

Science & Society

The role of National Botanical Gardens to benefit sustainable development

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China has an *in situ* conservation system built around national parks, and has begun establishing an *ex situ* conservation system led by National Botanical Gardens. We highlight how this National Botanical Gardens system will serve the global biodiversity conservation goal of harmonious coexistence between humans and nature.

The National Botanical Garden concept

Modern botanical gardens originated in mid-16th century Europe, initially focusing on medicinal plants; they have since evolved to meet the changing needs of society [1]. During the 18th century, they had a key role in spreading economically important plants around the world, and promoting the science of botany and use of economic plants [2]. More recently, their skilled cultivation of plants in beautiful landscapes has served aesthetic purposes and provided health benefits to visitors through contact with nature. Consequently, the urban green space and public education roles of botanical gardens have developed rapidly.

Now facing global change and ecosystem degradation, humanity recognizes the importance of plant conservation and the need to create and live on a 'garden earth'. The living collections and knowledge skills of botanical gardens support this vision and have the potential to help humanity and nature coexist in harmony [1,3].

The 3755 botanical gardens and arboreta across the world grow over 110 000 species, approximately one-third of all higher plants, including ~41% of threatened plants [4]. While botanical gardens in low-income countries have yet to equal the levels of research activity seen in higher income countries, they already protect threatened plants, strengthen the utilization of economic plants, and work to popularize science. Thus, they hold great promise for the future.

The National Botanical Garden concept stems from 18th-century Europe colonial expansion [5] and there are now around 80 National Botanical Gardens in 43 countries (Figure 1) [6]. Established and managed by the state, they research and conserve plant diversity, implementing international standards and strategies. Now, they urgently need to rise to the challenges of tackling biodiversity loss, climate change, ecosystem degradation, and unsustainable development.

The challenges for China

China's protected area system, led by its National Parks, and the establishment of an *ex situ* conservation system of National Botanical Gardens, brings together two complementary systems. This system will not only address the United Nations Convention on Biological Diversity, the Paris Climate Agreement, the Decade of Ecosystem Restoration and the Sustainable Development Goals, but will also achieve China's sustainable development by protecting biodiversity and providing plant resources and scientific and technological support for green development. This is necessary because China, similar to the rest of the world, faces ecosystem degradation and biodiversity loss made worse by the superimposed impact of global climate change. Meanwhile, the opportunities and solutions to these challenges offered by plants are insufficiently exploited.

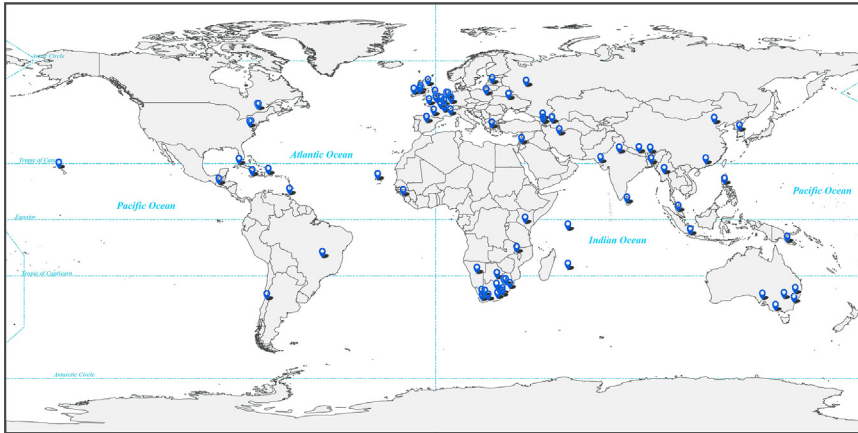
Population growth and urbanization have degraded 72% of China's forest area,

85% of its grasslands, and 75% of its wetlands to different degrees. This threatens a resource of enormous value, given the 35 784 species of higher plants in China, accounting for one-tenth of the world total. Of the species originating in China, 1374 are listed in the appendix of the Convention on International Trade in Endangered Species, and 1101 species are on the list of national key protection wild plants. At present, 3879 species of higher plants in China are on the threatened list and, given the lack of data for others, it is thought that ~15–20% of plants in China are under threat [7].

China's protected areas, including national parks, nature reserves, and nature parks, protect ~77% of China's indigenous higher plants, ~80% of the national key protected wild plants, and 84.4% of threatened plants. Between them, China's 195 botanical gardens cultivate 396 families, 3633 genera, and 23 340 species or subspecies, of which ~20 000 species are native plants, accounting for 60% of China's higher plants and 25% of the world total. China's botanical gardens conserve, *ex situ*, ~1500 threatened plant species, accounting for ~39% of indigenous threatened plant species [6]. Thus, botanical gardens have an active role in the conservation of native plant diversity in China [8]. However, three major challenges remain: (i) lack of unified planning and management at the national level; (ii) failure to give full play to the function of *ex situ* conservation of plants, with only 22% of botanical gardens having living plant collection archives and conducting research; and (iii) the conservation, research and management levels of the botanical gardens are not uneven. Therefore, there is a necessary and urgent need to develop China's National Botanical Garden system further.

The need for innovation

To strengthen biodiversity conservation, China is enhancing its protected area system with national parks as the mainstay. At the same time, to combine *in situ*



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Figure 1. Global distribution map of National Botanical Gardens.

and *ex situ* conservation, the Chinese Government approved the construction of the National Botanical Garden in Beijing and the South China National Botanical Garden in Guangzhou in 2022.

Next, China will comprehensively analyze its climatic zones, vegetation types, and biodiversity hotspots in relation to its existing botanical gardens, the status of regional sustainable development, and the intensity of support from local governments before selecting and investing in 10–12 candidate National Botanical Gardens. This will ensure the highest standards of botanical gardens, in accordance with national representativeness, conservation effectiveness, social welfare, and management feasibility. China's National Botanical Gardens will be built in accordance with 'the connotation of science, the appearance of art, the cultural heritage, international standards, and Chinese characteristics'. By 2050, more than 50% of China's native plants, more than 85% of national key protected species, and all 156 wild plant species with extremely small populations will be protected *in situ* within these gardens, and the corresponding scientific research, nature education, and resource utilization levels will be improved.

China's State Council requests that the first two National Botanical Gardens: 'Adhere to the harmonious coexistence between man and nature, respect nature, protect first, and share benefits; Adhere to the focus on *ex situ* conservation of plants, reflecting national representativeness and social welfare; Adhere to the systematic collection, complete preservation, high-level research and sustainable use of plant resource, and play a variety of functions as a whole; Adhere to the integration and display of plant knowledge and garden culture, enhance the function of science education, tell the story of Chinese plants, highlight the charm of Chinese culture and biodiversity, strengthen independent innovation, conform to international standards, and promote the construction of a National Botanical Garden system with Chinese characteristics, world-class and harmony of all things'.

China's National Botanical Gardens will be centers of innovation in scientific research, the conservation and utilization of plants, and public education. For example, the social and ecological relationship of botanical gardens will be brought into greater play via the integrated development of cities and botanical gardens through the

concepts of wildlife gardening and urban farming. More attention will be paid to the conservation of genetic diversity in wild plant species with extremely small populations and the development of benefit-sharing mechanisms for genetic resources [9], supporting the population reinforcement, reintroduction, and population restoration of China's most threatened plant species. Learning from nature and developing nature-based solutions will strengthen the relationships between elements, such as water, soil, air, and organisms, in botanical gardens and develop new strategies for carbon sequestration and adaptation to climate change. New community gardening methods simulating wild habitats will be developed together with the use of plant resources, knowledge, and skills to support ecological restoration of mountain, water, forest, field, lake, and grassland ecosystems against the background of global change. Using Big Data and artificial intelligence, the specimen, living plant, knowledge, and talent banks of each botanic garden will be systematically integrated to build an intelligent system for plant protection, scientific research, and public education. At the same time, National Botanical Gardens will actively explore the green mode of development and way of life by 'conspiring for the construction of global ecological civilization' to build a better harmonious and symbiotic relationship between humans and nature.

Concluding remarks and outlook

Over more than 500 years, the global community of botanical gardens has evolved, acquiring new roles and functions through time. Today, the world faces enormous challenges, with biodiversity loss, ecosystem degradation, and global change driving the need for sustainable development. The Kunming Declaration, issued by COP15 in Kunming in 2021, calls for global action to curb biodiversity loss, improve human well-being, and achieve sustainable development. The second phase of the

conference in Montreal in 2022 adopted the Kunming–Montreal Global Biodiversity Framework with an ambitious global vision of ‘living in harmony with nature and recognizing, conserving, restoring and sustaining the use of biodiversity values’ by 2050. In response, China proposes a comprehensive *ex situ* conservation system led by the National Botanical Gardens, to work with botanical gardens around the world in the cataloguing, assessment, *ex situ* conservation, public education, and resource utilization of plant diversity to serve the foundation of an ecological civilization and achieve harmonious coexistence between humans and nature.

Author contributions

H.R. contributed to conceptualization and writing of the original draft; S.B. contributed to review and editing.

Declaration of interests

The authors declare no competing interests.

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