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Editorial

Mountain Biodiversity, Species Distribution and Ecosystem Functioning in a Changing World

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Mountains encompass more than 30% of all land and 23% of the Earth's forests, with high levels of biodiversity and endemism, and they support diverse habitats and refuges for approximately 85% of amphibian, bird, and mammal species. More than 1/4 of the global human population inhabits mountain environments, many of whom are among the world's poorest people. However, mountains have had a tremendous impact on biodiversity and ecosystems around the world. Around 4000 m above the sea level on the Qinghai–Xizang Plateau, "the roof of the world" is characterized by a low temperature, short growing season, and diverse ecosystems, with "colder soils in a warmer world" and "escalating woody-plants encroachment into grasslands", which might reduce biodiversity and alter ecosystem functions. Biodiversity and people benefitting from nature are essential to human development and the success of the new Sustainable Development Goals [1]. According to the 2022 UN biodiversity Conference COP15, we must fulfill goals related to biodiversity conservation, the construction of ecological civilization, and harmony between humans and nature in the future. This Special Issue, therefore, focuses on studies dealing with many organisms and ecosystems in mountain areas and the responses to climate change and human activities from genes to ecosystems and from valleys to remote alpine regions.

The study of geographic diversity is attractive throughout the world. In northern China, Liang et al. investigated plant diversity along an altitudinal gradient in the Taihang Mountains and found that the plant diversity showed a hump-shaped pattern and anthropogenic factors play an important role [2]. Similarly, arbuscular mycorrhizal fungi (AMF) diversity associated with roots reflected a positive quadratic function with increasing altitude in the Taibai Mountains, which were mostly associated with soil and root nutrients [3]. In the pan-Himalaya region, the species richness in Meconopsis also showed a hump-shaped pattern along environmental gradients, which provides a theoretical background for the conservation and sustainable exploitation of Meconopsis species [4]. Concerning community assembly in alpine grasslands, based on an eleven-year-long fencing experiment along an altitudinal gradient (4400–5200 m) in Central Tibet, Deng et al. proved that stochastic processes drove plant community assembly during the restoration period [5]. Plant diversity is closely related to plant distribution and functions. In this issue, Li et al. found that the species richness level was higher on the north-facing slopes than it was on the south-facing slopes in the alpine meadows of the eastern Tibetan Plateau, and it was negatively correlated with leaf N concentration, providing evidence for interpreting the functional significance of leaf N:P stoichiometry with species composition [6].

Species distribution has frequently been studied under scenarios of future climate change. Xia et al. reviewed the progress on the geographical distribution and driving factors of Nepalese alder (*Alnus nepalensis*) and assumed that temperature would be the main environmental limiting factor since this species presented a clear northern limit of distribution and an upper limit of elevation [7]. Climate warming would, therefore, benefit

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its expansion. However, the responses to climate change differ among different species. For example, the suitable habitat for *Sabina przewalskii* and *Potentilla parvifolia* will enlarge in the 2070s, while that of *Picea crassifolia* will shrink [8]. *Capra sibirica*, a Siberian ibex in eastern Pamir, may respond to climate change by shifting to higher latitudes due to habitat reduction under future climate scenarios [9]. It seems that animals and birds are more acclimated to the changing climate than plants are. As an example, riparian birds in the Colorado mineral belt appears to be resilient to climate-change-driven increases in metals and rare earth element contents in water and aquatic macroinvertebrates [10].

At larger scales, how does vegetation vary in response to changes in climate and anthropogenic activity? Two papers in this issue analyzed the variation in vegetation using remote sensing data (MODIS NDVI) in a dry mountainous area over the last twenty years. Both cases reported an increased NDVI along the time series, which was associated with precipitation rather than temperature [11,12]. However, the NDVI was controlled by both precipitation and grazing regimes in some parts of the Mt. Qomolangma National Nature Reserve, which is probably because of the high grazing intensity due to tourism and the corresponding high population density [12]. In terms of scenery, according to the difference in plant height, ecotones between abandoned farmland and forest ecosystems can be accurately delineated via high spatial resolution imagery obtained using an aircraft system, which may allow researchers to gain a comprehensive understanding of agricultural abandoned land restoration and support the "Returning Farmland to Forest Program" in China [13]. Luo et al. applied ecological intactness scores (EIS) to indicate the status of the Giant Panda National Park (GPNP). They pointed out that the most of the GPNP's ecological intactness has remained stable during the past 40 years, while only 14% of the GPNP was degraded mainly due to LUCC and road construction [14].

In a practical application, Yunnan pine (*Pinus yunnanensis*) plantation mixed with broadleaved trees, like Nepalese alder, could improve soil quality and enzymes activity [15], which may improve the economy of forest land and enhance the ecological value. In addition, mixed forests have acquired remarkable insect resistance abilities and contributed to the protection of mountain forest ecosystem in southwest China. Li et al. identified the detoxification genes of *Tomicus yunnanensis*, a trunk borer that causes a large number of tree deaths, which provides a theoretical basis for insect resistance in mixed forests [16].

Concerning the relationship between biodiversity and ecosystem functioning, Hou et al. summarized the factors that affect biodiversity and ecosystem functioning (BEF). They further constructed a new conceptual model to provide a systematic means of understanding how different factors affect BEF. The model shows that the correlation between biodiversity and EFs involves a cascade process, while the separation of biodiversity and EFs from ecosystems without considering integrated features is not appropriate for BEF-related research [17].

This Special Issue features research articles with a focus on the Tibetan Plateau and the south-west mountain areas in China. The topic deals with the application of multiscale methods and approaches in the context of biodiversity from the genes and individuals and ecosystems to landscapes, including the adaptations of organisms, like plants, birds, and micro-organisms, spatial–temporal variations in vegetation patterns and land use statuses, and the possible driving factors for the functional adaptation of organisms to climate and anthropogenic changes. It is a shared mission to guarantee the harmonious development of humans and nature around the world and create a greener future. One indispensable component is to enable sustainable and resilient mountain development, which can enhance mountain people's ability to adapt to climate, environmental, and socioeconomic changes and enjoy the benefits and opportunities afforded by natural endowment.

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