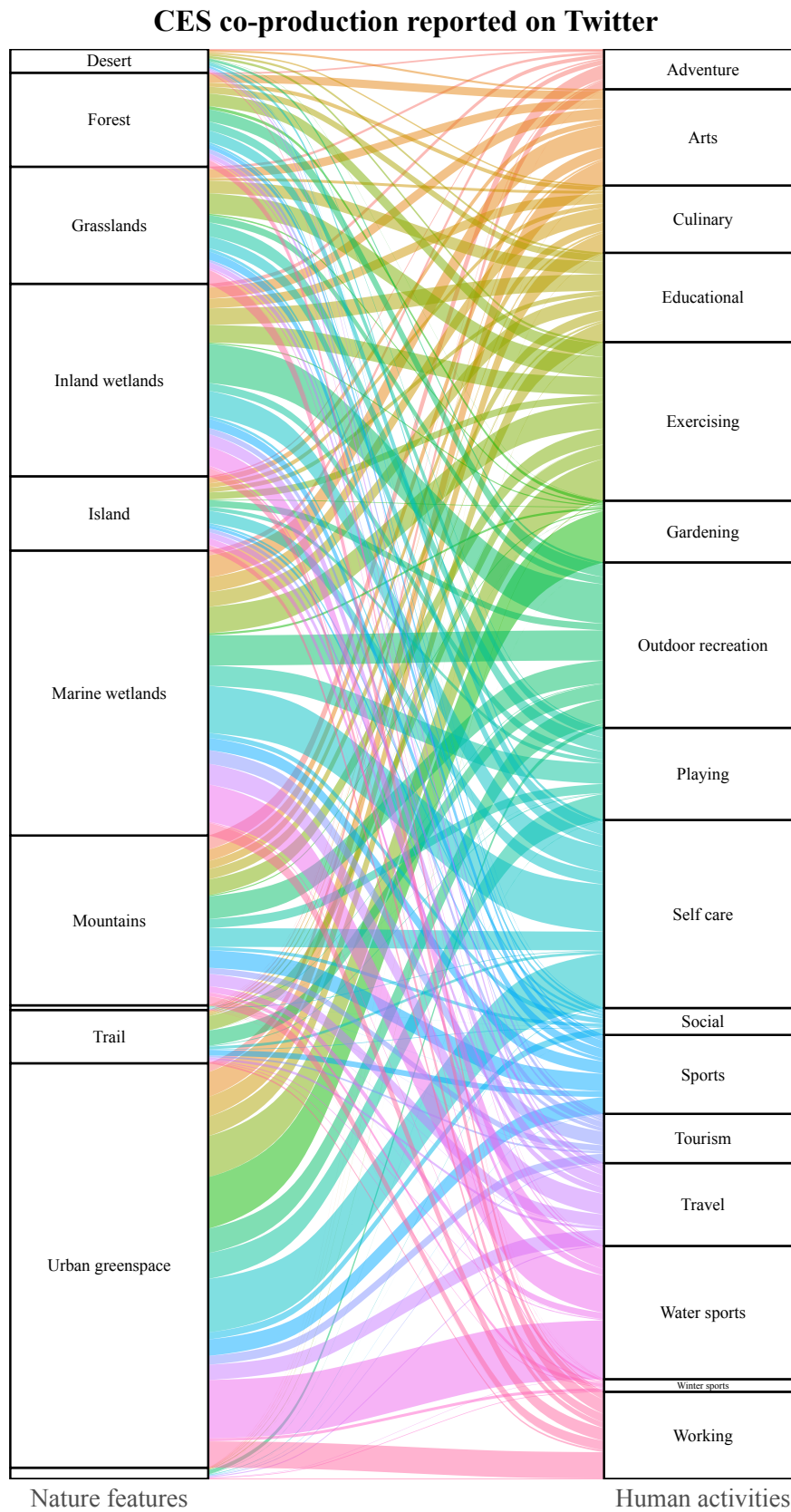


Figure 1: Co-occurrence of nature features (grouped by nature class) and human activities (grouped by activity class) on Twitter from 2018-2022 (41.7 million tweets).