Towards Nature-based Solutions at scale

10 case studies from China

Editors: M. Luo, Y. Zhang, E. Cohen-Shacham, A. Andrade, S. Maginnis

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

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Executive summary

The objective of this publication is to assess how well existing interventions in China that incorporate the use and management of ecosystems and ecosystem services align with best practice norms of Nature-based Solutions (NbS).

This is explored through ten case studies of established interventions and retroactively assessing how well they aligh with the Nature-based Solutions (NbS) Global Standard. They are presented here under one of three broad categories: natural, agricultural or urban types of ecosystems.

Based on the case studies results, it can be concluded that the several key elements required for successful “Nature-based Solutions” interventions are already commonly represented in project design, notably clarity of purpose, design at scale and biodiversity net gain. Areas that appear to be more likely to be overlooked and therefore required attention at the design stage are inclusion of stakeholders, adaptive management, recognition, balancing of trade-offs. Overall, we can conclude that a solid foundation already exists in the country

Part 1: NbS in natural ecosystems

Five case studies are presented, focusing on critical local and nationwide natural ecosystems. Each adopts holistic measures of integrated conservation, systematic restoration, and comprehensive management, to achieve the overall improvement of natural ecosystems, while strengthening their capacity to provide ecosystem goods and services to address societal challenges.

Case study 1: Holistic management and restoration of the Guanting Reservoir Watershed, to safeguard Beijing’s water security

This case study focuses on addressing water security and other challenges by improving ecosystem functions (particularly water conservation) and implementing systematic management approaches to natural ecosystems (mountains, rivers, forests, farmlands, lakes, grasslands) within the Guanting Reservoir Watershed. This project comprehensively demonstrates that the restoration of forests, wetlands and rivers, as well as the conservation of biodiversity, can effectively ensure water security and quality. Notable outcomes include disaster risk reduction, support for socio-economic development, and addressing environmental degradation and biodiversity loss.

After having assessed the case study with the NbS Global Standard, we believe that this case has an adequate fit with identifying societal challenges (Criterion 1), designing at scale (Criterion 2) and achieving net biodiversity gain (Criterion 3). However, it should seek to improve the stakeholder communication and engagement (Criterion 5), trade-offs balancing (Criterion 6) and adaptive management (Criterion 7) of the project.

Case study 2: Landscape restoration and sustainable management in the Helan Mountains

This case study focuses on restoring the natural ecosystem functions of the mountains to improve safety, ecology and landscape. The overall functionality of these ecosystems has been gradually improved by reducing anthropogenic threats (e.g. mining and overgrazing), restoring ecological corridors and improving landscape connectivity.

After having assessed the case study with the NbS Global Standard, we believe that this case has an adequate fit with identifying societal challenges (Criterion 1), designing at scale (Criterion 2) and attaining net biodiversity gain (Criterion 3). However, it should seek to improve the trade-offs balancing (Criterion 6) and adaptive management (Criterion 7). In further, it is critical to develop an inter-provincial cooperation mechanism or strategy, as the landscape is cross-jurisdictional.

Case study 3: Building a community of life in the Fuxian Lake Watershed

This case study focuses on the protection of the hydro-ecological environment of the Fuxian Lake Watershed in an effort to safeguard the ecological environment and water security of the Pearl River Basin and to support coordinated rural and urban development in central Yunnan. Through overall spatial planning and site-specific interventions, including reforestation, structural adjustment of agriculture, riparian restoration and conservation and management of the lake, a socio-economic-natural complex system has been developed that provides improved ecosystem functions and services.

After having assessed the case study with the NbS Global Standard, we believe that this case can strongly meet the indicators especially in terms of identifying societal challenges (Criterion 1), designing at scale (Criterion 2) and attaining net biodiversity gain (Criterion 3). Additionally, it also adequately fit to Criterion 7 & 8. However, the project can improve its consideration of trade-offs regard to ecological and social aspects.

Case study 4: Conservation and restoration for food, water, and people in the Ulansuhai Nur Watershed

This case study focuses on improving water security and preventing wind erosion and desertification. It has been implemented to conserve and restore various desert, farmland, mountain, grassland and river ecosystems. In addition, a special financial mechanism has been set up to facilitate private investment. After years of management and restoration, the eco-environmental quality, as well as biodiversity of Ulansuhai Nur Watershed were significantly improved.

After having assessed the case study with the NbS Global Standard, we believe that this case has partly fit to the indicators, such as identifying societal challenges (Criterion 1) and designing at scale (Criterion 2). However, the project should improve the long-term stability of funding, so as to ensure stakeholder interests (Criterion 4), developing strategies for stakeholder engagement (Criterion 5) and adaptive management (Criterion 7).

Case study 5: Integrated protection and restoration for the Qiantang River source water area

This case study focuses on the ecological conservation of Qiandao Lake, located on the upper reaches of the Qiantang River. By addressing pollution control, riparian restoration, forest restoration and mining site rehabilitation, the lake's water security has been significantly improved. In addition, a water fund was established as a mechanism for multi-stakeholder participation in the implementation of the NbS intervention. Finally, new technologies such as blockchain and artificial intelligence were adopted for water monitoring and agricultural development.

After having assessed the case study with the NbS Global Standard, we believe that this case may be partially fit to some of the indicators, such as balancing trade-offs (Criterion 6) and mainstreaming (Criterion 8). However, the project needs to attach importance to stakeholder engagement (Criterion 5) and adaptive management (Criterion 7).

Part 2: NbS in agricultural ecosystems

Two case studies focusing on rural development and associated landscapes. Both aim to promote the sustainability and multi-functionality of managed ecosystems and safeguard the livelihoods and well-being of communities by reducing agricultural pollutants, improving the provision of ecosystem services, enhancing biodiversity and revitalising rural areas.

Case study 6: Nature-based revitalization of Xunjiansi Village in Wuyuan County, Jiangxi

This case study focuses on the establishment of a community socio-economic development model based on ecosystem services and goods (e.g. tourism), research and practice through the protection and restoration of ancient water harvesting facilities and farmland ecosystems. The outcomes include village revitalisation, enhanced conservation and efficient use of natural resources, effectively contributing to addressing societal challenges (socio-economic development and disaster risk reduction), while enriching the knowledge base of NbS with traditional knowledge and local expertise from China.

After having assessed the case study with the NbS Global Standard, we believe that this case has a strong fit with the indicators, particularly in terms of identifying societal challenges (Criterion 1), designing at scale (Criterion 2), involving local communities (Criterion 5) and adaptive management (Criterion 7). It also performs well in ensuring sustainability and mainstreaming (Criterion 8). The project could improve in terms of analysing trade-offs (Criterion 6) at the planning stage.

Case study 7: Ensuring food security through conservation and the sustainable use of black soils in Jilin

This case study focuses on the development of a nature-based farming model in line with the concept of conservation agriculture by incorporating correlated, locally specific measures. These efforts have effectively protected black soils, increased the organic matter and carbon storage capacity of arable land, while facilitating an integrated response to food security and climate change mitigation.

After having assessed the case study with the NbS Global Standard, we believe that it can strongly adapt to the indicators, especially in terms of identifying societal challenges (Criterion 1), balancing trade-offs (Criterion 6) and adaptive management (Criterion 7). The project could add more considerations regarding the early involvement of the local community (Criterion 5).

Part 3: NbS in urban ecosystems

Three case studies are presented, focusing on urban areas and emphasising the introduction of NbS in cities. These aim to build an integrated and coherent ecological system within cities, improve ecosystem services in urban areas and enhance the resulting adaptive capacity of cities to climate change.

Case study 8: Integrating nature-based approaches for urban regeneration and development in Chongqing

This case study focuses on local ecological space conservation and urban regeneration. Through the sustainable use and management of natural resources, the societal challenges effectively addressed by this project include disaster risk reduction, socio-economic development and water security.

After having assessed the case study with the NbS Global Standard, we believe that this case has some strengths in terms of designing at city scale (Criterion 2), achieving biodiversity net-gain (Criterion 3) and balancing trade-offs (Criterion 6). The project could consider about alternative approaches (Criterion 4) and improve its strategy for adaptive management (Criterion 7) to maintain the ecosystem function and services.change.

Case study 9: Coordinated coastal restoration and management for sustainable development of Beihai City, Guangxi

This case study focuses on ecological restoration, systematic water pollution control and sponge city development to create a coastal wetland-urban complex system. Restoration is proposed according to zoning and specific measures for reservoirs, rivers, beaches and the sea. The project has improved water quality, biodiversity, disaster risk reduction capacity and the well-being of local communities. security.

After having assessed the case study with the NbS Global Standard, we believe that this case can strongly meet the indicators especially in terms of identifying societal challenges (Criterion 1), designing at scale (Criterion 2) and achieving net biodiversity gain (Criterion 3). However, the project should include further consideration of community involvement (Criterion 5).

Case study 10: Mangrove restoration to enhance coastal resilience of Shenzhen metropolitan zone

This case study focuses on the local systematic restoration of the ecological structure and functions of coastal mangrove forests through comprehensive river management, restoration of bird habitats, and prevention and control of invasive species and pests. The area of mangroves has increased, as has their capacity to provide habitat, adapt to climate change and sequester carbon.

After having assessed the case study with the NbS Global Standard, we believe that this case can strongly meet the indicators, particularly in terms of identifying societal challenges (Criterion 1), achieving biodiversity net-gain (Criterion 3) and mainstreaming (Criterion 8), since the project contributes to the establishment of International Mangrove Centre. Further improvement could be made by considering better community involvement (Criterion 5).

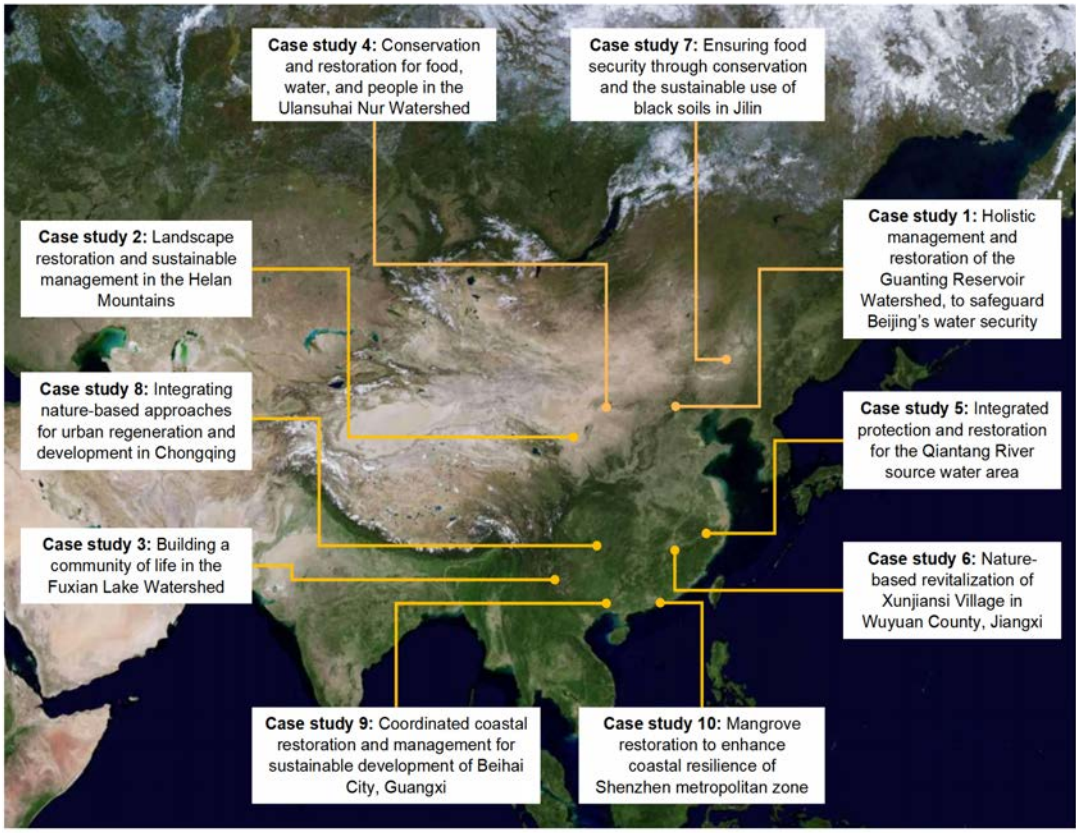

Fig 1. Locations of the ten case studies

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Glossary

Agritainment: Agritainment provides an opportunity for entertainment in an agricultural setting. Visitors or customers can provide a wide range of revenue-generating opportunities for farms.[1]

Ecological security/safety: To ensure humanity's level of unaffected by ecological destruction and environmental pollution in yield, living and health, including basic element of water and food security, air quality and green environment.[2]

First/second-class state protected animals: Precious and endangered animals in need of protection within China, as classified by the *Wildlife Protection Law* in 1988.environment.[2]

First/second-class state protected plants: Rare and precious plants listed in *China's List of Wild Plants under State Priority Conservation*.

Holistic and systematic approach to the conservation and improvement of mountains, waters, forests, farmlands, grasslands, and deserts (Shan-shui Initiative): This holistic approach follows the innate laws of ecosystems to achieve systematic protection and restoration, taking into account the full range of environmental factors-up and down mountains, above and under ground, on land and in the sea, in the upper and lower reaches of river basins, so as to increase the circulation of ecosystems and maintain ecological balance.[3]

List of wild animals under state priority conservation: A list of precious and endangered wildlife under national protection, as established by the former Ministry of Forestry and Ministry of Agriculture of the PRC, as per the relevant provisions of the *Wildlife Protection Law*.

[1]Kime, L. F., Harper, J. K., Hancharick, A., Becker, J. C., Harsh, R. M. (2011). *Agricutural Alternatives: Agritainment*. Penn State Cooperative Extension.
[2] Xiao, D., Chen, W. (2002). On the basic concepts and contents of ecological security. *The journal of applied ecology*. 13(3): 354-8. PMID: 12132171. [In Chinese]
[3] The Academy of Contemporary China and World Studies (2023). *A Holistic Approach to the Conservation of Mountains, Rivers, Forests, Farmlands, Lakes and Grasslands*. http://www.china.org.cn/english/china_key_words/2023-01/12/content_85056623.html

National ecological security barrier (ecological barrier) or ecological defence: An "ecological defence" is a complex ecosystem, located in a key part of a given area, that is capable of meeting the ecological needs of people living in it's functional area. There are three aspects to this definition: 1) An ecological reserve is a complex ecosystem, not a simple ecosystem. It may have different kinds of natural ecosystem and artificial ecosystem or economic ecosystem; 2) it must be located in a key area that can provide ecological protection for people living in its functional area; 3) it should be a health ecosystem and have certain functions that can meet the ecological requirements of human well-being.[4]

National geographical indication product protection demonstration zone: A protected area with a large industrial scale, greater social and economic benefits, a high level of protection, a sound system, a perfect mechanism, standardised management, distinctive product characteristics and high visibility, playing a role in demonstrating, guiding and promoting the protection of geographical indications.

National key ecological function area: Areas that maintain important ecological functions such as water and soil conservation, windbreak and sand trapping, all of which play a critical role in maintaining ecological security.

Production, living and ecological spaces/production-living-ecological (PLE) space: The concept of PLE space was first proposed in the report of the 18th National Congress of the Communist Party of China. It stressed that "production space should be intensive and highly efficient, living space should be moderately livable, and ecological space should be pristine and beautiful". PLE space was proposed to promote sustainable economic and social development, which has attracted increasing attention in China. PLE space in a city essentially covers the area of activities related to people's material production and spiritual life.[5]security.

Sponge city: A 'sponge city' refers to the sustainable development concept of the city, including flood control and water conservation.[6]

Three areas and four belts: From the geographic scope perspective, the seven key ecosystem areas cover all of the main ecological security barriers, representing the most valuable ecological assets of China. The identification of the key ecosystem areas is also geared towards a more balanced and sustainable development of several pivotal cross-regional economic hubs in China, including the Beijing-Tianjin-Hebei Region, Yangtze River Economic Zone, Guangdong-Hong Kong-Macao Greater Bay Area, Yangtze River Delta Region, Yellow River Region, etc.life.[5]

Water quality standard for surface water:

Class I: good water quality. The groundwater only needs to be disinfected, and the surface water can be used for daily drinking after simple purification treatment (such as filtration) and disinfection.

Class II: the water quality is slightly polluted. After conventional purification treatment (such as flocculation, precipitation, filtration, disinfection, etc.), the water quality can be used for daily drinking.

Class III: suitable for secondary protected areas of centralized domestic and drinking water sources, general fish reserves and swimming areas.

Class IV: suitable for general industrial protection areas and recreational water areas where the human body is not in direct contact.

Class V: suitable for agricultural water use areas and general landscape requirements.

[4] Wang, Y. K., Sun, X. F., Deng, Y. L., et al. (2005). A discussion on concept definition and academic value of ecological defence. *J Mt Sci*, 23(5): 431-436. [In Chinese]

[5] Wang, D., Jiang, D., Fu, J., Lin, G., Zhang, J. (2020). Comprehensive Assessment of Production–Living–Ecological Space Based on the Coupling Coordination Degree Model. *Sustainability*, 12(5):2009. https://doi.org/10.3390/su12052009

[6] China Water Risk (CWR). (2016). *Sponge cities: An answer to flood*. http://chinawaterrisk.org/resources/analysis-reviews/sponge-cities-an-answer-to-floods/

Introduction

In recent years, Nature-based Solutions (NbS) have gained increasing attention at a global scale, given their potential to address some of the most pressing societal challenges, such as climate change, water security, disaster risk reduction and human health. Countries, organisations, experts, and decision-makers around the world have interpreted and discussed the concept from different perspectives.

According to IUCN, NbS are “actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits”. NbS differ from traditional approaches and perceptions that rely upon engineering or technological solutions to solve environmental problems. Instead, they are based on the power of nature-well-functioning ecosystems and the services they provide to address societal challenges, such as climate change, disaster risk reduction, socio-economic development, food security, water security, ecosystem degradation and biodiversity loss, and human health.

Within the NbS conceptual framework, NbS are seen as an umbrella type approach that encompasses ecosystem-based and ecosystem-related approaches, all of which address societal challenges, while improving the provision of ecosystem services and carefully considering the trade-offs at their core, for the benefit of people and nature.

The IUCN Global Standard for NbS™ and its related guidance were published in 2020, proposing 8 criteria and 28 indicators for the planning and implementation of NbS interventions. Specifically, Criterion 1 emphasises the need to identify and effectively address societal challenges through NbS; Criterion 2 indicates that the design and planning of NbS should be informed by scale; Criterion 3, 4, and 5 ensure that NbS are consistent with the fundamental principles of sustainable development, and are environmentally sustainable, socially equitable and economically viable. Criterion 6 emphasises the trade-offs that need to be considered in NbS interventions between short-term and long-term benefits; Criterion 7 highlights the importance of adaptive management, while Criterion 8 specifies the need for NbS mainstreaming and integration.

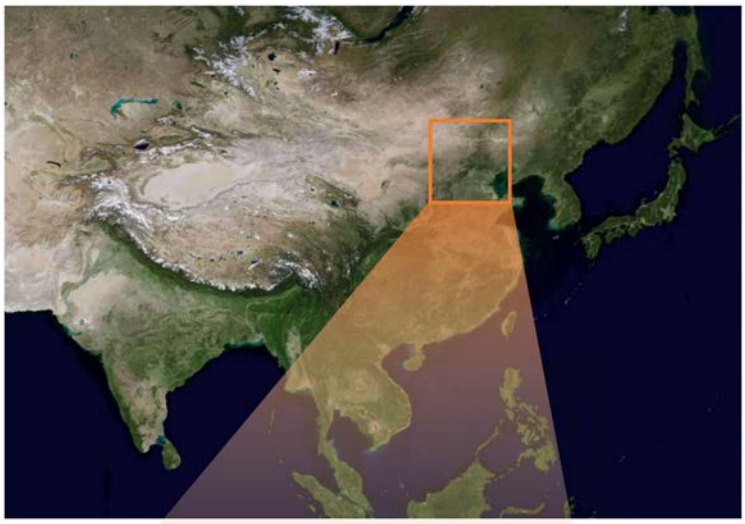
NbS address societal challenges based on or related to the provision of ecosystem services and result in benefits for society and nature; they are implemented taking into account adaptive management and governance; and they are actions to protect, sustainably manage and restore ecosystems.

Recently, large-scale ecological conservation and restoration programmes have been planned and implemented in China, leading to the emergence of various worthwhile practices in line with NbS. The aim of this publication is to present ten case studies and share Chinese practical experience and knowledge in planning and implementing interventions to address various societal challenges, protect the planet and help reverse trends of ecological degradation and biodiversity loss. While these interventions aimed to be NbS, the Global Standard for NbS had not yet been developed when they were planned and implemented. Therefore, this publication provides a detailed description of these ten case studies and a list of lessons learned from the case study managers and authors on how the Global Standard for NbS would have retrospectively helped to improve or ensure a more successful NbS intervention.

Nature-based Solutions are an emerging framework recognised by many stakeholders as essential to achieving sustainable development. Launched in 2020, the Global Standard for NbS will be reviewed by the next World Conservation Congress. This publication will help to better understand how NbS is being implemented in China, and the findings and examples will provide insights that will contribute to the upcoming revision of the Global Standard. Given the limited time and knowledge available, this report will inevitably include factors that require further elaboration, and we welcome all comments and suggestions from readers.

Case study 1: Holistic management and restoration of the Guanting Reservoir Watershed, to safeguard Beijing's water security

Authors: Ming Luo, Xu Zhou, Yan Zhou, Chongyao Yang



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Societal challenges addressed:

- Water security
- Environmental degradation and biodiversity loss
- Economic and social development

Sustainable Development Goals addressed:

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management

Total financing:

CNY 2.213 billion

Implementation period:

2016-present

Ecosystems:

F1 Rivers and streams
F3 Artificial fresh waters
F3.1 Large reservoirs
F3.2 Constructed lacustrine wetlands
T7.1 Annual croplands
T7.3 Plantations

Ecosystem services enhanced:

Water supply
Erosion control and sediment retention
Refugia

1.1 General background and challenges to address

The Sanggan River and the Yang River converge to form the Yongding River in Huailai County of Zhangjiakou City, Hebei Province, where it flows into the Guanting Reservoir, an important source of water for Beijing. The Guanting Reservoir Watershed covers an area of 280 km^2 and plays a significant role in runoff regulation and storage for flood control and disaster risk reduction.

The Guanting Reservoir Watershed is also of high value for biodiversity. Based on the data collected by the Shan Shui Conservation Center and Peking University, various wildlife species have been identified and classified according to the IUCN Red List, including one critically endangered, one endangered, and seven vulnerable species. In addition, 5 first-class and 26 second-class Chinese state protected animals were identified. The Guanting Reservoir Watershed also serves as a stopover for migratory birds along the East Asian-Australasian flyway.

In recent decades, the watershed has faced several environmental challenges: Firstly, in the mountainous areas of the headwaters, quarrying for mining has damaged the massif and contributed to soil erosion; secondly, agricultural and domestic wastes from villages upstream of the Yongding River has caused water pollution; furthermore, in the floodplains, large areas of land have been haphazardly reclaimed for maize cultivation, resulting in severe non-point source pollution from the application of chemical fertilisers; finally, on the banks of the reservoir, riparian ecosystems have been degraded and suffer from poor integrity, connectivity, and habitat fragmentation.

1.2 Main objectives

This project aims to safeguard the water security of Beijing through the holistic management of ecosystems such as rivers, streams, and wetlands in the Guanting Reservoir Watershed, thereby enhancing the ecosystem services of water regulation, supply, and filtration. Moreover, the planned restoration of the riparian buffer zone can effectively reduce the risk of flooding and the damage it causes.

1.3 Methods

Preparatory activities

To reduce the threat to the ecosystems in the Guanting Reservoir Watershed, pollution from 300 illegal polluters was banned at over 400 sites, including racecourses, restaurants, and farmyards. In addition, 30 highly polluting quarries have been closed[1]. The local government has taken an active role in the holistic management of the watershed, developing long-term ecological conservation and restoration plans, and taking control of the property development projects along the watershed.

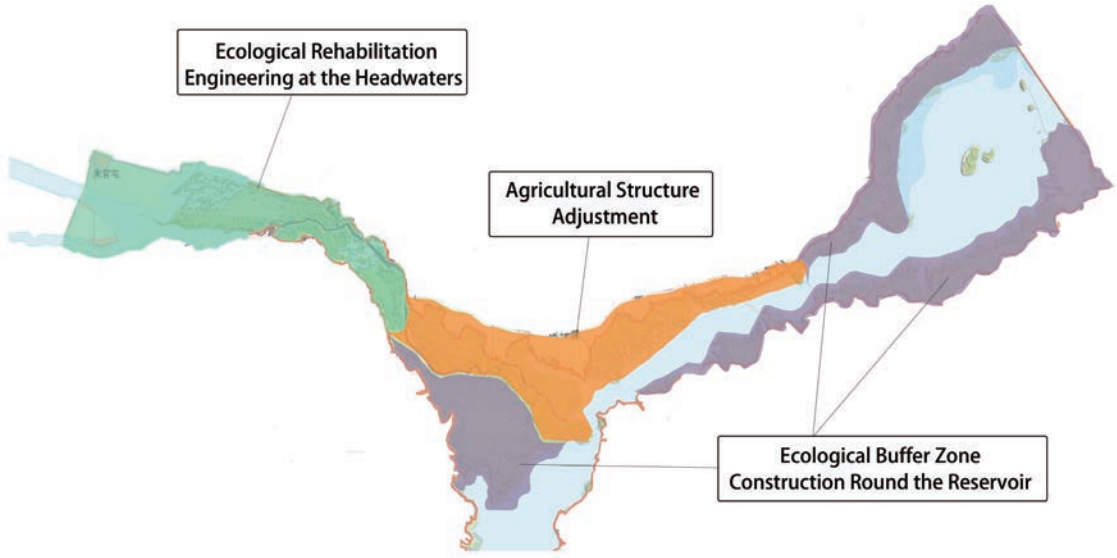


Fig 2. Illustration of the ecological restoration project in the Guanting Reservoir Watershed (© LCRC)

Ecological restoration

Rehabilitation of mining sites

30 quarries in the northern and southern mountains were closed. Vegetation restoration took place at 128 mining sites. The seven mines that remained in operation were required to fully comply with “Green Mining Standards” during production[1]. Special bonds worth CNY 375 million were acquired from the local government for the management of the high-steep slope. In addition, various companies had joined forces to restore the high-steep slope.

Restoring vegetation and connecting ponds

Along the north bank of the reservoir and the entrance, 667 ha of grass and over 60 ha of arbors and shrubs have been planted. Over 33.3 ha of wetland ponds have been constructed to create a tree-grass-water ecosystem and improve water conservation.

Restoring river habitat connectivity and natural patterns

The restoration of the Yang, Sanggan and Yongding Rivers led to the simultaneous restoration of the river flow. At the same time, the natural patterns of the rivers were restored using ecological engineering, vertical design and micro-topography reconstruction tools. Emphasis was placed on the spatial diversity and structural heterogeneity of the watercourses, and the original meanders, pools and shallows were identified.

Fig 3. Original appearance of the mine (© LCRC)

Agricultural adaptation

Some 6,667 ha of maize and other crops were converted to vineyards. This has increased financial income and reduced the use of chemicals by 2,800 tonnes[1].

Fig 4. (a) Photo of the area before restoration (© LCRC)

Fig 4. (b) Photo of the area after vegetation restoration and puddles connection engineering (© LCRC)

Creation of an ecological buffer zone around the reservoir

An ecological buffer zone 30-100m wide has been created around the Guanting Reservoir, consisting of wetlands reclaimed from farmland and aquaculture farms, and vegetation belts of arbors, shrubs and herbs.[7] With a total area of 20 km^2, the buffer zone effectively purifies surface runoff flowing into the reservoir. To avoid single-species selection and the introduction of alien species, moisture-resistant shrub and local arbor species were planted.

Fig 5. (a) Aerial photo of the riparian area before ecological buffer zone construction (© LCRC)

Fig 5. (b) Aerial photo of the riparian area after ecological buffer zone construction (© LCRC)

Biodiversity conservation

In the riparian area of the reservoir, the project makes full use of the gently sloping banks and shallow water to artificially adjusts the micro-topography thereby creating create more habitats suitable for a variety of waterfowl. Aquatic vegetation has been restored over large areas, in places where the water flow is smooth and the water level stable. Conversely, in ecologically degraded areas of tidal wetlands, different types of habitat have been created for different water birds to live, feed and breed. When creating the vegetation belts, bulbs and berries were deliberately restored to provide food sources for the birds.

In addition, at the confluence of the Yang and Sanggan Rivers, the topography of the wide estuary was adjusted to increase the water area, providing habitats for various waterfowl. Artificial floating islands have been constructed in key water quality control areas to provide additional footholds for birds. Twelve wind turbines that had a negative impact on birds were phased out[1].

1.4 Outcomes

Water security has improved since the implementation of the holistic management intervention. In addition to the reduction of non-point source pollution, the purification capacity of ecosystems has been strengthened, and the water quality of the Guanting Reservoir Watershed has steadily improved. Since 2019, water monitoring has shown that water quality has reached Class III, according to the national standard. Fertiliser use has been reduced by 2892.4 t/a, pesticide use by 16.45 t/a, COD by 347.46 t/a and NH_3-N emission by 69.49 t/a.[8]

In addition, ecological integrity and biodiversity have been enhanced. The connectivity of different reservoir ecosystems has been greatly enhanced. The ecological buffer zone functioned well to purify surface runoff. After the restoration intervention, the number of plant species increased from 106 to 318. Moreover, 252 animal species were identified, including 191 bird species. Populations of *Larus relictus*, *Podiceps cristatus*, *Grus grus*, *Tadorna ferruginea*, and *Cygnus* have been continually increasing. In addition, a rare bird species (*Ciconia boyciana*) has been sighted in the reservoir area during a stopover on a migration route.

Finally, the economic benefits of the project have been significant. The annual production of grapes was worth CNY 1.5 billion. Income from tourism in the reservoir area has also increased by more than 12% per year[1].

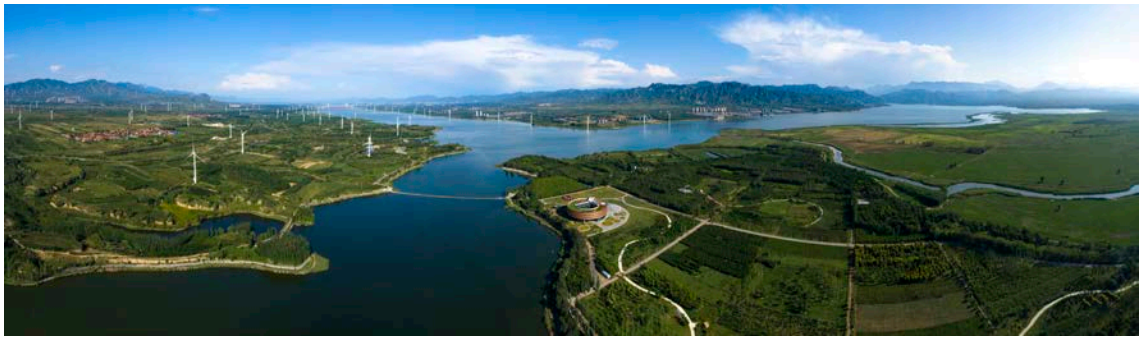
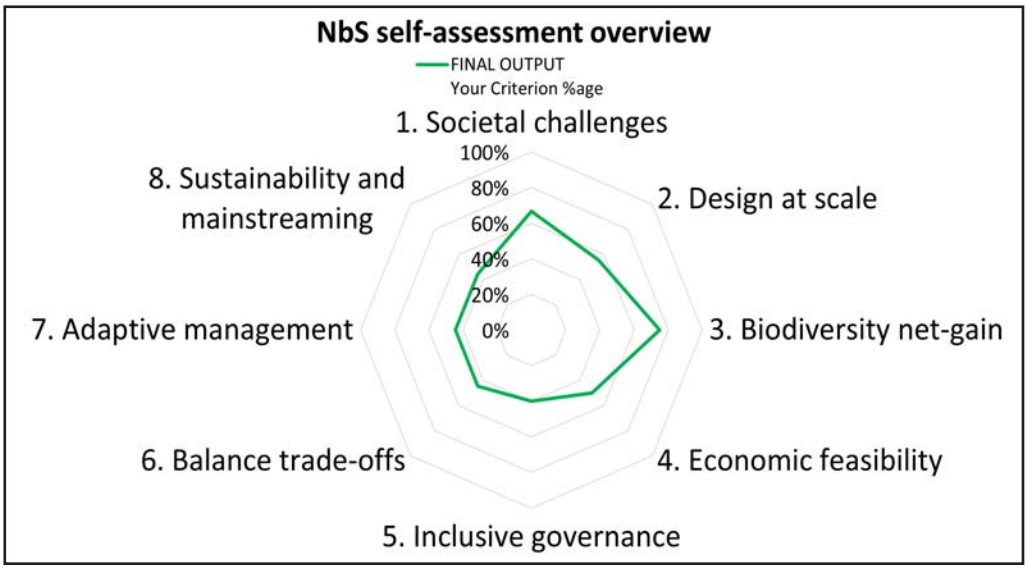


Fig 6. Aerial view of the Guanting Reservoir Watershed after restoration (© LCRC)

1.5 Link to Global Standard for NbS



Box 1. Case 1 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

In this case, the project managed to safeguard water security and reduce disaster risk by improving relevant ecosystems functions and services in the Guanting Reservoir Watershed, seeking to simultaneously reverse environmental degradation and biodiversity loss, and facilitate social and economic development.

According to the NbS Global Standard, the project meets the indicators in Criterion 1 focusing on the societal challenges, and effective interventions were planned and implemented. It has made an effort to increase ecosystems integrity, connectivity and resilience by restoration, addressing environmental problems by reducing pollution and removing the real estate projects and wind turbine generators that have negative impacts on birds and their habitats. Hence, the project manages to restore the vegetation, and enhance the provision off ecosystem functions and services - water supply, erosion control, sediment retention and refugia.

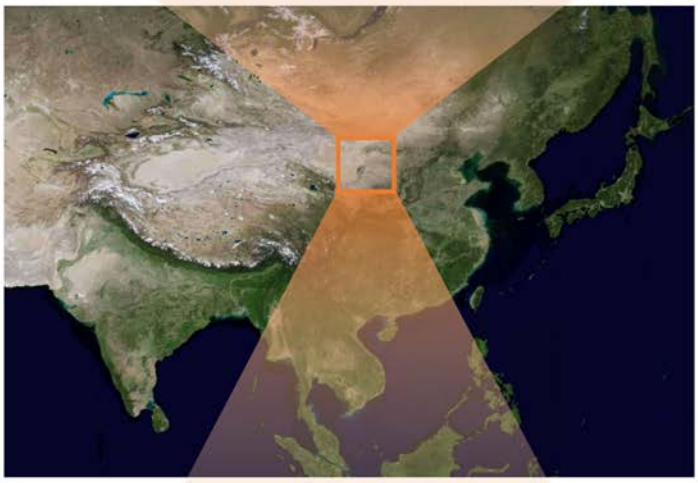
The project's strength are underlined with Criterion 1 focusing on identifying and responding to societal challenges, Criterion 3 on seeking opportunities to conserve biodiversity. In addition, several aspects can be improved in accordance with NbS Global Standard, such as Criterion 5 that focuses on stakeholders' participation and engagement in the project, at the design, planning and implementation stages, to ensure that their benefits can be taken into account. In addition, to meet Criterion 4, the project team should conduct cost-benefit and cost-effectiveness analysis to alternative approaches, and attach importance to documentation about relevant processes and activities, and develop an active publicity strategy.

[7] Construction Plan for Demonstration County of Huailai County Ecological Civilization Construction (2020 - 2022). (2020). [In Chinese]
[8] Evaluation Report on Water Environmental Carrying Capacity of Huailai County in 2019. (2020). [In Chinese]

Data sources:
[1] Zhangjiakou Municipal Bureau of Natural Resources

Case study 2: Landscape restoration and sustainable management in the Helan Mountains

Authors: Ming Luo, Chongyao Yang, Yiqiang Guo, Yuanpeng Chen



Total financing:

CNY 15 billion

Implementation period:

2017-present

Societal challenges addressed:

Water security

Disaster risk reduction

Environmental degradation and biodiversity loss

Sustainable Development Goals addressed:

Ecosystems:

T2.1 Boreal and temperate high montane forests and woodlands
T5.1 Semi-desert steppes
T6.4 Temperate alpine grasslands and shrublands
T7.3 Plantations

Ecosystem services enhanced:

Disturbance regulation
Water regulation
Erosion control and sediment retention
Refugia

NbS type approaches Implemented:

Ecosystem restoration
Ecological engineering
Area-based conservation

2.1 General background and challenges to address

Straddling the Ningxia Hui Autonomous Region and the Inner Mongolia Autonomous Region, the Helan Mountains lie at the junction of the Qinghai-Tibet Plateau, the Inner Mongolian Plateau and the Loess Plateau, stretching more than 250 km from north to south and 20 to 40 km from east to west.

For thousands of years, the Helan Mountains have formed an ecological barrier, intercepting the eastward flow of the Siberian cold wave, preventing the encroachment of the surrounding deserts, and effectively protecting the ecology of the Yellow River Basin.

As one of China's biodiversity hotspots and an important industrial base for energy and raw materials in northwestern China, the Helan Mountains are home to rich species of flora, fauna and underground mineral resources, including 1,900 species of insects and 352 species of terrestrial vertebrates, 58 of which are on China's List of Wild Animals under State Priority Conservation (7 and 51 first and second class state protected animals, respectively).

Since 2012, China's central government has attached great importance to the ecological protection and restoration of the Helan Mountains, with a total investment of more than CNY 15 billion. In fact, the project is included in the third batch of national pilot projects for ecological protection and restoration of mountains, rivers, forests, farmlands, lakes and grasslands, with a budgeted investment of CNY 5.366 billion and an additional CNY 2 billion in awards and subsidies from the central government[1].

The relatively fragile ecosystem of the Helan Mountains is located in a transitional zone between arid and semi-arid regions. This natural ecological fragility has been exacerbated by extensive human disturbance, such as high intensity grazing and long-term continuous open-cut and underground mining. Following the establishment of the Helan Mountain National Nature Reserve, rapidly expanding populations of blue sheep (*Pseudois nayaur*) have led to overgrazing of the local vegetation.

Fig 7. Blue sheep © Smithsonian Wild (CC BY-NC-SA 2.0)

2.2 Main objectives

The project aims to safeguard water security and combat desertification through the ecological restoration of abandoned mines. As a result, local mining industries and communities are shifting their livelihoods towards agroforestry and ecotourism. In addition, an increase in local species has been observed due to the restoration of grasslands from grazing and afforestation of hillsides.

2.3 Methods

The project proposes to restore degraded landscapes and reduce human threats for the benefit of safety, ecology and landscape, to restore degraded ecosystems, increase the degree of wilderness, reconnect landscape patches and improve environmental connectivity to restore the overall functionality of the natural ecosystems of the Helan Mountains.

Closure of mining sites

In the Ningxia Hui Autonomous Region, such remediation has been carried out on more than 150 km^2, with 122 mining sites closed and 169 human activity sites remediated inside the Helan Mountain National Nature Reserve, as well as 45 sites on the reserve's periphery that seriously affect the local ecology, and two concentrated coal processing plants. In addition, the policy of 'returning pastureland to grassland' has resulted in the restoration of natural vegetation within the protected area. In the Inner Mongolia Autonomous Region alone, a total of seven mines in the Helan Mountain National Nature Reserve, covering 176 ha, have been withdrawn.[9,10]

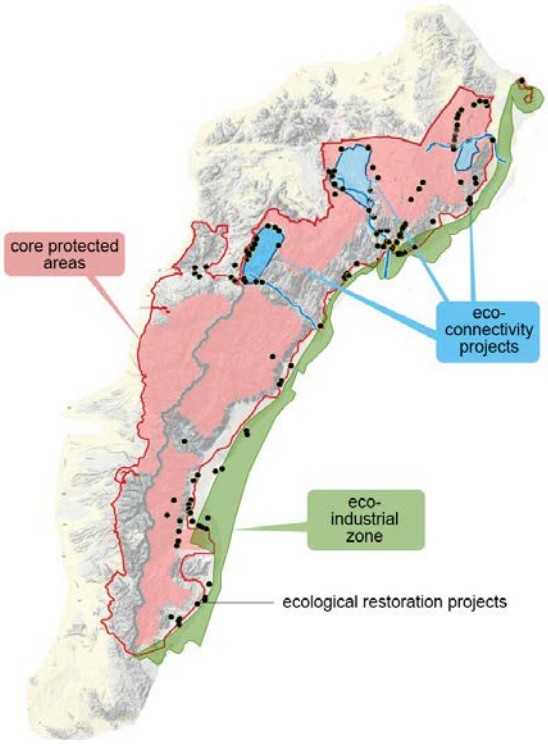


Fig 8. Schematic diagram of Helan Mountain area (© LCRC)

Large-scale restoration of damaged ecosystems

To reduce the disaster potential of landslides and floods, measures such as geological disaster elimination, management of abandoned mines, and improvement of flood control channels have been implemented, with priority given to not blocking ecological corridors or migration channels for plants and animals.

Measures such as collection of germplasm resources, expansion of rare plant species and protection of water sources have been carried out in headwater and natural areas in the local typical landscapes and mountains to achieve vertical distribution of forest vegetation. Both transplanting and domestication techniques have been carried out to maintain propagating populations of valuable and rare plant communities, including *Tetraena mongolica*, *Ammopiptanthus mongolicus*, *Prunus mongolica*, and *Glycine soja*.

In addition, vegetation rehabilitation has been carried out according to rainfall patterns. In montane areas with more than 400 mm/yr rainfall, suitable native tree seeds were sown. In areas with 200-400 mm/yr rainfall, grasses, shrubs and trees were sown, while in areas with less than 200 mm/yr rainfall, rehabilitation focused on grasses and meadows.

Enhancement of landscape connectivity and restoration of ecological corridors

Restoration activities have been carried out on 5,900 ha of former mining sites. Through geomorphological reshaping, soil reconstruction and the restoration of original vegetation, natural ecosystems and habitats have been regenerated, enlarged and corridors widened with the aim of restoring a systematic and complete food web, while providing a suitable habitat for valuable and rare wildlife, such as the Black Stork (*Ciconia nigra*), Golden Eagle (*Aquila chrysaetos*), Great Bustard (*Otis tarda*), Eurasian Sparrowhawk (*Accipiter nisus*) and other top predators that may be reintroduced in the future, including the Snow Leopard (*Panthera uncia*).

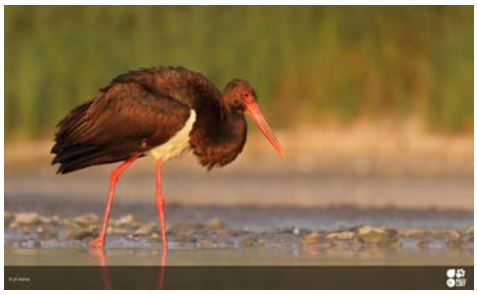


Fig 9. (a) Black stork © Jiří Bartoš

Fig 9. (b) Eurasian sparrowhawk © Petr Saj

2.4 Outcomes

Gradual restoration of degraded ecosystems in the Helan Mountains

The regional vegetation has shown an overall growth trend, with the forest cover of the reserve increasing by 1% and the total vegetation cover increasing by 20%, while the forest communities within the reserve are in positive succession. In addition, as a result of the restoration work, the area of scrub now exceeds that of 1964, with the majority of species being nationally protected plants. *Amygdalus mongolica*, a second class state protected plant, has also reappeared following the restoration of the pastures.[11]

Increased biodiversity and carbon sequestration

Monitoring data has shown that the restoration measures, including mountain closure and grazing management, have stimulated plant growth and renewal, resulting in a significant increase in plant and animal populations. In a sample plot in the southern Helan Mountains, 12 new representative shrubs of *Zygophyllum xanthoxylon* were found following restoration. In addition, the populations of blue sheep and red deer have increased from 16,000 to 50,000 and from 2,000 to 7,000 respectively.[10]

Finally, research has estimated that the carbon sequestration capacity of the ecosystems within the Helan Mountain Nature Reserve in Shizuishan City has increased by 33% following ecological protection and restoration, with the total estimated carbon storage increasing from 110,400 tC in 2015 to 146,900 tC in 2019[2].

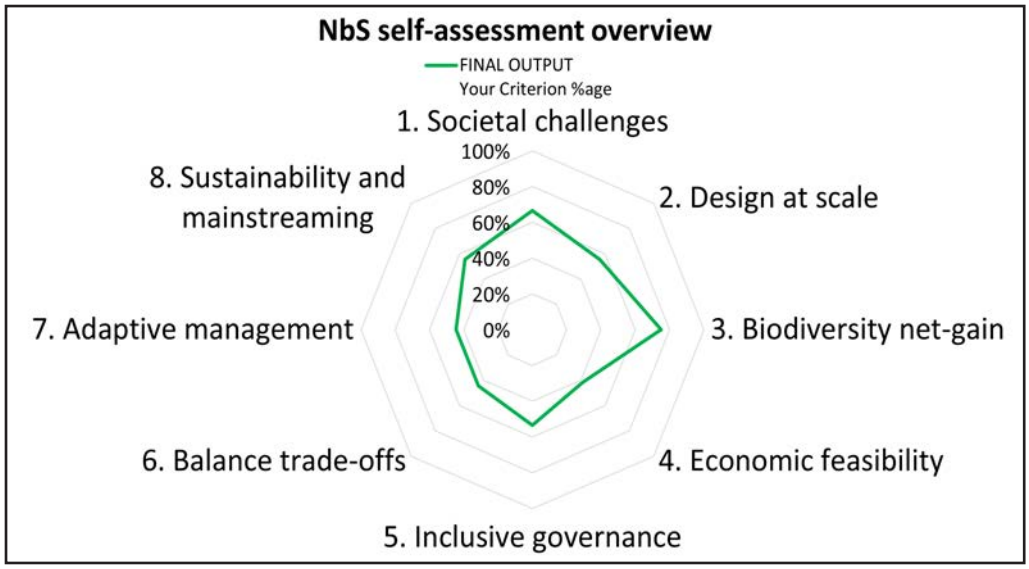
Fig 10. Aerial view of Helan Mountains after restoration (© LCRC)

Green transformation for sustainable development

Green transformation has taken place in the Helan Mountains, where miners have become vineyard owners. This has created a multifunctional agricultural landscape with an annual gross production value of CNY 23 billion, attracting 500,000 visitors a year and generating nearly CNY 1 billion in tourism-based income. The wine industry also provides 120,000 jobs and an annual income of nearly CNY 900 million. The eastern foothills of the Helan Mountains have also been recognised as a National Geographic Indication Product Protection Demonstration Zone.

Fig 11. Transformation of mine into a vineyard (© LCRC)

2.5 Link to Global Standard for NbS



Box 2. Case 2 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

In this case, since the Helan Mountains are located in the Yellow River Basin, and the dividing line between the three deserts of Tengger, Mu Us and Ulan Buh at the same time, the project therefore focuses on reducing disaster risk especially to prevent desertification, and safeguard water security. In addition, the relevant restoration interventions can contribute to reverse environmental degradation and biodiversity loss.

According to the NbS Global Standard, the project has adequate matches to the indicators in Criterion 1 in terms of clearly understanding the societal challenges, effective interventions were planned and implemented, and seek to conserve biodiversity (Criterion 3). The project also made an effort to safeguard stakeholder interests through livelihood transformation (Criterion 6) and promote the experience of rewilding (Criterion 8). Hence, the project manages to restore the vegetation, thus enhance the ecosystem functions and services of disturbance regulation, water regulation, erosion control and sediment retention and refugia.

The project has advantages in terms of identifying and responding to societal challenges, managing to safeguard stakeholder benefits, but some aspects can be improved in accordance with NbS Standard. The Helan Mountains locate across two provinces, thus, a provincial trans-boundary mechanism should be established between Ningxia and Inner Mongolia to strength the cooperation with regard to the project in the area of Helan Mountains, in order to improve the synergy and monitoring of the interventions (Criterion 5). Moreover, the project should develop an effective adaptation strategy and a strategy for long-term management (Criterion 7).

[9] Helan Mountain National Nature Reserve Management Burea (2017). Helan mountain national nature reserve 'green shield 2017' clean-up and rectification special operation. *Ningxia Forestry*, (5): 18-21 [In Chinese]

[10] Lili, Y., Yuping, Y. (2020). The effectiveness, problems and countermeasures of ecological environment protection in Helan Mountain Nature Reserve. *Inner Mongolia Forestry*, (11): 17-21 [In Chinese]

[11] Yushan, Z., Ping, S., Xingqiang, Z., & Dongjuan, C. (2004). Effect of closing hillsides for afforestation on ecological environment of Helan Mountain. *Inner Mongolia Forestry Survey*, (04): 7-9 [In Chinese]

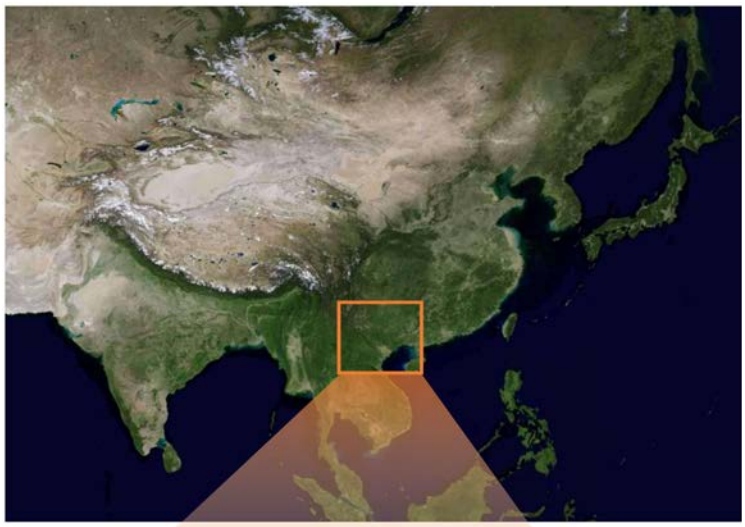
Data sources:

[1] Department of Natural Resources of Ningxia Hui Autonomous Region

[2] Research Center for Eco-environmental Sciences, Chinese Academy of Sciences

Case study 3: Building a community of life in the Fuxian Lake Watershed

Authors: Ming Luo, Yan Zhou, Yan Chen, Xu Zhou



Map data ©2022 Tianditu, MNR of the PRC & NavInfo

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Societal challenges addressed:

Water security

Environmental degradation and biodiversity loss

Economic and social development

Sustainable Development Goals addressed:

11 SUSTAINABLE CITIES AND COMMUNITIES

14 LIFE BELOW WATER

15 LIFE ON LAND

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management
Area-based conservation

Total financing:

CNY 9.313 billion

Implementation period:

2017-2020

Ecosystems:

F2.1 Large permanent freshwater lakes
Upland streams
F3.2 Constructed lacustrine wetlands
T7.1 Annual croplands

Ecosystem services enhanced:

Water regulation
Water supply
Erosion control and sediment retention
Refugia
Food production
Recreation
Culture

3.1 General background and challenges to address

Located in the Yunnan-Guizhou Plateau, there are two lakes, Fuxian and Xingyun, in the basin with a total drainage area of 1,098.49 km^2. It is also located in the 'Wuliang-Ailao Mountains', an important area for biodiversity conservation and one of the most important ecological functional zones in the country.

Fuxian Lake is an important safeguard for maintaining the ecological security of the Pearl River Basin and southwest China, as well as an essential factor for the sustainable rural and urban development of central Yunnan. It is an oligotrophic, deep, freshwater lake with the largest water storage capacity and water quality in China, making it an important national strategic water reserve.

A total of 464 tracheophyte species were identified in Fuxian Lake National Wetland Park and surrounding areas. During monitoring between 2017 and 2019, 32 fish species were recorded[1].

Located on a unique low-latitude plateau, Fuxian Lake has a less dynamic water flow, with a modelled water exchange cycle of more than 200 years, which inherently increases the fragility of the ecosystem; once polluted, the lake is extremely difficult to recover. In 2002, a large area of cyanobacteria bloomed in Fuxian Lake, causing the water quality to drop from Grade I to II. Xingyun Lake, which is part of the Fuxian Lake Watershed, has also experienced frequent cyanobacteria blooms, resulting in severely polluted water quality as high as Grade V.

The Yunnan provincial government has long attached great importance to protecting the ecology of Fuxian Lake and has made unremitting efforts to do so. In 2017, the Fuxian Lake Watershed Ecological Conservation and Restoration Project was included in the second batch of the Shan-shui Initiative, with a total investment of CNY 9.728 billion, of which CNY 2 billion was provided by the central financial authorities.

Human activities such as mining and upland farming have led to a decline in vegetation cover in the local mountain areas, as well as phosphate pollution and soil erosion. In addition, high water and fertiliser consumption has led to serious agricultural non-point source pollution. In particular, fish ponds, farmland and other land uses occupy the lakeshore buffer zone, weakening the filtering function of the wetlands. In addition, invasive species and the negative impact of human activities on natural spawning grounds have led to the depletion of native fish stocks in Fuxian Lake, threatening its biodiversity.

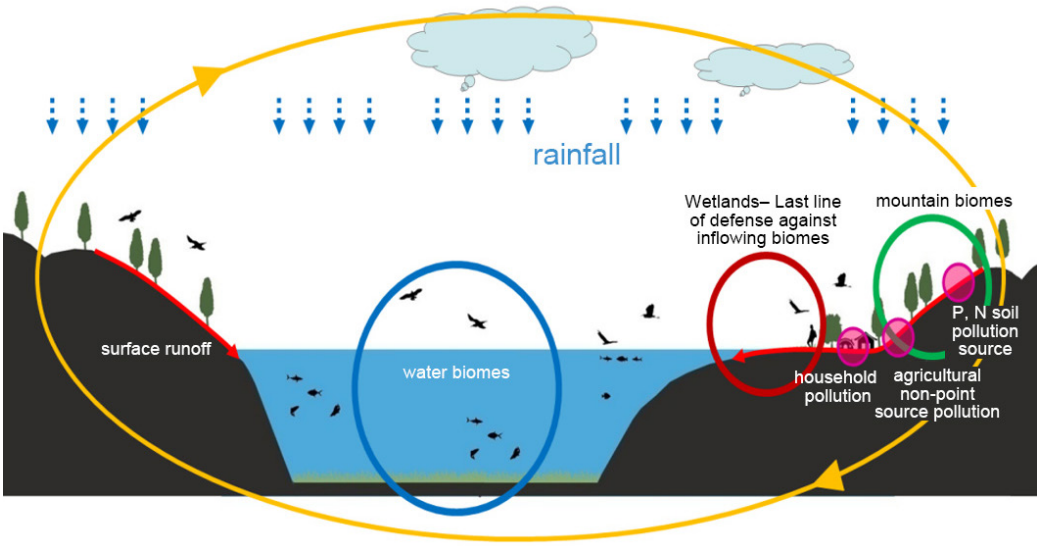


Fig 12. Diagram of lake ecosystem cycle © Wetland Planning Project Team

3.2 Main objectives

The project aims to ensure water security through the structural adjustment of agriculture, the preservation of trees and shrubs in riparian buffer zones, and the construction of an ecological purification zone. These approaches can enhance the ecosystem services of water regulation, supply and purification, while reducing disaster risk.

3.3 Methods

The Fuxian Lake Watershed Ecological Conservation and Restoration Project focuses its efforts on the entire basin. Some projects have been carried out to optimise the ecological and agricultural landscape and the spatial layout of the basin, including the relocation of industrial and mining enterprises, the closure of livestock and poultry farms, the construction of sewage networks and treatment plants, and the control of pollution in the rivers.

Recognising that the main source of pollution is surface runoff in particular soil pollutants containing nitrogen, phosphorus and potassium, and non-point source pollution from agriculture - measures and actions are being taken across mountains, dams, lake shores and water bodies. These include forest restoration and expansion, water pollution prevention and control, and pollution filtration, protection and treatment.[12]

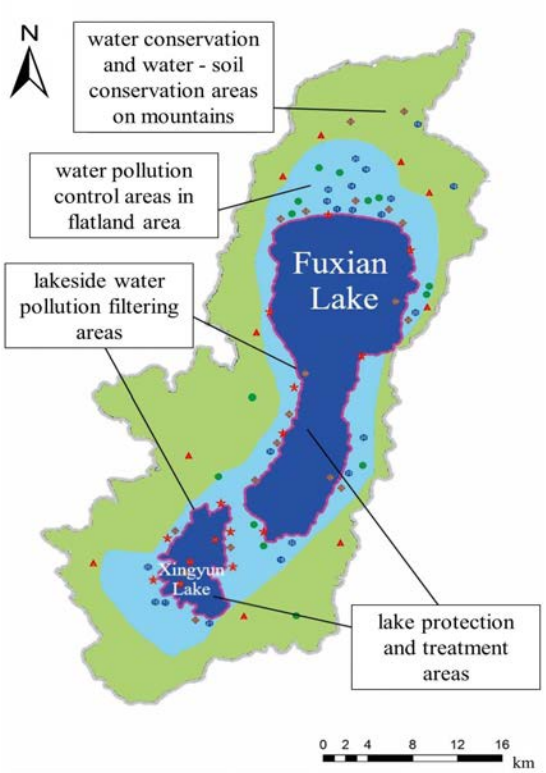


Fig 13. Distribution of the four conservation and restoration management units, and 41 sub-projects (© LCRC)

Forest restoration and expansion

To strengthen soil and water conservation in montane areas, action has been taken on three fronts:

1. *Returning farmland to forest:* By matching sites with native tree species 2,700 ha of farmland has been returned to forest.
2. *Combating desertification*: Efforts have been made to restore and manage the 4,202.1 ha of stone desertification areas, including the planting of environmentally resilient crops with economic value, such as honeysuckle.
3. *Ecological rehabilitation of mines*: The main types of mines in the basin are phosphorite, clay brick quarry, limestone quarry, etc. The ecology of 400 ha of abandoned mines has been restored.

Fig 14. Process of forest restoration (© LCRC)

Structural adjustment of agriculture

To effectively reduce agricultural nonpoint source pollution, adjustments in agricultural practices have been made in the Fuxian Lake catchment area, such as fallow crop rotation and planting of blueberry, pyrethrum, vetiver or other crops requiring less chemical treatment, as well as rice, lotus root and other aquatic crops with wetland purification effects.

As a result, it is estimated that 4,500 and 700 tonnes of nitrogen and phosphorus respectively have been reduced each year (reductions of 78.9% and 63.6% respectively). In addition, water savings reach 12.71 million m^3 annually, a reduction of 41%.

Lakeshore buffer zone construction

The total shoreline length of Fuxian Lake is 100.8 km, while the total area of the buffer zone is about 822.4 ha. In order to strengthen its pollution filtering capacity, three types of projects have been implemented after 560 ha of farmland in the buffer zone was returned to wetlands:

Large-scale ecological restoration of the buffer zone

According to the spatial differences in lakeshore slopes and land use within 100 m of the lakeshore, the dominance of native arbor-shrub-grass vegetation species was restored, including *Cinnamomum glanduliferum*, shrubs and herbaceous plants. At the same time, other projects have been carried out, including the construction of fish ponds, bird habitats, ecological demonstration areas, publicity events, education centres, lakeshore cleaning and beach protection.

Fig 15. Ecological buffer zone (© LCRC)

Water purification project around the lake
Three sub-projects were implemented: the construction of ecological, water-permeable purification zones around the lake (consisting of green belts and gravel beds), water purification of ditches flowing into the lake, and water purification of estuaries flowing into rivers.

Estuary wetland and riparian zone enhancement project
Trees, shrubs and other plants in the buffer zone are maintained and replanted on a daily basis. Aquatic plants are also harvested.

Conservation and management of the lake

Research shows that from 1983 to 2015, the number of native fish species decreased by 44%, while the number of exotic fish species increased by 167%[2]. Therefore, the conservation and management of Fuxian Lake mainly focuses on habitat protection and artificial release of native fish species. Specifically:

1. Protecting submerged aquatic vegetation and restoring degraded habitats with native submerged aquatic vegetation.
2. Adding rubble and gravel to the lake to simulate fish habitats and restore sediment.
3. Protection of fish spawning outlets in karst caves and restoration of damaged sediment.
4. Release ~1 million white fish per year into a 5 km^2 small water area delineated by purse seines and buoys within the National Aquatic Germplasm Resource Conservation Area for Endemic Fish in Fuxian Lake.

3.4 Outcomes

Reducing ecological risks and reversing ecosystem degradation

From 2016 to the first half of 2020, the water quality of Fuxian Lake remained stable at the Grade I level. The total nitrogen, ammonia nitrogen, permanganate, chlorophyll A and eutrophication indices of Fuxian Lake decreased by 19%, 41%, 13%, 60% and 4% respectively, while transparency and dissolved oxygen increased by 19% and 7% respectively.

In addition, the water quality compliance rate remained at 100% at both national and provincial monitoring stations. In total, 74 km^2 of forest were restored and soil erosion was controlled on 6.73 km^2. Overall, the forest cover in the Fuxian Lake Watershed increased from 34.95% to 39.25%, and the corresponding forest stock increased by 39%[3].

Biodiversity restoration

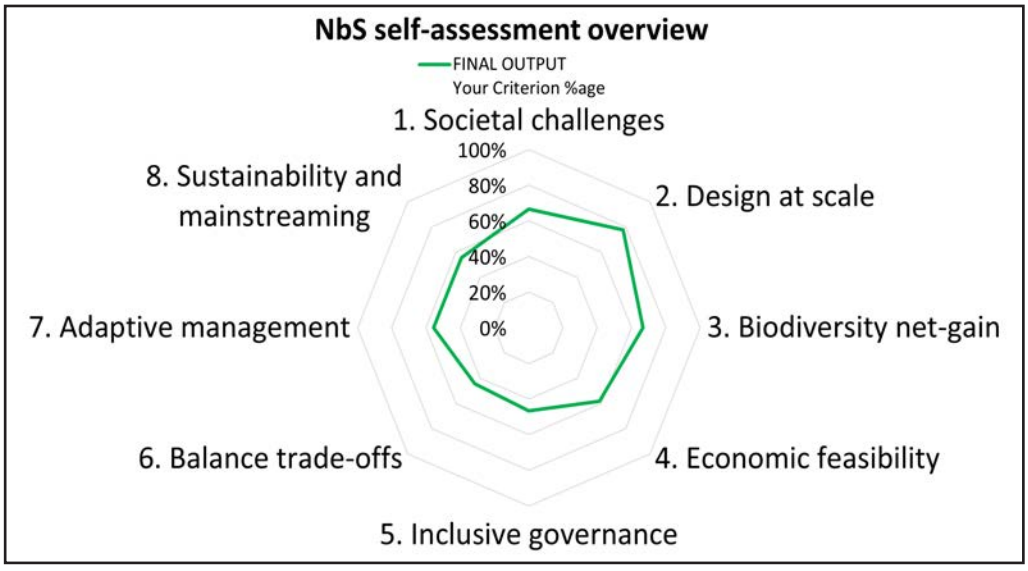
Surveys and statistics have shown that the number of emergent plant species in Fuxian Lake has increased to 12, while the seasonal white fish fishery has resumed for the first time in more than 20 years[3]. The basin has also become a permanent habitat and wintering ground for a wide range of birds and other wildlife. In particular, in March 2019, 25 endangered *Plegadis falcinellus*, which is listed as a second class state protected animal, were observed there.

Fig 16. Glossy Ibis © Jan Veber

Balanced, greener, and higher quality development

Strictly following the agricultural planning development and planting standards, green, ecological and circular agriculture with plateau characteristics has been developed, using fertiliser-, pesticide- and water-saving crops such as lotus root, blueberry, rice, wheat, rapeseed and so on. In addition, industrial and mining enterprises have all moved out of the Fuxian Lake outflow areas, and eco-cultural tourism has been developed in their place.[13]

3.5 Link to Global Standard for NbS



Box 3. Case 3 NbS criterion percentage © Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

The Fuxian Lake Watershed in this case shares some characteristics with the case of Guanting Reservoir Watershed, which plays an important role in maintaining the socioeconomic development of local communities by providing ecosystem products and services. Therefore, the project mainly aims to safeguard water security, and transform to sustainable ways of development. It manages to restore the vegetation, thus enhance the ecosystem functions and services of water regulation, water supply, erosion control and sediment retention, refugia, food production, recreation and culture.

According to the NbS Standard, this project adequately matches Criterion 1 on identify societal challenges, Criterion 2 on designing at the scale of watershed, Criterion 3 that focuses on ensuring biodiversity net-gain and ecosystem integrity, and joint working group was established to enhance inclusive governance (Criterion 5).

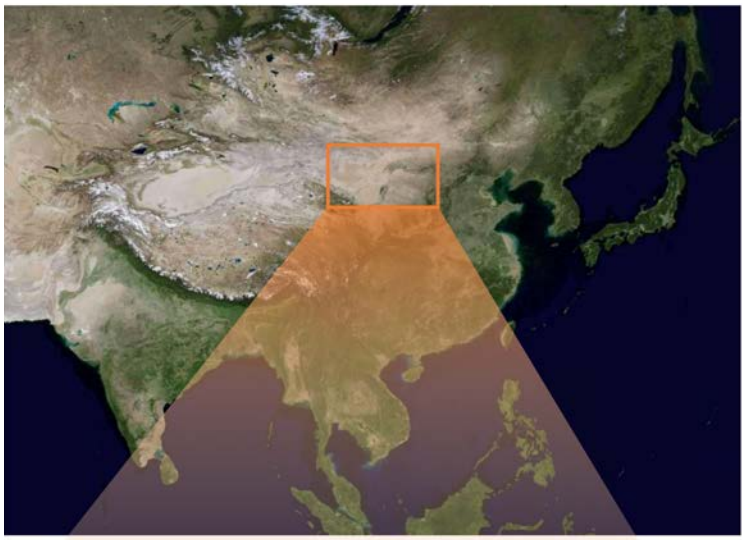
However, after assessing the case study against the Global Standard's criteria and indicators, some aspects can be improved accordingly, especially on strengthening economic feasibility at early stage (Criterion 4), and conducting deeper research and analysis about trade-offs in regards to biophysics, time and interests (Criterion 6), emphasising the importance of maintenance.

[12] Department of Natural Resources of Yunnan Province. (2019). Periodic Summary of the Effectiveness of the Pilot Project of Ecological Protection and Restoration of of Mountains, Rivers, Forests, Farmlands, Lakes, Grasslands, Deserts of Fuxian Lake, Yunnan Province. [In Chinese]
[13] Yuxi Municipal People's Government. (2017). Implementation Plan for Pilot Project of Ecological Protection and Restoration of Mountains, Rivers, Forests, Farmlands, Lakes, Grasslands, Deserts of Fuxian Lake, Yunnan Province (2017-2020). [In Chinese]

Data sources:
[1] National Research Centre for Highland Wetland / Southwest Forestry University
[2] Yuxi Municipal People's Government
[3] Department of Natural Resources of Yunnan Province

Case study 4: Conservation and restoration for food, water, and people in the Ulansuhai Nur Watershed

Authors: Yan Zhou, Lijia Zhang, Xiao Zhang , Shuai Wang



Map data ©2022 Tianditu, MNR of the PRC & NavInfo

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Societal challenges addressed:

- Water security
- Environmental degradation and biodiversity loss
- Economic and social development

Sustainable Development Goals addressed:

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management
Area-based conservation

Total financing:

CNY 5.746 billion

Implementation period:

2018-2020

Ecosystems:

T5.1 Semi-desert steppes
T7.1 Annual croplands
F2.1 Large permanent freshwater lakes
TF1.3 Permanent marshes

Ecosystem services enhanced:

Disturbance regulation
Water regulation
Water supply
Erosion control and sediment retention
Refugia
Food production
Waste treatment

4.1 General background and challenges to address

The Ulansuhai Lake Watershed covers an area of 16,300 km^2 in Bayannur Township in western Inner Mongolia, covering a significant part of the Hetao Plain. Ulansuhai is the eighth largest freshwater lake in China and the largest functional wetland in the Yellow River Basin - a rare formation for desert or semi-desert areas. It is located at the intersection of two of the world's eight major bird migration routes, one from South and Southwest Asia to Central Asia and the other from Southeast Asia to Australia.

As a key part of the "Northern Sand Prevention Belt" in China's "Two Barriers and Three Belts" strategic ecological security system, the basin has the important functions of ensuring water security along the Yellow River, conserving biodiversity and regulating regional climate.

In addition, as one of China's three major agricultural areas, the Hetao Plain is an important production base for crops and oils, and plays a critical role in ensuring the country's food security. Accordingly, the Ulansuhai Lake Watershed comprises the largest area for both agricultural water use and natural purification along the middle and upper reaches of the Yellow River. Irrigation water ultimately flows into Ulansuhai, which acts as a natural purifier before being discharged into the Yellow River.

Regional water quality and ecosystem functions have been gradually deteriorating since the 1980s, posing a serious threat to the Yellow River's water security. From 2005 to 2014, the water quality of the lake area remained at the lower Grade V. Specifically, water pollution peaked in 2008, and there was once a widespread outbreak of xanthophyceae in the region.

More recently, both the provincial and municipal governments have promoted the transformation of agriculture and livestock farming in the basin into landscapes of conservation and restoration through a national approach known as 'Integrated Management of Mountains, Rivers, Forests, Farmlands, Lakes, Grasslands and Deserts'. In 2018, the Ulansuhai Ecological Conservation and Restoration Project was included in the third batch of National Pilot Projects of the Shan-shui Initiative, with a total investment of CNY 5.746 billion, of which CNY 2 billion was invested by the central government.[14]

Human activities, including over-farming, overgrazing, wetland reclamation, mining, and discharge of industrial, municipal and agricultural effluents, have caused serious ecological and environmental problems in the basin, such as desertification, grassland degradation, soil erosion, soil salinisation, water quality degradation, biodiversity loss, and fundamental damage to the basin's structures and functions. With such significant environmental degradation, the importance of the area as an ecological barrier providing ecosystem services has collapsed, posing challenges to both water and food security.

4.2 Main objectives

The project aims to safeguard water security and reduce disaster risk through the ecological restoration of mountains, grasslands, and wetlands, as well as the reclamation of farmland into a lake. This will prevent and control desertification, improve water quality and increase biodiversity.

4.3 Methods

Six ecological restoration units have been delineated according to different geographies and dominant basin ecosystem types. Focusing on the key ecological issues of each unit, the project seeks to align ecosystem management with green and high-quality economic development, while establishing new financing mechanisms and stronger financial cooperation within the private sector.

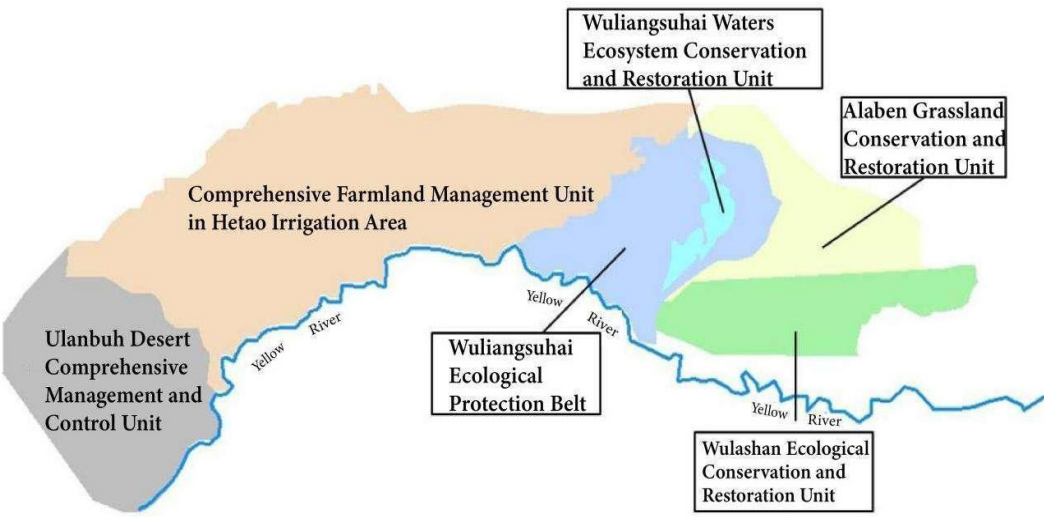


Fig 17. Diagram of six restoration units (© LCRC)

Unit-based management measures

Ulanbuh Desert comprehensive management and control[14]

Straw checkerboards and biodegradable fabric sand barriers, together with other sand prevention and water conservation measures (e.g. drip irrigation), were used to help preserve the fragile ecosystem and prevent the relatively easy recurrence of desertification and weak sand barriers. Additional efforts to manage and prevent the eastward expansion of the desert included planting *Cistanche salsa* near the root of a *Haloxylon ammodendron* stand.

Fig 18. (a) Photo of the area before desertification control (© LCRC)

Fig 18. (b) Photo of the area after desertification control (© LCRC)

Comprehensive farmland management in Hetao Plain

A multi-faceted approach was taken to address several issues, including non-point source pollution and farmland salinisation. From one perspective, sludge dredging, the establishment of a multi-pond purification system, ecological revetment, the construction of ecological floating islands and ecological water replenishment were used to improve water quality and reduce pollutant inputs. From another perspective, the use of chemicals, water and film on agricultural land was controlled as part of a comprehensive saline soil management programme.

Wulashan ecological conservation and restoration

In order to address the outstanding environmental problems at the Wulashan mine, such as soil erosion and degradation of forest and grassland vegetation, various geological environment, disaster recovery and vegetation restoration measures have been taken to improve the geological and geomorphological conditions of the damaged massif and the water retention capacity.

Conservation and restoration of the Alaben grassland

In order to combat the accelerated degradation of grasslands, desertification, soil erosion, etc., measures have been taken such as grass sowing, in addition to closure and grazing bans, with a combination of natural and artificial approaches for water conservation, vegetation restoration, reduction of pollutant and sediment inflow, windbreak and sand prevention.

Fig 19. Process of Alaben grassland reastoration (© LCRC)

Management of the Ulansuhai ecological protection belt

To address the degradation of Ulansuhai, a water conservation forest has been planted by the lake, grass seeds have been sown in the ecologically fragile areas of fixed and semi-fixed dunes, bird breeding areas have been created, wetland restoration and construction has been carried out in the estuary, and water conveyance channels have been opened to restore connectivity in areas where reeds are dense.

Conservation and restoration of the Ulansuhai aquatic ecosystem

To address the problems of severe pollution and water surface shrinkage, ventilation and water flow were facilitated in Ulansuhai to improve storage and self-purification capacity. Other measures included the harvesting and utilisation of reeds and underwater plants, the establishment of three-dimensional aquaculture in the lake area, the removal of nutrients from the lake body through a nature-based aquaculture food chain, the establishment of no-fishing areas, etc.

Fig 20. (a) Aerial photo of the riparian area before ecological mangement (© LCRC)

Fig 20. (b) Aerial photo of the riparian area after ecological protection belt management (© LCRC)

Promoting eco-friendly development

The resources for green agriculture in the basin provide the greatest advantage for eco-friendly development, so the local government has made considerable efforts to establish services for green, organic, high-end agriculture, as well as the development of renewable energy, digital economy, eco-tourism and eco-aquaculture.

Mobilising private sector to develop new financing mechanisms

The project followed the DBFOT (design, build, finance, operate and transfer) approach to facilitate market-based financing, project management and operation. Specifically, a company was empowered to act as a financing platform on behalf of the Bayannur Municipality, with open bidding for project investment, development, operation and financial management.

A dedicated development fund was established with joint contributions from both the municipal state-owned company and the winning bidder, as initiated by the latter. Accordingly, the Ulansuhai Lake Watershed Ecological Conservation and Restoration Pilot Project Investment Co. (SPV) was established and tasked with the overall design, development, operation and financing of the project, as well as establishing a handover and exit mechanism.

4.4 Outcomes

Improved ecological conditions and increased biodiversity

By the end of 2020, the project have restored over 2,667 ha of the Ulanbuh Desert. In addition, the damaged massif has been rehabilitated and over 60% of the landform and landscape in the mining area has been restored. In addition, hydrodynamics, circulation and water quality have steadily improved, with the overall water quality of the Ulansuhai reaching Grade V in 2019.

There has also been a significant increase in the number and diversity of bird species. There are now more than 20 species of fish, as well as over 6 million birds of 260 species, including the spot-billed pelican, which is a first class government protected animal, and the mute swan and Eurasian Spoonbill, which are second class state protected animals. The mute swan population in particular has increased from 200 in 2000 to nearly 1,000.

Fig 21. Riparian restoration (© LCRC)

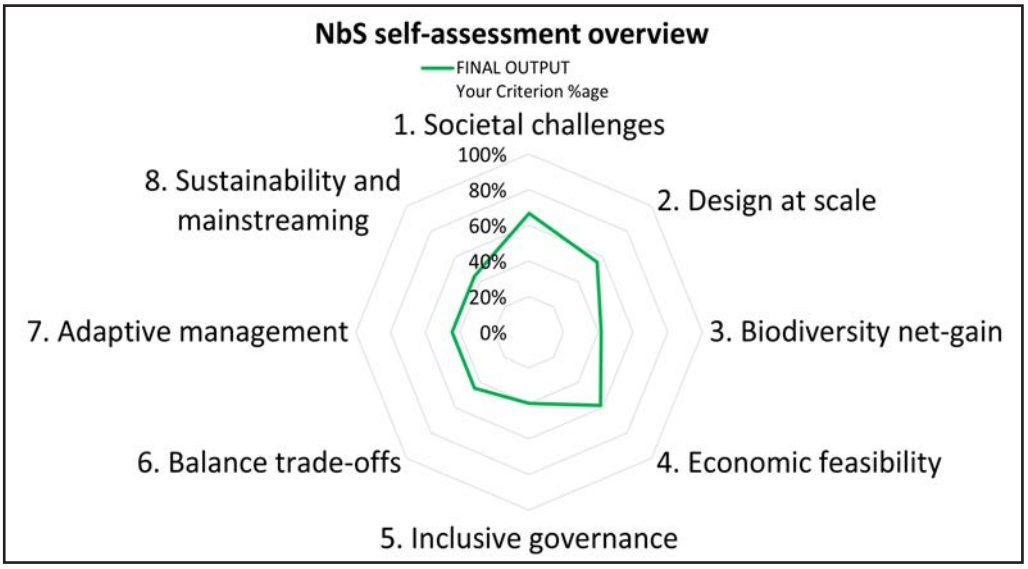
Green and high-quality development

High-quality agriculture in Hetao has seen significant improvement in terms of popularity, influence and market competitiveness. In 2019, the average per capita disposable income of permanent residents in the surrounding rural pastoral areas was CNY 19,064, an annual increase of 10.7%. More than 10 high-tech agricultural enterprises using modern technologies are promoting the development of agriculture, including mutton sheep, wheat, sunflower and biological breeding technology, with a total annual output value of CNY 10.5 billion.

The implementation of the pilot project has promoted the development of primary industries, such as agriculture, forestry, animal husbandry and fisheries, and tertiary industries, including eco-tourism and agritainment, forming a pattern of green routes to industrial growth in which socio-economic development and environmental protection are mutually coordinated and promoted.

4.5 Link to Global Standard for NbS

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.



Box 4. Case 4 NbS criterion percentage ©Juntao Hu

This case shares some characteristics with the cases of Helan Mountains and Fuxian Lake. The Ulansuhai Nur Watershed plays an important role in both desertification prevention and water retention. Therefore, the project mainly aims to safeguard water, reducing disaster risk and facilitate sustainable economic and social development.

The project manages to restore the various ecosystems to enhance the provision of their functions and services such as disturbance regulation, water regulation, water supply, erosion control and sediment retention, waste treatment, refugia and food production.

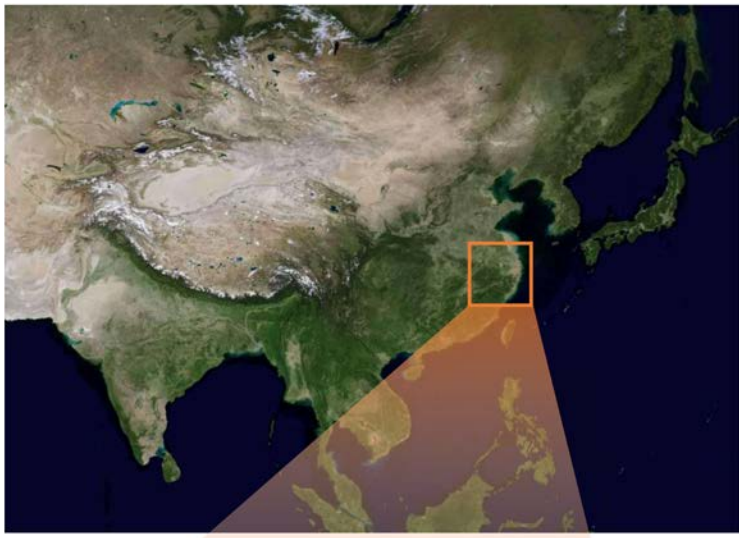
According to the NbS Global Standard, the project has adequate matches to Criterion 1 & 2, in which indicate explicit identification of societal challenges, and project design was conducted at different levels of scale. Moreover, the project established an innovative financing mechanism to ensure economic feasibility (Criterion 4).

After assessing the case study against the Global Standard's criteria and indicators, some aspects can be improved accordingly, such as better involvement of local communities in project implementation and maintenance (Criterion 5), including trade-offs on aspects like biophysics, time and interests (Criterion 6), and specific strategy of adaptive management (Criterion 7).

[14] Inner Mongolia Department of Finance, Inner Mongolia Department of Natural Resources. (2018). Implementation Plan for Pilot Project of Ecological Protection and Restoration of Mountains, Rivers, Forests, Farmlands, Lakes, Grasslands, Deserts of Ulansuhai Nur Watershed. [In Chinese]

Case study 5: Integrated protection and restoration for the Qiantang River source water area

Authors: Yong Jin, Tong Jin, Hua Cheng, Quan Mu



Map data ©2022 Tianditu, MNR of the PRC & NavInfo

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Societal challenges addressed:

- Water security
- Environmental degradation and biodiversity loss
- Economic and social development

Sustainable Development Goals addressed:

- 8 DECENT WORK AND ECONOMIC GROWTH
- 11 SUSTAINABLE CITIES AND COMMUNITIES
- 15 LIFE ON LAND

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management

Total financing:

CNY 5.208 billion

Implementation period:

2019-2022

Ecosystems:

F3.1 Large reservoirs
F3.2 Constructed lacustrine wetlands
T2.4 Warm temperate laurophyll forests

Ecosystem services enhanced:

Water regulation
Water supply
Erosion control and sediment retention
Food production
Culture

5.1 General background and challenges to address

Qiandao Lake, which literally means “Thousand Island Lake”, is an ultra-large reservoir located in Chun’an, Zhejiang Province, and is the largest artificial freshwater lake in the Yangtze River Delta with large number of islands.

With a normal storage capacity of 17.84 billion m^3 and a water surface area of 567.40 km^2, the water quality of Qiandao Lake is relatively high among China’s major reservoirs, and it plays an important role in ensuring water security while providing regulatory services such as flood control and disaster risk reduction. Since 2019, it has served as an important source of drinking water for 13 million residents in downstream cities, including Hangzhou.

The area around Qiandao Lake includes the Huangshan-Huaiyu mountain range, which is China’s largest national forest park, a priority area for biodiversity conservation and a national key ecosystem function area, with 93% forest cover and rich wildlife resources. As such, it serves as an important ecological barrier for Zhejiang Province and eastern China as a whole.

Accordingly, the conservation and restoration of the Qiandao Lake ecosystem is a priority for the Zhejiang government. In 2018, the Qiantang River Source Area Landscape Conservation and Restoration Project was launched with an estimated investment of CNY 5.208 billion. To date, a total of CNY 3.969 billion has been invested in this project, including CNY 500 million from the central government, CNY 2.403 billion from all levels of provincial and local public budgets, and CNY 1.066 billion from other sources.

To explore new opportunities in the private sector, several representatives of the financial sector formed a partnership, the Qiandao Lake Water Fund, which includes the Alibaba Foundation, Minsheng Tonghui Foundation, Wanxiang Trust and The Nature Conservancy (TNC), as the county sought to synergize public funding, private investment and World Bank loans.

The lake faces several challenges. In particular, non-point source (NPS) pollution caused by inappropriate agricultural practices and the overuse of pesticides and fertilisers are the main threats to the water quality of Qiandao Lake. The invasion of pests such as *Bursaphelenchus xylophilus* is also affecting the biodiversity of the local forests. Housing, resorts and other tourist developments near the lake have also led to habitat loss and threatened the ecological safety of the lake.

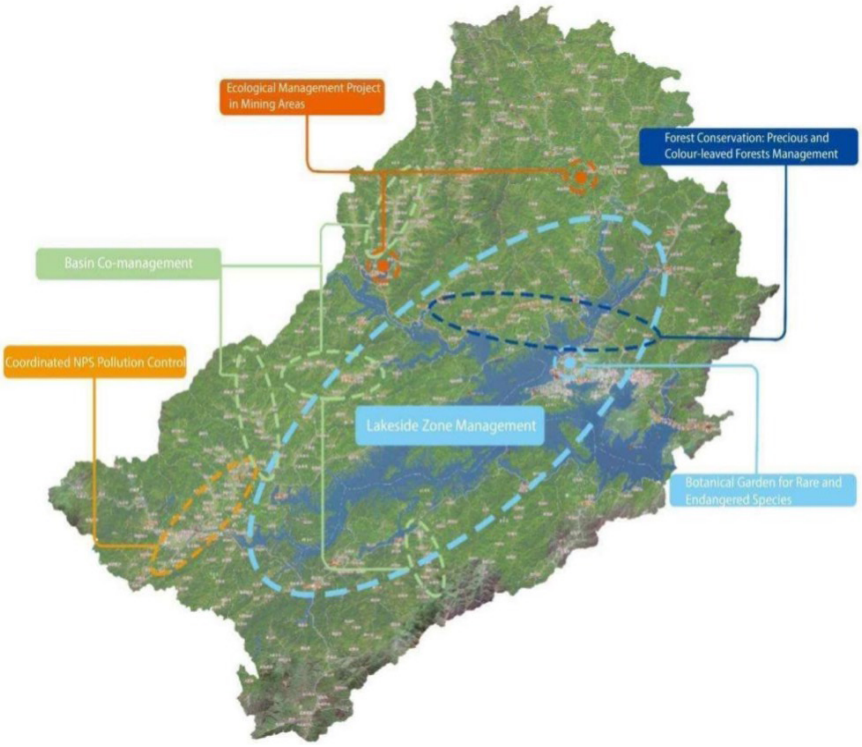


Fig 22. Site location map (© LCRC)

5.2 Main objectives

The project aims to ensure water security and maintain ecosystem stability through ecological restoration of wetlands, riparian areas and forests, while rehabilitating abandoned mines. These efforts have improved the provision of ecosystem services such as water regulation, supply and filtration. In addition, the local industrial and mineral industry is being restructured towards agroforestry and ecotourism, reducing pollution and the risk of geological disasters.

5.3 Methods

The project has been implemented throughout the Qiandao Lake Watershed (landscape scale), targeting the control of inflow pollution, restoration of forest ecosystems and ecological management in mining areas, as well as ecological improvement, green agriculture and spatial optimisation of the basin.[15]

Spatial planning and management

Measures were implemented to strictly follow a zoning-based approach to ecosystem functions, including the establishment of a dedicated natural landscape planning in and around the lakeshore, and the introduction of regulations on lakeshore development and construction.

Specifically, a 20m radius from the shore was designated as a no-development zone, while a 20-100m radius was designated as a strict management zone. The project also aimed to improve local water quality by assessing the source and distribution pattern of NPS pollutants in the basin, and identifying the extent of priority management areas and ecological measures for water quality control.

Pollution control

The water quality of Qiandao Lake has deteriorated over the past three years, with total nitrogen and phosphorus levels in the surface water exceeding standards and maintaining an average mesotrophic water quality. Following an ecological approach to river management, some of the traditional, impermeable, hardened watercourses were replaced with natural, appropriate riparian and lakeshore vegetation. In addition, activities such as revetment construction and dredging were carried out to create ecological corridors and restore river biodiversity.

Fig 23. Riparian restoration (© LCRC)

Forest ecosystem restoration

Conservation and enhancement work was carried out by implementing activities such as logging bans, afforestation and reforestation, forest maintenance, closing access to hillsides to facilitate regeneration, improving deciduous forest stand structure and diversity to maintain a healthy ecosystem status.

For the prevention and control of forest pests and diseases, efforts were made to control *Bursaphelenchus xylophilus*, remove dead or infected wood and pine, and other tasks to ensure healthier forests.

With regard to vegetation restoration and reforestation, measures have been taken to improve stand structure and to establish stands of aesthetic value (e.g. with colourful foliage or valuable species) through afforestation, direct replanting, etc. on barren hills and wasteland.

Environmental management of mining sites

Control of geological hazards: Investigations of potential hazards and other erosion control measures have been carried out, such as restoring vegetation on barren mountains and mitigating geological hazards and flooding along road sections.

Ecological environment management: Efforts were made to rehabilitate and manage 33 abandoned mines and tailings ponds by planting resilient plant species with well-developed root systems capable of surviving extensive management, such as *Rosa rugosa*, *Cynodon dactylon*, *Lespedeza formosa* and *Halocnemum strobilaceum*.

New financing and co-management mechanisms

For NPS pollution control, the innovative management and financing Qiandao Lake Water Fund was established with a intial fund of CNY 10 million from Alibaba and Minsheng Tonghui Foundations, and technical support from TNC. This was one of the first financial mechanisms in China to conserve water and support market-based investment in green development, such as eco-agriculture, nature education and eco-tourism, that could financially benefit local residents, and an early paradigm for multi-stakeholder co-management and sustainable financing.

5.4 Outcomes

Significantly reduced risks and improved catchment ecology

Significant progress has been made in the control of NPS pollution. The use of physical and biological techniques has progressed, while the development of green agriculture and the establishment of circular farming has led to a reduction in the use of chemical fertilisers and pesticides.

Soil conservation measures have been applied to 3,527 ha of the target area, reducing the area of soil and water loss by 7.54% and further improving the status of local soil and water[1]. Approximately 7,753 ha of forest has been restored, and biodiversity has been enhanced. Currently, Chun'an maintains a forest cover of 78.63%. The drainage of wastewater from tailings has been effectively prevented, and 50 ha of mining area have been rehabilitated.

Fig 24. Development of green agriculture (© LCRC)

As a result, the water security have improved. Water quality is high at all inflow and outflow monitoring points, with 35 major inflow streams meeting the established water quality standard. In addition, the water quality of Qiandao Lake was ranked at the top of China's 61 key lakes (reservoirs).

Fig 25. (a) Photo of the area before river management (© LCRC)

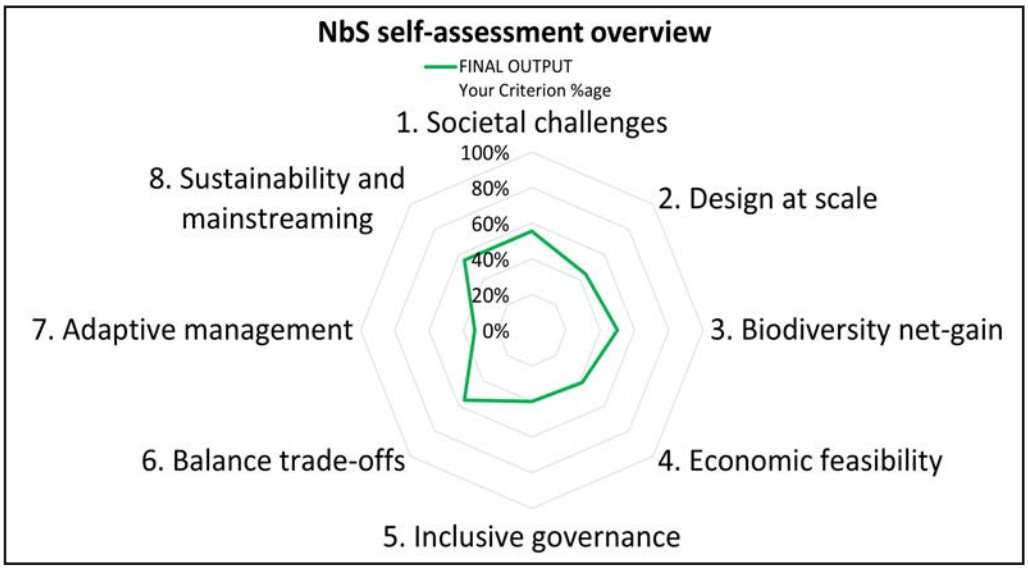
Fig 25. (b) Photo of the area after water conservancy (© LCRC)

Multi-stakeholder participation mechanism taking shape

The Qiandao Lake Water Fund, in partnership with Ant Group, has used blockchain technology to ensure the traceability of agricultural products harvested from the 344 hectares of water-conserving farming.

Other benefits include a 30-40% increase in family income. More than 3,000 people were trained in various water conservation and NPS pollution control sessions as part of the public engagement on water conservation/pollution control, and nearly 1,000 residents participated in nature education courses and other themed events.

5.5 Link to Global Standard for NbS



Box 5. Case 5 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

The project focuses on safeguard water security, promoting sustainable economic and social development, and seek to conserve and improve biodiversity. It manages to restore the ecosystem in the landscape so as to enhance the ecosystem functions and services of water regulation, water supply, erosion control and sediment retention, refugia, food production, recreation and culture.

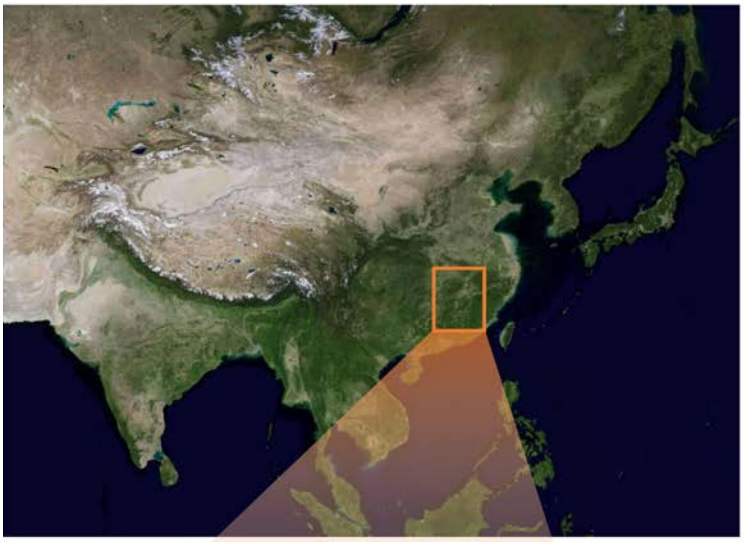
According to the Standard, this project has adequate matches to the criteria in terms of identifying societal challenges, balance trade-offs (Criterion 6) and mainstreaming (Criterion 8). Moreover, the project has engaged with private sector to ensure economic feasibility (Criterion 4). The project team needs to strengthen its understanding of the characteristics and principles of NbS, distinguishing between ‘nature-based approaches’ and ‘measures for nature’, in order to improve its consideration of safeguarding society (Criterion 1).

[15] Zhejiang Provincial Department of Finance, Zhejiang Provincial Department of Natural Resources, Zhejiang Provincial Department of Ecology and Environment. (2018). Implementation Plan for Pilot Project of Ecological Protection and Restoration of Mountains, Rivers, Forests, Farmlands, Lakes, Grasslands, Deserts of Qiantang River Source Area, Zhejiang Province. [In Chinese]

Data sources:
[1] Department of Natural Resources of Zhejiang Province

Case study 6: Nature-based revitalization of Xunjiansi Village in Wuyuan County, Jiangxi

Authors: Jianing Li, Yan Zhou, Mengyun Xie, Yifan Hu



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Societal challenges addressed:

Disaster risk reduction

Economic and social development

Human health

Sustainable Development Goals addressed:

8 DECENT WORK AND ECONOMIC GROWTH

11 SUSTAINABLE CITIES AND COMMUNITIES

Ecosystems:

T7 Intensive land-use systems

Ecosystem services enhanced:

Water regulation

Erosion control and sediment retention

Food production

Recreation

Culture

Total financing:

CNY 190.22 million

Implementation period:

2016-2022

NbS type approaches implemented:

Ecosystem restoration

Ecological engineering

Ecosystem-based management

6.1 General Background and Challenges to address

Wuyuan County is located in the northeast of Jiangxi Province, South China, and has a wide distribution of traditional communities and ancient buildings dating back to the Ming and Qing Dynasties. Xunjiansi Village is one of these ancient communities, endowed with rich natural resources and agricultural culture.

Affected by limited resources and frequent local natural disasters, Xunjiansi has developed 'ecologically prudent'[16] practices to maintain the sustainability of agricultural production and the living environment. This voluntary, restrictive technique implements nature-based approaches in an agricultural and residential setting by addressing multiple aspects of the natural environment, including land use (building geologically appropriate houses without altering landforms), vegetation (protecting sacred forests, conserving water, and regulating climate), and water resources (maintaining water intakes and ponds, and storing water in buildings).

Recently, as industrialisation and urbanisation have intensified, there has been a significant out-migration of local populations and a gradual decline in traditional rural communities across China. Xunjiansi's long-established model of self-sufficiency and traditional agricultural landscape has also faded.

In light of this phenomenon, Professor Yu Kongjian from Peking University has been leading a team experimenting with a nature-based lifestyle in Xunjiansi since 2015, called the "Wangshan Lifestyle". The Wangshan lifestyle, which means "mountain view" in Chinese, is one in which can "truly enjoy the moments of being close to mountains, water and home".

It is an attempt to explore ways to achieve sustainable rural development, a high quality of life and a path towards a vision where "clear waters and lush mountains are invaluable assets". The primary objective is to further promote revitalising practices in rural areas through the development of green livelihoods and lifestyles.

To date, the implementation of the Wangshan Lifestyle in Xunjiansi has been successful through the combined establishment of housing, eco-farming, tourism, research, and cultural practices. Local natural resources are being better protected and used more efficiently, while once desolate and abandoned rural communities are becoming prosperous, supporting the application of NbS to China’s rural revitalisation strategy.

As is typical throughout China, the village of Xunjiansi was facing several challenges, such as the channeling and hardening of rivers, the excessive use of chemicals, stagnant development, and low local incomes. In addition, a large number of young and middle-aged residents had emigrated, resulting in an abundance of abandoned land, dilapidated housing, weakened community infrastructure and facilities, and a decline in cultural education. Local landscapes and heritage were ineffectively protected, resulting in the gradual disappearance of the villagers' sense of identity and belonging.

6.2 Main objectives

This project aims to reduce regional disaster risk while ensuring food and water security by revitalising the village through smart hydraulic systems and more sustainable agricultural practices. The project strengthens ecosystem services related to water supply through improved filtration and reuse on the field. Such healthy and environmentally friendly recirculation systems will allow local villagers to live and farm in a more ecologically sustainable way, while preserving the village’s indigenous characteristics.

Fig 26. Villagers' vision to the futural community (© LCRC)

Fig 27. Rural art in the village (© LCRC)

6.3 Methods

Based on a systematic assessment of the natural and cultural baseline, a comprehensive project design was developed in terms of spatial planning for agriculture, housing and conservation, proposing measures for eco-farming, research and education. A novel strategy has been designed to address urban-rural interactions, as well as the production and provision of ecosystem services, to ensure their security, integrity and abundance for human well-being, to lead people to rethink the value of ecosystems, and to achieve a harmonious coexistence with nature alongside the co-prosperity of urban and rural areas.

Fig 28. Spatial plan of Xunjiansi Village (© LCRC)

Creating a sponge landscape and improving ecological infrastructure

As a first step, measures have been taken to protect and restore the old water conservation systems (Fig. 28). These small-scale systems can conserve water resources and natural run-off patterns, assist with groundwater recharge, rainwater and wastewater purification, flood regulation and storage, as well as meeting daily water production needs.

Fig 29. (a) Photo of the area before river management (© LCRC)

Fig 29. (b) Photo of the area after water conservancy (© LCRC)

Secondly, efforts have been made to reduce the channelling and hardening of rivers, preserve natural watercourses, maintain aquatic habitats, reduce NPS pollution and recharge groundwater supplies.

Thirdly, the project included conservation and restoration efforts of the inlet and its respective forests at the intersection of the village's water systems. Preserving the inlet and its surrounding forests could help regulate the local microclimate, while contributing to the capacity for soil and water conservation, wind protection and sand fixation.

Reviving traditional farming practices

Eco-farming in Xunjiansi revived traditional farming practices to restore soil fertility through fallow, crop rotation and straw mulching. Notably, no chemical fertilisers or pesticides were used (Fig. 29), and a multifaceted spatial design was used to support a healthy farmland ecosystem by allowing complementary farming practices such as chicken and bee keeping in an open bamboo forest.

Fig 30. Tea harvest in Xunjiansi (© LCRC)

Building an eco-education centre

Xunjiansi has become a centre for local training in rural revitalisation and agriscape, with ongoing research and study events.

The Wangshan Field Theatre has attracted over 50 million online views as part of Xunjiansi's cultural and creative practices, and is becoming China's first live streaming platform for rural revitalisation.

Fig 31. Site research and study event (© LCRC)

6.4 Outcomes

Enhanced ecosystem services

The Wangshan Lifestyle explored conservation options, improved local ecosystems and promoted the construction of a sponge city. These activities played an important role in improving the structures and functions of hydrological ecosystems to enhance the ecosystem service of water regulation, thereby addressing the water issue in a comprehensive, systematic and sustainable manner.

Fig 32. (a) Photo of the area before intervention (© LCRC)

Fig 32. (b) Photo of the area after water drainage construction (© LCRC)

Significant increase in community development and income

A mechanism for the rural revitalization of local communities has been sought through a sustainable model, without absolute reliance on public finance. Firstly, local per capita income in Xunjiansi village has increased by 71% from 2015 to 2021. Second, high-quality agricultural products with higher prices have been developed. For example, black tea was originally produced with chemical fertilizers and pesticides and sold for ~ CNY 100 kg^{-1}. After upgrading to organic, safe and traceable tea with local branding, the price has risen to CNY 4,000 kg^{-1}. Third, eco-cultural tourism is booming. In 2015, few artists came to the village for inspiration, but recently the village has seen a growing number of local homestays and visitors.

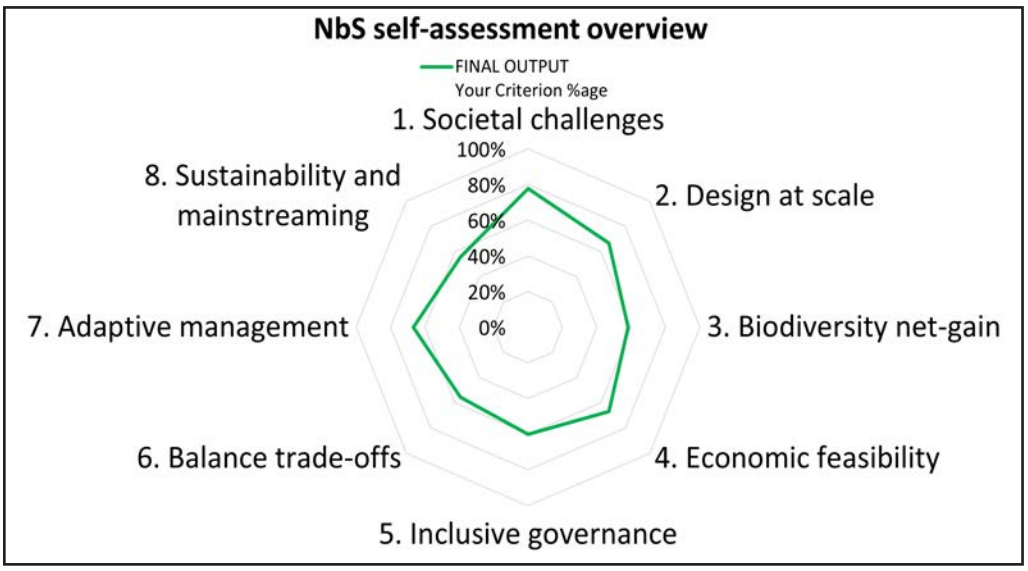
Cultural heritage protection

Tangible and intangible cultural heritage has been systematically protected. Residents have gradually realised the value of local ecosystems, culture and landscapes, and have developed a stronger sense of belonging and identity with their homeland. Villagers are more aware of how “clear waters and lush mountains” can become “invaluable assets”, while understanding and adopting a sustainable lifestyle that depends on healthy natural ecosystems.

Fig 33. (a) Photo of the area before interventions (© LCRC)

Fig 33. (b) Photo of the area after customary renovation (© LCRC)

6.5 Link to Global Standard for NbS



Box 6. Case 6 NbS criterion percentage © Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

In this case, the project succeeded in ensuring water security and reducing disaster risk by improving relevant ecosystem functions and services in the Guanting Reservoir Watershed, while reversing environmental degradation and biodiversity loss and facilitating social and economic development.

This project and approach has promoted the localisation of NbS in China, while providing experience and references for rural development and revitalisation. It provides a successful example of promoting green livelihoods and lifestyles in rural communities, establishing healthy relationships between ecosystem services and human well-being by creating a sustainable and replicable model.

After comparing with the criteria of the NbS Global Standard through self-assessment, we summarise the areas that are strongly related to the Standard and the areas for improvement of the case, which may be considered for referral to practitioners.

In this case, the project has a clear objective to address the societal challenges of disaster risk reduction and economic and social development. During the planning and design phase, the design team conducted in-depth interviews in Xunjiansi village and identified the villagers' suffering from flooding, low incomes, labour shortages and a weak sense of belonging. To improve the living environment and revitalise the village, the team ensured that the provision of ecosystem services such as water regulation, erosion control, sediment retention, food production, recreation and culture were enhanced to achieve the design objectives.

According to the Standard, the project adequately addresses the indicators in Criterion 1 in terms of understanding the societal challenges facing the village and the rights holders and beneficiaries. The design team fully respected the local lifestyle and culture and clarified the villagers' needs. The designers listened to the communities and promoted their restoration activities to the local villagers (Criterion 6). It is also noteworthy that the project included the development of both economic feasibility and adaptive management mechanisms. The village of Xunjiansi created a multi-county tour, research study and cultural innovation activities to monitor and evaluate the long-term NbS effect, to keep learning and improving, and most importantly, the mechanisms provided strong assurance of sustainable income to support the village (this is reflected in the assessment of Criterion 4 & 7).

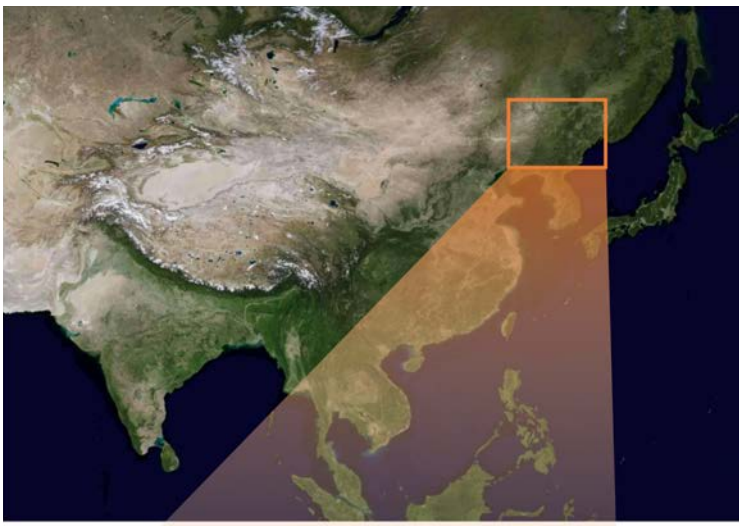
Although case 6, as a rural regeneration project, meets most of the criteria of the NbS standard, it still needs to pay more attention to biodiversity aspects (Criterion 3). Firstly, the design team could strengthen research and analysis of local biodiversity and integrate the results into the project research system as an ecological baseline. And secondly, this would provide an opportunity to strengthen public education of local residents and government staff based on nature awareness and advocating the non-use of chemical fertilisers, pesticides, bird nets and other practices harmful to biodiversity and the farmland ecosystem.

Fig 34. Photo of project designers and local communities (© LCRC)

[16] Kongjian, Y. (1992). The basin experience and the landscape of ecological restraint in Chinese agricultural culture. *Journal of Beijing Forestry University*, (04): 37-44. [In Chinese]

Case study 7: Ensuring food security through conservation and the sustainable use of black soils in Jilin

Authors: Baoguo Li, Xiang Wang, Ying Wang, Ming Luo



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Societal challenges addressed:

- Climate migitation and adaptation
- Disaster risk reduction
- Economic and social development
- Food security

Sustainable Development Goals addressed:

- 2 ZERO HUNGER
- 11 SUSTAINABLE CITIES AND COMMUNITIES
- 13 CLIMATE ACTION

NbS type approaches implemented:

Ecosystem restoration
Ecosystem-based management

Total financing:

CNY 500 million

Implementation period:

2009-2020

Ecosystems:

T7.1 Annual croplands

Ecosystem services enhanced:

Erosion control and sediment retention
Soil formation
Food production

7.1 General background and challenges to address

With the growing challenges of food security, climate change, greenhouse gas emissions and deteriorating ecosystem health, scientists are exploring techniques learned from nature to address these pressing issues. For example, NbS have been adopted in the EU and the US and have been effectively researched in areas such as sustainable agriculture, which focuses on holistic planning and design; climate-smart agriculture, which supports adaptation to climate change; carbon farming, which aims to sequester carbon in the atmosphere; and regenerative agriculture, which responds to the problems of modern agriculture.

One of the world's three major black soil belts - the black soil of Northeast China - is mainly found in the Liaohe, Songnen, and Sanjiang plains. Natural black soils develop organically on the gravel and clay layers of the Tertiary-Quaternary-Pleistocene or Holocene, while the region's unique climate, hydrological conditions, and vegetation types have laid the foundation for the accumulation of organic matter, forming a deep and fertile black soil layer.[17]

The formation and development of black soils are extremely slow, taking on average ~200-600 years for each 1cm of black soil to form, and is therefore considered an extremely scarce resource.[18] The black soils in this particular region are some of the most fertile in the world, characterized by high carbon content, porosity, and ploughability. They are used as a major base for commodity grain production in China, covering 36 million hectares, or a quarter of the country's total arable land, making the black soil region a critical and central part of ensuring national food security.[19]

However, traditional plowing techniques destroy the protective layer of straw on the surface and alter soil microorganisms and animal communities, in addition to deteriorating the ecological and productive functions of the soil. Therefore, to protect soil ecology and productivity, China has widely adopted a sustainable agricultural NbS method developed, practiced, and promoted by the China Agricultural University (CAU) and the Chinese Academy of Sciences (CAS), known as the "Lishu model".

Due to years of intensive farming and excessive nutrient inputs, the black soils are now subject to severe wind and water erosion, significant amounts of dust are released into the air during spring ploughing and a significant amount of topsoil, which is essential for agriculture, is lost. In areas of high gully erosion, gullies are cut and torn into the land, causing a range of problems including thinning of the topsoil layer, significant reduction in topsoil organic matter and deterioration of soil structure and function. The result is a serious threat to the sustainable health of black soils and thus to national food security.[20]

7.2 Main objectives

This project aims to safeguard food security by implementing conservation tillage to recover and conserve black soil, which has come to be known as the panda of farmland.

Fig 35. (a), (b), (c) Photo of water erosion © Xingyi Zhang
(d) Photo of wind erosion © Baoguo Li

7.3 Methods

After more than a decade of research, scientists and researchers from CAU, CAS and other institutions have developed a maize straw mulching cultivation technique (i.e. the “Lishu Model”) based on local conditions. With maize straw mulching as the core process, this intervention involves integrated mechanisation of direct seeding, fertilisation, weeding, disease prevention and harvesting processes to effectively protect topsoils and address the key issues of soil degradation caused by maize straw removal on regional black soils.

Accordingly, a combination of straw-based mulching methods was used to achieve multiple benefits, including soil protection, water conservation, resistance to erosion, drought and soil hardening. Overall, the system is simple to operate, cost effective and has great potential to increase yields.

7.4 Outcomes

Improved water retention and soil moisture retention

Water retention capacity has been improved by maintaining soil porosity with a uniform, continuous and stable distribution of pore sizes, while more rain and irrigation water is retained through straw mulch no-tillage.[21]

Improved soil fertilization

Years of straw mulching have led to an increase in soil organic matter, as well as increases in nitrogen, phosphorus, potassium and other nutrients in the soil, with a 20% reduction in the use of chemical fertilisers.[21]

Erosion reduction

Wind and water erosion degrade the living environment and cause large losses of fertile topsoil. In addition, short periods of heavy rainfall in summer can easily generate run-off on hills and gentle slopes, washing away surface soils and creating more gullies that fragment farmland or severely damage the ecosystem, which are the main causes of black soil degradation.

Layers of mulched straw, on the other hand, act like a blanket covering the soil, effectively reducing wind and water erosion, limiting run-off and reducing the formation and development of gullies. It is also favourable to the treatment of erosion gullies. Compared to conventional farming practices, conservation tillage can reduce runoff by an average of 60% and soil loss by about 80%.[21]

Stable and high yields

Composting straw results in increased organic matter content and organism health, improved soil structure and higher fertiliser utilisation rates. The combination of these favourable factors can lead to stable and high yields, especially in relatively dry years. In fact, the results of a field trial in Gaojia Village of Lishu Town over more than 10 yrs show that the average yield under the Lishu model was 5-10% higher than that of control groups.[21]

Biodiversity conservation

Known as an “ecosystem engineer”, the earthworm is a consumer, decomposer and regulator in the ecosystem, playing an essential role in improving soil structure, water retention and air permeability, while decomposing soil organic matter, allowing more efficient conversion of soil nutrients and generating more nutrients available for plant growth. Earthworms and worm castings provide a desirable substrate amendment for the growth and reproduction of micro-organisms and soil microbes.

Additionally, straw mulching has a significant impact on the number and weight of earthworms, reaching 114 individuals·m^{-2} and 18.03 g·m^{-2} in this project; whereas the quantity of earthworms per square meter, in the conventional ridge tillage and no-tillage, no-mulching practices were 15 and 19, respectively (without any significant difference in weight).[21]

Accordingly, the density of earthworms in the straw-covered field was six times higher than in the conventional ridge and furrow field, which is likely to be a major factor in the observed improvement in soil biological properties. Straw mulching also provides shelter and food for wildlife such as game birds and small mammals, thereby increasing biodiversity.

Cost-effectiveness and emissions reduction

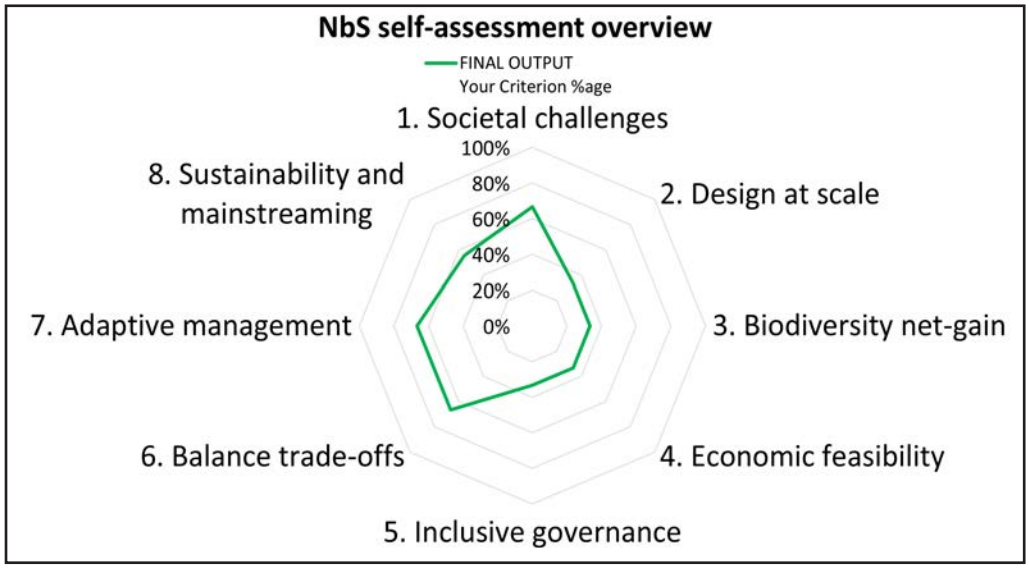
In the Lishu Model, the completion of a single no-tillage seeder operation, rather than ≥ 2 repeated operations as required in conventional practices, means that fewer machines or man hours are required, or that area coverage could be enhanced within the same amount of time or under lower labor intensity, providing cost-effective options on both operation and production sides. In addition to saving CNY 1,000–1,400 ·ha^{-1}, it also reduces the power of agricultural machinery by 15–20%, energy consumption by 25–30%, and it effectively reduces carbon emissions.[21]

Green farming and improved quality

Compared to conventional farming, the Lishu Model reduces the required inputs of machinery and chemical fertilizers, as well as drought stress. Preliminary research has shown that reductions in the components of stress resistance affect corn quality.

In 2017, the Lishu County was applied for building a large-scale standardized production base of green food raw materials (maize), as its core approach. In 2019, it was recognized as a “national large-scale standardized production base of green food raw materials (corn)” by Ministry of Agriculture and Rural Affairs. Meanwhile, the market price of the maize produced under this base is 10–20 CNY·ton^{-1} higher than that of ordinary produce.

7.5 Link to Global Standard for NbS



Box 7. Case 7 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard’s 8 criteria, we sum up the areas in which the case study strongly meets the Standard’s criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

This case is unique among all case studies, given that this research practice it aims at conserving the critical resource of black soil, through regenerative agriculture. The findings provide theoretical basis for the application of no-till practices and understanding how to rebuild soil sustainability in the northeast of China.

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

This case is unique among all case studies, given that this research practice it aims at conserving the critical resource of black soil, through regenerative agriculture. The findings provide theoretical basis for the application of no-till practices and understanding how to rebuild soil sustainability in the northeast of China.

Therefore, the project aims to safeguard food security and promote sustainable management and development, through restoration and natural process, enhancing the provision of ecosystem functions and services (erosion control and sediment retention, soil formation and food production).

According to the NbS Global Standard, the project adequately matches the criteria of identifying societal challenges (Criterion 1) and balancing trade-offs (Criterion 6). It does incorporate adaptive management (Criterion 7) as an research based project. However, the project should also increase the participation of local peasants in planning and design stage and afterward monitoring, since they are the major stakeholder (Criterion 5).

[17] Xiaozeng, H., Na, L. (2018). Research progress of black soil in Northeast China. *Scientia Geographica Sinica*, 38(7): 1032-1041. [In Chinese] http://geoscien.neigae.ac.cn/CN/10.13249/j.cnki.sgs.2018.07.004

[18] Baixing, Y., Jie, T. (2005). Study on black soil erosion rate and the transformation of soil quality influenced by erosion. *Geographical Research*, 24(4): 499-506. [In Chinese] http://www.dlyj.ac.cn/CN/10.11821/yj2005040002

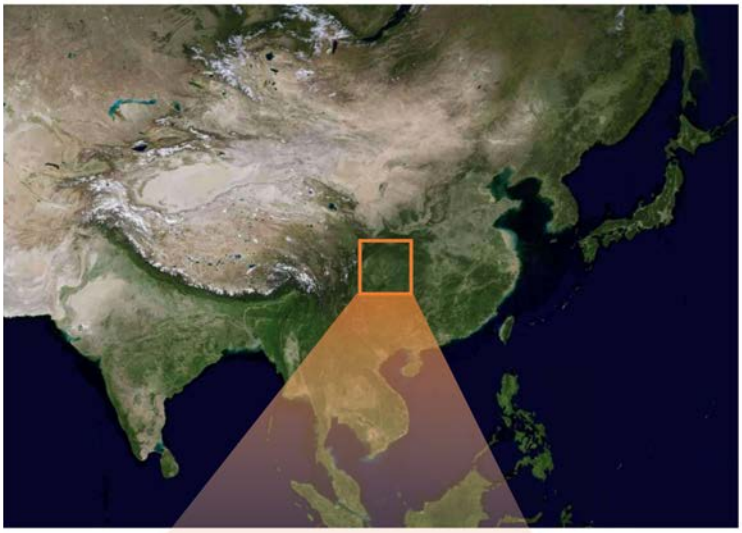
[19] Jingshu, X., Jingkuan, W. and Yandong, X. (2017). *Evaluation of cultivated land quality in black soil region of Northeast China*. Beijing: China Agriculture Press. [In Chinese]

[20] Ministry of Water Resources, Chinese Academy of Sciences, Chinese Academy of Engineering. (2010). *Soil Erosion Control and Ecological Security in China: Northeast Black Soil Region.* Beijing: Science Press. [In Chinese]

[21] Baoguo, L., Guiman, W. (2019). *Conservation tillage technology in Northeast China: pear tree model*. Beijing : Science and Technology Literature Press. [In Chinese]

Case study 8: Integrating nature-based approaches for urban regeneration and development in Chongqing

Authors: Yan Zhou, Zihan Zhai, Manyi Li, Lei Ma



Map data ©2022 Tianditu, MNR of the PRC & NavInfo

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Societal challenges addressed:

- Disaster risk reduction
- Economic and social development
- Water security

Sustainable Development Goals addressed:

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management
Area-based conservation

Total financing:

CNY 10.283 billion

Implementation period:

2018-2020

Ecosystems:

T7.4 Urban and industrial ecosystems
F1 Rivers and streams

Ecosystem services enhanced:

Disturbance regulation
Water regulation
Erosion control and sediment retention
Waste treatment
Refugia
Recreation

8.1 General background and challenges to address

Located in southwest China on the upper reaches of the Yangtze River, Chongqing is a mega-city built on a ridge. There are several green mountain ranges in the municipality, including the Daba, Wu, and Wuling mountains. It is also crossed by the Yangtze River, which is joined by the Wu River, the Min River, and other tributaries, stretching 691 km across the region and joining the Jialing River in its central area. Based on its natural and geographical landscape of “4 mountains, 3 valleys, and 2 rivers” and a healthy ecological environment, Chongqing is built on mountains and surrounded by rivers.

Shaped by the Yangtze River, Jialing River and the surrounding mountain ranges, the central urban area is located in a typical ridge and valley region with high ecological sensitivity and intensive human activities. The pressure on the environment and natural resources is enormous, as 25% of the city’s population lives in 5% of its land area and produces 43% of its GDP. This leads to a weakening of ecosystem services (such as climate regulation) and a pronounced urban heat island effect.

In order to strengthen the capacity of disaster risk reduction and ensure urban safety and residents’ well-being, the government coordinates the management of mountain, river, forest, farmland, lake and grassland ecosystems with urban renewal, and implements a series of projects to restore urban ecology and improve urban functions.

In the process, they have explored and gained some practical experience in achieving harmony between man and nature amidst the use and transformation of natural resources, especially in coordinating the layout and function of construction and ecological space.

In the process of rapid urbanisation, conflicts between man and nature are increasing, and the downtown or central areas are becoming overcrowded. In addition, urban construction is conventionally dominated by reinforced concrete with inadequate ecological infrastructure, leading to reduced disaster resilience.

8.2 Main objectives

This project aims to preserve the city's landscape pattern, improve its ecological areas and strengthen its resilience. It pays particular attention to methods that can help a waterfront city adapt to climate change, sustain economic and social development, and ensure human health.

8.3 Methods

Over a large scale, the project ensures the connectivity of the ecological network; whereas across smaller scales, measures were taken to improve the ecological infrastructure, create blue and green ecological spaces, and explore techniques to realize the value of ecological products through urban micro-regeneration.

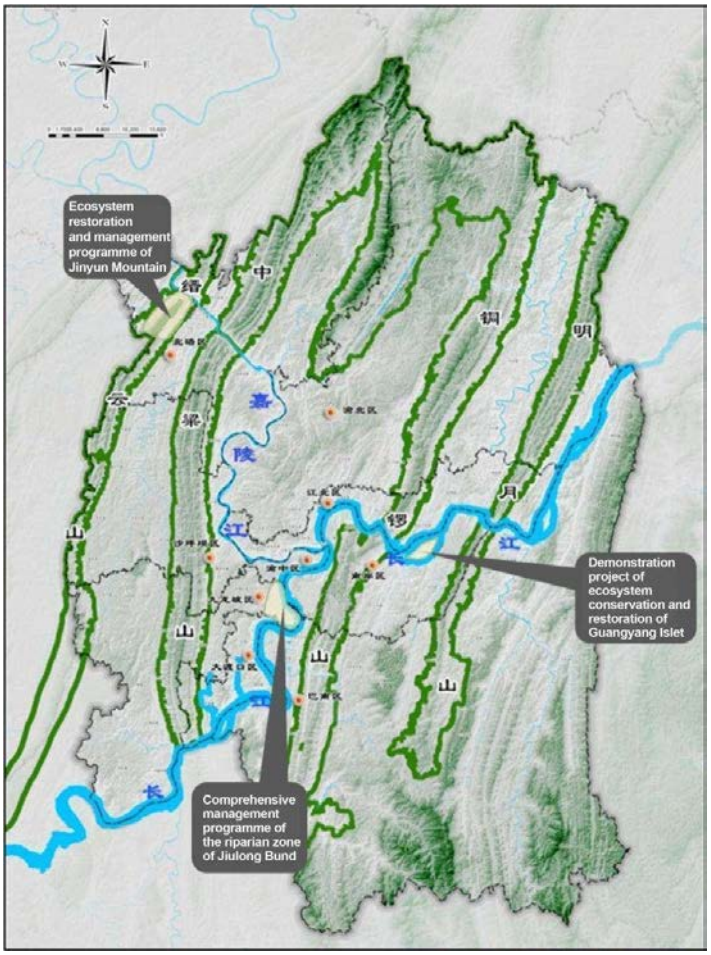


Fig 36. Natural landscape map of Chongqing central districts (© LCRC)

Fig 37. (a) Aerial photo of the riparian area before cementl buildings removal (© LCRC)

Fig 37. (b) Aerial photo of the riparian area after cement buildings removal (© LCRC)

Strengthening planning and regulation to conserve and restore important ecological space

Greater efforts are needed to limit the role of the ‘Three Lines’ (namely the Ecological Conservation Red Lines, the Permanent Basic Farmland, and the Urban Growth Boundaries developed by the Territory Development Plan) in preserving and enhancing important nature reserves and urban eco-spaces.

The Jinyun Mountain Nature Reserve, located on the banks of the Jialing River, is a natural ecological barrier to the centre of Chongqing; however, villagers living within the reserve have been engaged in unsustainable resource extraction. In June 2018, several measures were taken to address these issues, including the demolition of illegally constructed infrastructure to restore green spaces, the reclamation of mining areas, and the sustainable management of lakes and reservoirs. As a result, the Jinyun Mountains have been restored to their “green lung” and natural barrier status.

In 2017, development and construction on Guangyang Islet was suspended and replaced by ecosystem and landscape-based urban planning, including protecting mountains, managing water, growing forests, dredging farmland, cleaning lakes and cultivating grasslands. In turn, the island’s natural habitat was restored, preserving Chongqing’s unique ecological landscape.

Fig 38. (a) Aerial photo of Guangyang Islet

Fig 38. (b) Western part of the islet after restoration

Fig 38. (c) Sloping field and water restoration

Fig. 38 (a) to (c) © Chongqing Guangyang Island Green Development Co., Ltd

Building a vertical city and composing structures to fit the natural landscape

Through the adoption of multi-landform city and compound architectures, the project has applied planning and architectural design methods adapted to the characteristics of a mountain city, and through layer construction,staggered overlapping and other mountain architecture techniques, to form the corresponding landscape characteristics with the integration of human and natural landscapes, as well as traffic and ecological corridors.

Original ecological areas have been transformed into green urban infrastructures. By transforming and greening such ‘gray’ infrastructure, the city increases the amount of urban green space within its limited area to the maximum extent possible.

Restoring the urban ecology by exploiting its topographical features and water flow

Measures have been taken to improve surface infiltration and reduce run-off. Specifically, ecological restoration is coordinated to increase the city’s stormwater capacity according to runoff evolution laws.

Building parks as a method of buffering relations between people and nature within cities

The original site of the Dafosi Wetland Park in Tongnan consisted mainly of tidal flats carved out by the Fu River, mostly sand and gravel, with severe water infiltration, where the riverbanks were built as hardened flood defences. Through the implementation of nature-based interventions, the park restores the habitats of the mudflats for flora and fauna, builds ecological river embankments, and creates riverside wetland parks in urban areas.

Management and improvement of the eco-environment of the "two rivers and four banks", with the development of ecological infrastructure in green and blue spaces

Ecological restoration projects have been designed and implemented to manage the coastal zone of Jiulong Bund according to the water level difference as follows: When the water level is less than 165m, the focus is on natural preservation of the beach to maintain the original landform and wetland landscape; from 165m to 170m, near-natural restoration methods are used by cultivating herbaceous plants and other plant species in accordance with the natural ecosystem succession process; from 170 to 175 m, the focus is on creating a forest-marsh habitat zone, reinforced with more native plants such as bamboo willow, Chinese tallow tree and Taxodium 'Zhongshansha'; from 178 to 185 m, both herbs and flowers are cultivated to form a flora and fauna community for slope protection; while above 185 m, the concrete flood wall is covered with green plants to create a vertical eco-space.

Through the application of interface ecological regulation, three-dimensional riverbank eco-space construction and resilient riparian landscape restoration, six different landscapes have been created within a 20m water level difference, and a resilient ecosystem adapted to summer flooding and winter water storage has been created.[22]

Pioneering the extraction of economic value from ecological products, while at the same time exploring long-term mechanisms for ecological conservation and restoration.

1) *Ecological Land Quota Trading Mechanisms*. New development land for business purposes will not be approved until land quotas have been purchased to create market demand; while idle and abandoned development land in rural areas, nature reserves and other areas with important ecological functions must be reclaimed as qualified farmland, forest or grassland before land quotas are issued and economic value is generated through market transactions.

2) *Forest Cover Quota Trading Mechanisms*. As forest cover is a compulsory target, areas that do not meet the target are allowed to purchase quotas from compliant areas.

3) *Horizontal Ecological Compensation Mechanism.* Districts or counties from upper and lower reaches signed agreements for a two-way compensation system based on the water quality at the river confluence to improve the ecological environment of the downstream areas and increase the fiscal revenues of the upstream areas.

8.4 Outcomes

Improvement of ecological benefits through increasing biodiversity

There has been a significant increase in biodiversity thanks to ecological restoration efforts, which have been tailored to each ecosystem and have been implemented accordingly. In total, 22 national wetland parks have been established in Chongqing, and the protected wetlands cover an area of 207,200 ha, recording 563 species of vertebrates and 707 species of higher plants.

Generation of social benefits through improved urban ecological landscapes

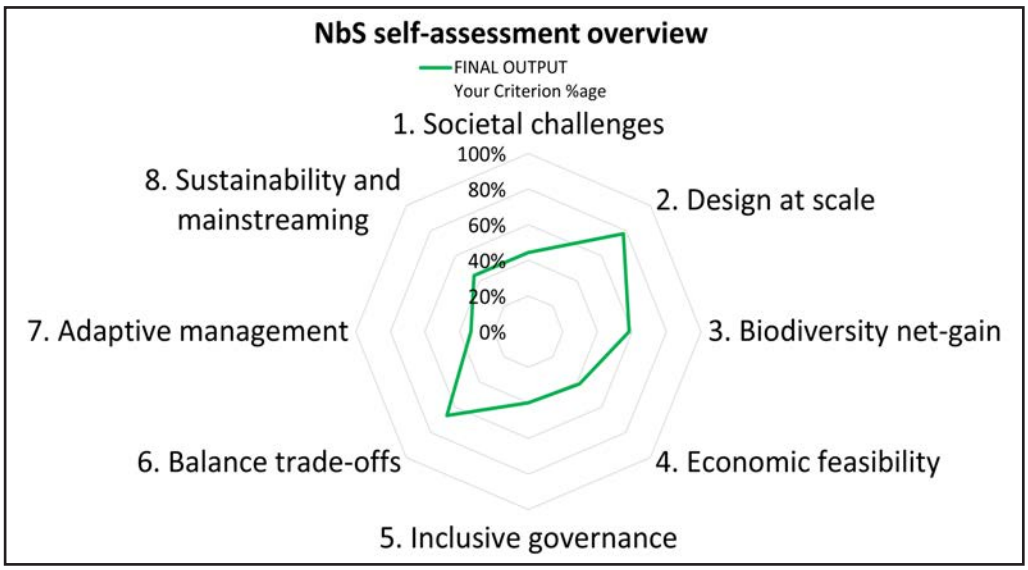
As part of efforts to restore urban ecology, 1,263 urban parks (total area 15,834.55 ha) have been built, 45% of which are located in central districts, covering 7,142 ha. From 2018 to 2020, 92 community sports and cultural parks will be built on the undeveloped urban areas to meet the leisure and exercise needs of nearly 3.5 million residents. From 2019 to 2020, 1,198.9 ha of green spaces were added on slopes and precipices in central districts.

Enhanced economic benefits through natural capital gains in urban and rural areas

From 2018 to 2021, the city traded 286 ha of reclaimed land through the land quota trading mechanism, with a total trade turnover of CNY 801 million[1]. In March 2019, Jiangbei District and Youyang County signed the country's first horizontal ecological compensation agreement to improve forest cover, with the former paying the latter CNY 187.5 million for a quota of 5,000 ha of forested land.

As of January 2021, the city has traded a total of 12,800 ha of forest cover quotas through the trading mechanism, with a total trading volume of CNY 480 million[2]. By the end of 2019, Chongqing has established the horizontal ecological compensation mechanism for 19 secondary rivers with a watershed area of ≥ 500 km^2 and covering ≥ 2 districts and counties, with a total compensation fund of CNY 96.918 million.

8.5 Link to Global Standard for NbS



Box 8. Case 8 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

This case is unique among all case studies since it is a city regeneration project, with some ecological restoration, conservation and sustainable management. The project aims to reconstruct the relationship between human and nature, reducing disaster risk and safeguard water security. It has enhanced ecosystem functions and services of climate regulation, disturbance regulation, water regulation, erosion control and sediment retention, refugia and recreation.

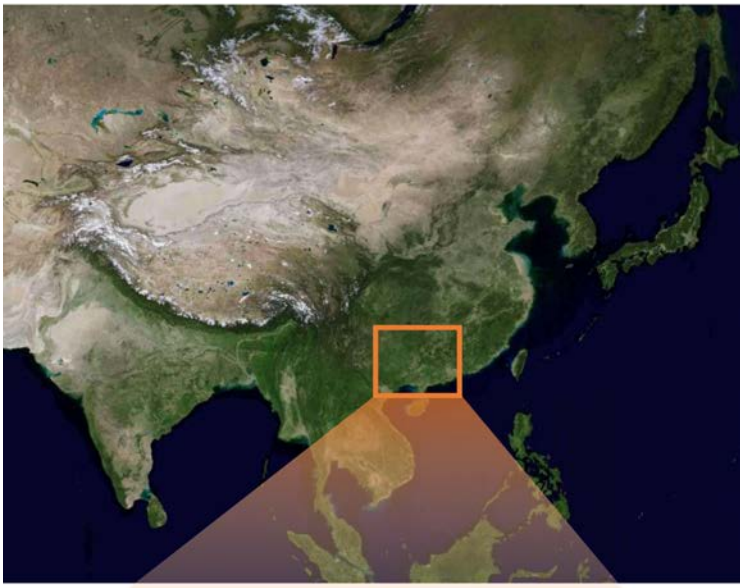
According to the Standard, the project has adequately matched Criterion 2 focusing on designing at scale and Criterions 6 focusing on balance trade-offs. However, the project should have more emphasis on engaging stakeholders, especially the residents, to improve inclusive governance (Criterion 5). Moreover, it should consider improving the co-relation and synergy among all the NbS projects in Chongqing and the corresponding ecosystems.

[22] Xingzhong, Y., Jia, Y., Lei, G. et al. (2018). Demonstration study on ecological restoration and landscape optimization of urban riverside littoral zone in the Three Gorges Reservoir area. *Shanghai Urban Planning Review*, (6):132-136. [In Chinese] https://d.wanfangdata.com.cn/periodical/shcsgh201806035

Data sources:
[1] Chongqing Municipal Bureau of Planning and Natural Resources
[2] Chongqing Municipal Agriculture and Rural Committee

Case study 9: Coordinated coastal restoration and management for sustainable development of Beihai City, Guangxi

Authors: Lihua Lu, Yan Zhou, Xiangyan Su, Feibo Huang



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Societal challenges addressed:

Climate change migitation and adaptation

Disaster risk reduction

Environmental degradation and biodiversity loss

Sustainable Development Goals addressed:

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management
Area-based conservation
Green infrastructure

Total financing:

CNY 2.3 billion

Implementation period:

2018-2020

Ecosystems:

T7.4 Urban and industrial ecosystems
MT3 Anthropogenic shorelines
MFT1.2 Intertidal forests and shrublands

Ecosystem services enhanced:

Climate regulation
Disturbance regulation
Water regulation
Erosion control and sediment retention
Recreation
Culture

9.1 General background and challenges to address

Beihai City is located at the southern end of Guangxi Zhuang Autonomous Region and along the northeastern coast of Beibu Gulf, with a flat and open terrain surrounded by the sea on three sides. The city is rich in natural resources and has three important marine ecosystems - mangroves, seagrass beds and coral reefs - with rich biodiversity, ecosystem services and high research value.

Beihai Binhai National Wetland Park is a typical example of a 'freshwater-estuary-coastal' complex wetland ecosystem, and serve as the central 'green lungs' and core green corridor of the city. The wetland park contains nine species of mangrove resources under national protection, 17 species of endangered flora and fauna, and 86 species and 38 species of migratory birds jointly protected by Sino-Japan and Sino-Australia[1].

Beihai is characterised by a subtropical marine monsoon climate influenced by monsoon circulation and complex meteorological systems. Various types of meteorological disasters, such as droughts, floods and typhoons, occur simultaneously or in succession, seriously threatening local economic and environmental security, as well as people's lives and property.[23,24]

The rapid development of urbanisation, coastal industrialisation, aquaculture and tourism has created a number of problems in this region. Sewage discharges are a continuous source of pollution and increased siltation in many parts of the waters.[25-27] Coastal wetland ecosystems have been degraded, natural shorelines disconnected, mangrove areas reduced, biodiversity lost, and urban flooding increased.

In response, the Beihai Municipal Government has implemented a land-sea coordinated pollution control and ecological restoration programme based on the principle of urban development through ecological approaches.

9.2 Main objectives

The project aims to promote climate change mitigation and adaptation, while proposing to reduce vulnerability and disaster risk through the restoration of mangrove ecosystems and coastal wetlands. It has also promoted the construction of sponge cities to improve water storage capacity to combat urban waterlogging.

9.3 Methods

While targeting water pollution control and sponge city development, ecological restoration has been carried out according to the characteristics of coastal ecosystems, local conditions and spatial design. Efforts have also been made to promote eco-tourism and eco-product development.

Fig 39. Spatial layout of the ecological restoration activities (© LCRC)

Sponge city construction

Effective control, natural storage, infiltration and purification of surface runoff was achieved by exploiting the role of ecosystems in absorbing, storing and releasing rainwater, thereby reducing urban flooding. Firstly, both engineering (construction of infiltration, storage, retention, harvesting, treatment and discharge facilities) and natural measures (such as green belts or stormwater regulation and treatment ponds) were used to increase the city's flood control, drainage and water supply capacity, improve the urban environment and create a healthier water cycle. Secondly, measures have been taken to protect natural aquatic environments such as rivers and lakes, to link water systems and to maintain the water storage function of the city itself.

Systemic ecosystem restoration

A comprehensive management approach was adopted to facilitate systemic restoration per planing patterns, zonings, and sites, designed according to different environments (freshwater, brackish, saltwater) and ecosystems (ditches, reservoirs, rivers, mud flats, sea, etc.).

The ecological restoration of the upstream reservoir included the rehabilitation of the existing pits and ponds around the Liyudi reservoir, the construction of ecological islands to create new habitats, the extension of the shoreline of the water body and the increase of the self-purification capacity, thereby comprehensively improving the ecological status of the reservoir.

The ecological restoration of watercourses included efforts to remove some cement buildings along the Fengjiajiang River. Well-growing trees were maintained, while vegetation with a high capacity for pollutant filtration and interception was planted, creating a vegetative river filter belt system to improve ecological functions along the river.

The ecological restoration of freshwater wetlands in the upper and middle reaches of the Fengjiajiang River included the removal of cement weirs to restore natural ecological exchange, and the increase of vegetation along slopes and aquatic plants to enhance purification function and biodiversity. Similarly, freshwater ponds have been transformed into ecological wetlands with pollution trapping and purification functions.

Fig 40. (a) Photo of the fish ponds (© LCRC)

Fig 40. (b) Photo of the fish ponds after rehabilitation (© LCRC)

The ecological restoration of the brackish water environment in the lower reach of the Fengjiajiang River was undertaken based on a method of self-renewal. Hard weirs were replaced by local associate mangroves favorable to water quality improvement, such as *Barringtonia racemosa*, and *Heritiera littoralis Dryand*. These species also provide habitats for birds. Native palms were planted in areas surrounding the estuary as they are saline–alkali resistant, maintain adaptability to harsh environments, and are resistant to typhoons.

Mangrove forest conservation and restoration entailed the closure of beaches for afforestation, tending to young and middle-aged stands, and planting of local mangrove species (primarily Avicennia marina and Kandelia candel) to conserve the native mangrove diversity, while restoring the biodiversity and stability of wetland ecosystems. To date, about 24.7 ha of mangroves have been successfully restored, and 18 ha of new mangroves have been planted[2]. In addition, non-native mangrove species, such as *Laguncularia racemose* and *Sonneratia apetala* have been controlled from further expansion.

The restoration of Silver Beach included cleaning up the beach environment, removing seawalls, restoring the shoreline, etc. These activities have helped to strengthen the coastal disaster prevention and mitigation capacity, while improving the natural coastal protection functions of Silver Beach and the overall landscape quality. To date, 7.44 ha of beach and approximately 1.43 km of shoreline have been restored[3].

Fig 41. Grey mangrove © Dave Aplin

Fig 42. Mangrove forest restoration (© LCRC)

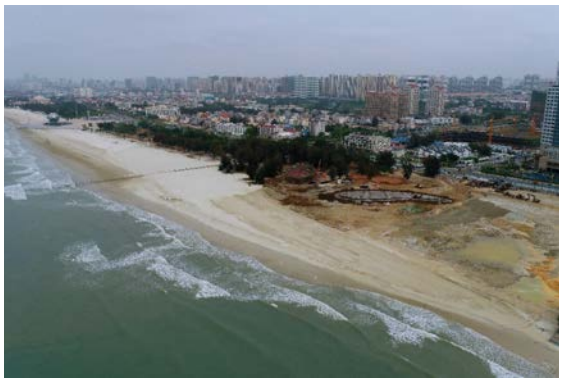


Fig 43. Silver Beach shoreline restoration (© LCRC)

Innovative financing and eco-development

To attract private investment, the programme adopted a DBFOT (Design, Build, Finance, Operate, Transfer) model. Initially, the Beihai government and private financiers contributed CNY 76 million and CNY 682 million, respectively, to establish a joint venture company to operate the programme, while the remaining financial gap was filled by bank loans. Under the terms of operation, the municipal government pays CNY320 million each year for the services provided by the programme. Finally, assets in good condition will be transferred to the government free of charge.

The programme will improve the environment of Beihai City and the quality of Silver Beach, allowing the public to enjoy improved cultural and recreational services. New development and tourism opportunities may also emerge, promoting sustainable urban development, creating additional jobs and attracting further national and international attention.

9.4 Outcomes

Improved water quality

To date, an annual reduction of 1,366 tonnes of primary pollutants and 16.5 million tonnes of discharged wastewater has been achieved across the Fengjiajia River Basin, while the quality of surface water, long at Grade V, has risen to or exceeded Grade IV[4]. In addition, the water quality of Silver Beach improved by 40% from 2019 to 2020.

Biodiversity gains

Initial statistics show that 182 species of coastal birds can now be found across the region, an increase of 46 species since 2017, including the critically endangered spoon-billed sandpiper. In addition, the recovery of mudflats is leading to a steady increase in benthic organisms (e.g. peanut worms), from 66 species before 2016 to 153 species. The Chinese horseshoe crab, green turtle and other rare marine species have been found in the estuary, where 17 mangrove species have also been identified[5].

Capacity building for disaster prevention and mitigation

Firstly, the development of Sponge City has improved the city's flood control and drainage capacity. Second, the restoration of Silver Beach has improved its revetment function and increased its resilience to marine disasters such as typhoons and storm surges. Thirdly, mangroves not only reduce the impact of wind and waves, but also increase the capacity to prevent beach erosion, promote siltation, stabilise shorelines, and purify seawater and air, thereby strengthening the financial and personal security of the surrounding communities.

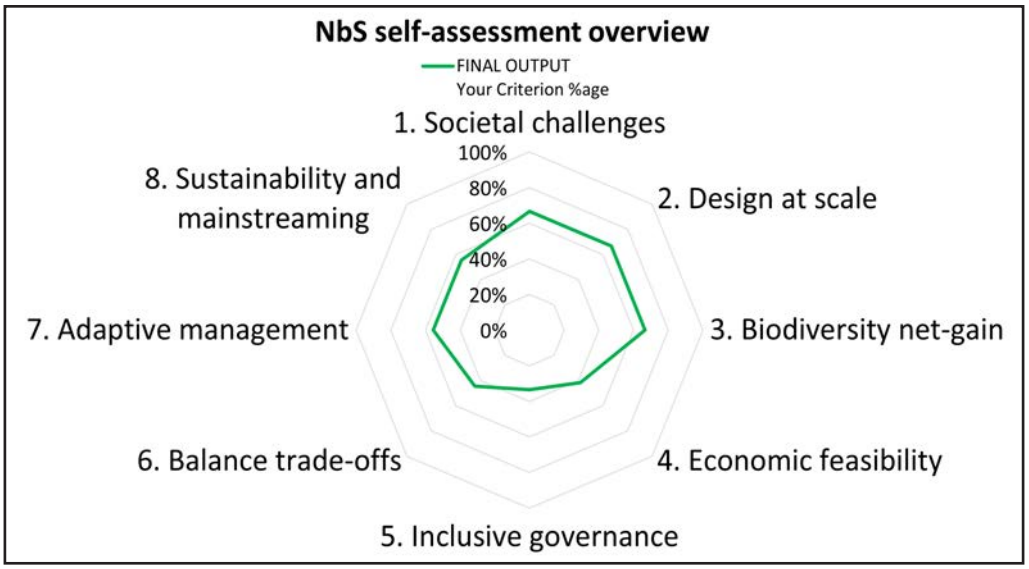
Eco-product development

Since the program was launched, it has been preliminarily estimated that the increases in land values alone could be over CNY 20 billion[4]. Tourism will also be boosted, with an estimated 500,000 tours or more annually, expected to increase revenue by about CNY 10 million[6].

Improving local residents' quality of life

Through community engagement and co-management, rural residents have found better ways to improve their production and living conditions, generate additional income and improve their quality of life. In addition, local communities are becoming more environmentally aware and empowered to prioritise environmental protection as a matter of course.

9.5 Link to Global Standard for NbS



Box 9. Case 9 NbS criterion percentage ©Juntao Hu

Under the programme, efforts have been made to conserve and restore the coastal wetland ecosystem and improve the city's adaptability to climate change, taking into account the integrity and interrelationship of terrestrial and marine ecosystems. In addition, appropriate measures have been taken to address the problems of this densely populated area, where various issues such as urban wastewater, quality of life, ecotourism and recreation, disaster prevention and mitigation, and socio-economic development need to be addressed.

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

In this case, the project aims to address the societal challenges of disaster risk reduction, water security, and economic and social development. It focuses on the water issue, including meteorological disasters and pollution in multiple ecosystems, and restores the site by integrating mangroves, converting fish ponds into wetlands and planting various types of plants to improve water quality. Enhanced ecosystem services include climate regulation, disturbance regulation, water regulation, erosion control, sediment retention, recreation and culture.

According to the NbS Global Standard, the project clearly addresses the challenges of natural disasters, water pollution and wetland degeneration (Criterion 1) in the upper, middle and lower reaches of the Fengjiajiang River and other multi-ecosystems (Criterion 2). In addition, according to the natural resource data baseline on the website of the Beihai City Natural Resources Bureau, it is obvious that after the restoration project, the number and species of local birds, benthic organisms and even rare marine animals are increasing in an integrated and connected ecosystem (Criterion 3).

Referring to the NbS Global Standard, this project can be improved in terms of economic feasibility (Criterion 4), which considers alternative solutions to ensure the effectiveness of the Beihai City NbS design and analysis, while recording cost-effectiveness studies to measure and monitor the economic variables. In addition, the score for inclusive governance (Criterion 5) is slightly lower than the other criterion scores. It could be suggested that more local residents should be involved in all processes of the NbS intervention and that they should be given more opportunities to express their rights and interests in the project.

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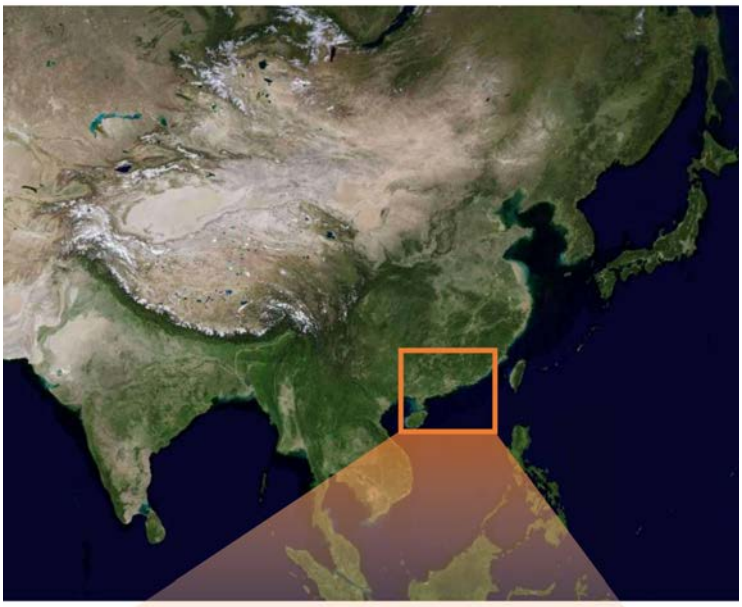
[26] Shuwen, L., Suxia, L., Xiaoting,Y. and et al. (2018). The impact of coastal tourism on the ecological environment of Beihai Silver Beach. *Technology Innovation and Application* (14): 41-43. [In Chinese]
[27] Chunhua, Z., Jingui, L. and Jing, Y. (2017). Preliminary study on the causes of mudding and hardening of Beihai Silver Beach. *Ocean Forecast*, 34 (06): 83-88. [In Chinese]

Data sources:
[1] Department of Natural Resources of Guangxi Province
[2] Guangxi Beihai Binhai National Wetland Park Administration office; Beihai North Drainage Environment Development Co. LTD
[3] Beihai Municipal Bureau of Oceanography
[4] Beihai North Drainage Environment Development Co. LTD
[5] Guangxi Beihai Binhai National Wetland Park Administration office
[6] Beihai Municipal Bureau of Natural Resources

Case study 10: Mangrove restoration to enhance coastal resilience of the Shenzhen metropolitan zone

Authors: Ming Luo, Chongyao Yang, Yan Zhou, Xiangyan Su



Map data ©2022 Tianditu, MNR of the PRC & NavInfo

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Societal challenges addressed:

Climate change migitation and adaptation

Disaster risk reduction

Environmental degradation and biodiversity loss

Sustainable Development Goals addressed:

NbS type approaches implemented:

Ecosystem restoration
Ecological engineering
Ecosystem-based management
Green infrastructure

Total financing:

CNY 300 million

Implementation period:

2008-2021

Ecosystems:

MFT1.1 Coastal river deltas
MFT1.2 Intertidal forests and shrublands
MT3 Anthropogenic shorelines

Ecosystem services enhanced:

Climate regulation
Disturbance regulation
Water regulation
Erosion control and sediment retention
Recreation
Culture

10.1 General background and challenges to address

Mangrove wetland ecosystems have been described as ‘guardians of the coast’, ‘blue carbon stars’, and ‘natural biodiversity banks’. Specifically, mangroves can absorb carbon dioxide, regulate climate, purify water, provide defense against tsunamis and typhoons, support various species of fish and benthic animals, and provide essential ecosystem services.

Bordering both Shenzhen and Hongkong, two of China’s largest metropolitan areas, the wetlands of Shenzhen Bay are the wintering habitat and stopover for one of the world’s nine major bird migratory routes - the East Asian-Australasian Flyway - with some 100,000 migratory birds wintering and passing through each year.

To effectively conserve this mangrove wetland ecosystem close to the centre of the megacity, the Shenzhen government has launched a series of coastal mangrove restoration policies in Shenzhen Bay, including mangrove conservation, sustainable management, and restoration, which have led to an increase in the total area of mangrove forests and reversed the trend of mangrove wetland ecosystem degradation.

The rapid increase in urbanisation in Shenzhen has been accompanied by a decrease in the mangrove areas. In addition, direct industrial and municipal wastewater discharges have increased harmful pollutants and wetland degradation. Along the coastal estuary, watercourses have been channeled, preventing the exchange of matter and energy between terrestrial and aquatic ecosystems. Diked fishponds have also been degraded, reducing the ecological function of providing habitats and feeding grounds for migratory birds. In addition, invasive plant species such as *Mikania micrantha* and *Leucaena leucocephala* have taken over large areas, while outbreaks of insect infestations have become more frequent, and local species have been replaced across ecological niches, all of which have led to an oversimplified and increasingly fragile structure of wetland communities.

10.2 Main objectives

This project aims to improve the disaster risk reduction and climate change adaptation capacity of the megacity of Shenzhen through the restoration and conservation of mangrove wetlands.

Fig 44. Spatial plan of Shenzhen Bay restoration projects(© LCRC)

10.3 Methods

The local government has insisted on coordinated land-sea management planning to strengthen environmental protection. For example, improved sewage treatment plants are being built with a pipe system that separates rainwater and sewage. Strict controls are also in place for land-based pollutants, and a number of pioneering pollution treatment projects are being implemented.[28]

In terms of ecological restoration and the following criteria, which focus on balancing the needs of wildlife with those of urban development and citizens, pond habitats for aquatic birds have been restored through comprehensive water management.

In addition, measures have been taken to prevent and control invasive species, plant diseases and pests, and to restore mangrove forests in order to systematically restore the structure and functions of the mangrove ecosystem in Shenzhen Bay. At the same time, rich and enjoyable nature-related educational activities have been carried out and promoted to increase the interest and participation of the public. To this end, CNY 300 million was invested in the project, of which CNY 270 million came from the central government and CNY 30 million from social investment[1].

Fig 45. (a) Photo of the conventional watercourse (© LCRC)

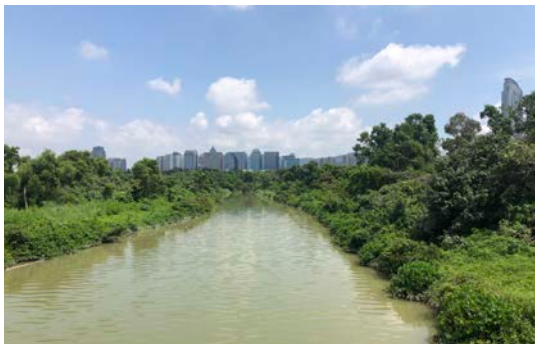


Fig 45. (b) Photo of the ecological watercourse after restoration (© LCRC)

Water management

The Fengtang River is the main river flowing through the Futian Mangrove Wetlands in Shenzhen Bay. As it is highly channelized, little vegetation has been able to grow along the river, resulting in a very limited provision of ecosystem services.

To address this problem, the first step was to de-channelize the forms and structures of the watercourses, soften the course of the Fengtang River, and re-construct the banks of the river with its branches, removing rigid structures from the surface, lowering the water level, and reforming the side slopes into a gentle gradient. A certain thickness of humus was applied to the side slopes to restore the soil environment for better plant growth.

Secondly, according to the ecological characteristics of the environment from the outer tidal flats to the inner banks, various plant communities were restored to rehabilitate the bank vegetation, and a comprehensive ecosystem of mangroves, associate mangroves and riverine plants was developed, contributing to the restoration of both the main mangrove wetland functions and the estuarine ecosystem of the Fengtang River.

Fishpond restoration

Diked fish ponds provide habitat for various bird species. The ponds in the Futian Mangrove Wetlands Nature Reserve (Futian Reserve) cover an area of approximately 6.67 km^2, accounting for 18% of the reserve's total area.[29] However, due to problems with water depth and simplified habitats, these diked fishponds are largely inadequate to meet the needs of the various birds that inhabit the area.

Learning from the experience of Mai Po Nature Reserve in Hong Kong, the Futian Reserve Management Office, in cooperation with the Shenzhen Mangrove Wetlands Conservation Foundation (MCF, IUCN member), aimed to

develop diversified habitats for waterbirds and successfully restored 3 fishponds within the Futian Reserve, transforming them from aquaculture ponds back to organisation focused on environmental protection, and the first NGO ever to operate a government-mandated ecological park - the Futian Mangrove Ecological Park.funded organization that focuses on environmental protection,

A mosaic distribution of deep water, shallow water and central tidal flats has been mapped for the fishpond restoration area (Fig. 42). Reed communities have been established along the banks to meet the habitat needs of various waterbird species. In addition, to further restore suitable bird habitat, the water levels of the central mudflats are controlled so that the island is completely submerged (> 0.3 m) in summer, preventing plant growth along the slopes. During the winter, water levels are maintained between 0.0-0.1m on the uncovered and shallow mudflats to support waterbird habitats.[30]

Fig 46. (a) Photo of the fish ponds distinction (© LCRC)

Fig 46. (b) Photo of the fish ponds after rehabilitation (© LCRC)

Researches of water birds have shown a dramatic increase in numbers and communities following the ecological restoration project from September 2015 to May 2019. 28 species and 13,737 individuals have been added to the area. There was also a significant increase in numbers during the spring and autumn migratory seasons, accompanied by a remarkable increase in community diversity.[30]

Fig 47. (a) Photo of Pacific golden plover (© LCRC)

Fig 47. (b) Photo of migratory birds (© LCRC)

Prevention and control of diseases, pests, and invasive species

Natural enemies of pests in mangrove forests primarily live within the bank-side shrubs of the diked fishponds. By recovering herbaceous communities on the embankment, and providing habitats for the pests' natural enemies, both the species number and individuals of predatory insects have increased, proving an effective measure for pest and disease prevention.

Sparse shrubs and low herbs - such as plants from families Gramineae, Cyperaceae, Compositae, Commelina, Verbena, and Acanthaceae - were planted across vast areas along the buffer zone between mangrove forests and diked fish ponds suitable pest predator habitats. Both heights and densities were reduced in the arboreous communities, creating suitable habitats for insects, including spiders, bees, and flies, while assisting with the recovery of predatory insect numbers of species and individuals.

Simultaneously, strong integral connectivity is guaranteed among subsystems of mangrove forests and fishponds, while migratory routes from ponds to mangroves were kept open for the predatory insects to migrate into mangrove forests, and play their essential role in preventing the spread of pests and diseases. [31]

Regarding invasive species, alien herbaceous hygrophytes were rooted out through desilting projects, while good-quality local hygrophytes were planted, such as *Kandelia candel*, *Aegiceras corniculatum*, *Acanthus ilicifolius*, and *Bruguiera gymnorhiza*. Terrestrial invasive plant species were also artificially removed before supplementing local species, and regular clearing work was conducted throughout the subsequent management on an annual basis to prevent the further spread or growth of invasive species. Specifically, in an attempt to eliminate M. micrantha, the dominant harmful plant species throughout Shenzhen Bay, various ecological control measures were taken, ranging from artificial removal, biological control, and the plant photosynthesis time control.

Mangroves and mudflats restoration

The mangrove forest restoration project consists of forest plantation and mudflat restoration; these activities have been carried out on an area of 220 ha. in the western estuary of shenzhen bay, work has mainly focused on restoring local mangrove forests, in addition to constructing bird mudflat habitats and artificial mudflats to provide resting places for shorebirds. the reforestation efforts have been effective, with a total of 30.2 hectares of mangrove forests planted to date[1].

Fig 48. Aerial photo of Shenzhen Bay (© LCRC)

Nature related education

Thanks to the cooperation of the Futian District Education Bureau, the Futian District Science and Technology Association and the Reserve Authority, MCF organised nature-related education courses on a monthly basis and opened them to all schools in Futian. More than 200,000 citizens, including (but not limited to) primary and secondary school students, participated in these educational events.

Fig 49. Photo of wetland education activity (© LCRC)

Strengthened Shenzhen–Hongkong cooperation

Both Shenzhen and Hongkong have implemented a series of projects on mangrove conservation and restoration across Shenzhen Bay. Long-term cooperation has been established among Futian Reserve Management Office, MCF, Shenzhen Bird-watching Society, Hongkong Agriculture, the Fisheries and Conservation Department, Hongkong Mai Po Nature Reserve, and Hongkong Bird-watching Society.

Thanks to these cooperation and exchanges, stakeholders in Shenzhen have learned from Hongkong's sophisticated experience in fishpond management and nature related education, further broadening their ideas and views of coastal wetland conservation. In addition, close cooperation between the two megacities can be seen in the annual Shenzhen-Hongkong Coastal Wetlands Conservation Forum and the Shenzhen River Governance Project, jointly launched by the two governments, which has successively completed the desilting of waterways, embankment reinforcement, sewage outfall rehabilitation and water surface sanitation.

10.4 Outcomes

Increasing biodiversity

Within the restoration area, mangrove wetlands have recovered from loss of function, and biodiversity has shown a consistent increase. Namely, the richness of *Kandelia candel*, *Aegiceras corniculatum*, *Acanthus ilicifolius*, and *Bruguiera gymnorhiza* has increased with a vegetation coverage > 95%.

There has also been a remarkable increase in both the number and diversity of species, particularly following the restoration of fish ponds into bird habitats. Through a series of successive restoration actions, the project is playing an important role in maintaining the ecological status and value of Shenzhen Bay on migratory bird flyways. In particular, the restoration project has led to a positive and steady increase in the number of endangered *Platalea minor*, with the global population increasing from 825 in 2000 to 4864 in 2020, and from 135 to 361 in Shenzhen Bay alone.

Carbon sequestration and climate regulation

The method, as proposed by the Blue Carbon Initiative jointly published by Conservation International (CI), the IUCN, and United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 2014, has been localized in and applied to Futian Reserve. Results have shown that in Shenzhen Bay, each hectare of mangrove forests absorbs about 40 $tCO_2 \cdot yr^{-1}$ from the atmosphere, highlighting the crucial role mangroves play in carbon fixation, mitigating climate change, and helping achieve carbon neutrality. [32]

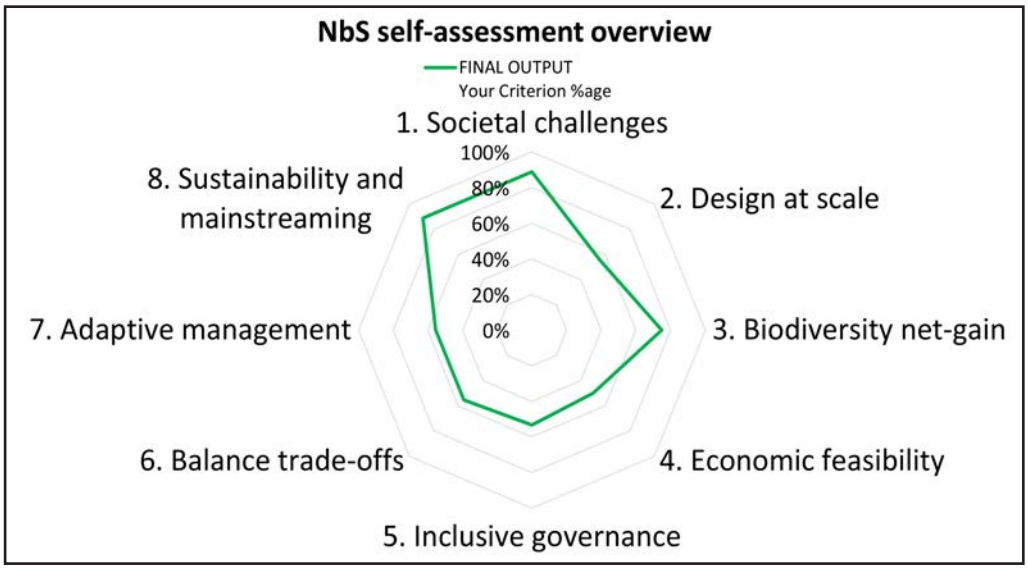
Moreover, the wide and open water surface of Shenzhen Bay has had vast areas of mangrove forests restored. Accordingly, the cooling effect and direct regulation of climate contributed by water vaporization and plant transpiration greatly mitigate the urban heat from nearby Shenzhen.

Achieving human-nature harmony

The mangrove forest ecosystem restoration project has succeeded in maintaining the harmony and connectivity between the restoration zone and the surrounding areas, while establishing a natural link between the sea and the city, and between birds and people, thus promoting the synthetic functions of coastal wetland ecosystems. In addition, the project will highlight the characteristics of coastal wetlands and mangroves throughout Shenzhen Bay, enhancing the value of both the environment and human settlements, while contributing to the development of surrounding areas.

At present, the coastal mangrove wetlands in Shenzhen Bay serve as a demonstration of how to build an environmentally friendly city, as well as a famous scenic spot for citizens and visitors at home and abroad, providing services such as sightseeing, leisure and science popularisation to more than 10 million visitors every year.

10.5 Link to Global Standard for NbS



Box 10. Case 10 NbS criterion percentage ©Juntao Hu

After having assessed the case study with the NbS Global Standard's 8 criteria, we sum up the areas in which the case study strongly meets the Standard's criteria and those in which it met them partially or weakly. The latter helps identify what aspects are to be improved, which may be of considerable importance for practitioners.

In this case, the project focuses on addressing the societal challenges of climate change mitigation and adaptation, disaster risk reduction, environmental degradation, and biodiversity loss. Coastal ecosystems such as mangroves are successfully restored, enhancing the provision of ecosystem functions and services related to climate regulation, disturbance regulation, water regulation, erosion control and sediment retention, recreation, and culture.

According to the NbS Global Standard, the project strongly addresses Criterion 1, 3 and 8, which focus on clearly identifying societal challenges, seeking opportunities for net biodiversity gain, and promoting sustainability and mainstreaming. An important aspect of the project is the implementation of local and national mangrove conservation and restoration policies. Together with other similar activities, this project contributes to the establishment of the International Mangrove Centre in Shenzhen, facilitating global action and research on mangrove conservation.

In addition, this project will work with various organisations to develop nature education and enhance the recreational and cultural services of the ecosystems. In terms of the NbS Global Standard, some aspects of the project could be improved, focusing on balancing trade-offs (Criterion 6), which takes into account the impacts of changing ecosystems, and adaptive management (Criterion 7), especially in terms of planning and documenting evidence, and strengthening cooperation with Hong Kong to facilitate synergies.

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Data sources:
[1] Shenzhen Municipal Bureau of Natural Resources

General reflections

It is important to reiterate that all these case studies were designed and implemented before NbS achieved its current global recognition. This means that although these were established with the intent of incorporating the use and management of ecosystems, they were not designed as NbS per se! However, this still provides an excellent opportunity to consider how close these interventions are to NbS best practice and thereby raise awareness and build capacity by reflecting on the project planning according to the NbS criteria. The overall results are encouraging while noting there is still scope for improvement.

We consulted with Yan Zhou, Yan Chen and Chongyao Yang, the authors of most of the case studies (i.e. Case 1, 2, 3, 4, 8, 9 and 10) from the MNR's Land Consolidation and Rehabilitation Centre (LCRC), about the significance of the standard for ecological projects. They praised the NbS Standard for its reference value, particularly in terms of its focus on social benefits, design at scale, stakeholder involvement, trade-offs and adaptive management. They also felt that the localisation process of NbS in China should create more specific and locally adapted guidance for the use of the NbS Global Standard, to make it easier to implement in practice. It is noted that an International Standard Committee exists to provide guidance on how the Standard can be used consistently across a range of different national and local conditions.

In 2021, LCRC experts organised NbS self-assessment meetings for several ecological projects, including the case of Fuxian Lake, and drafted a preliminary Standard Operation Procedure (SOP) for self-assessment. The experts suggest that NbS self-assessment should be embedded in the project cycle and carried out at least three times for the planning, mid-implementation and post-implementation phases.

In general, if self-assessment is carried out during the planning phase, project documentation can be strengthened and used for decision making. Meanwhile, it can also enhance stakeholder empowerment through better awareness and approaches to stakeholder identification and engagement. In addition, current ecological conservation and restoration projects in China often focus on efforts on ecosystems and species rather than treating societal challenges as a primary goal, while the self-assessment leads to more consideration of social benefits.

Although the principles of ecological projects in China are not entirely consistent with the NbS Global Standard, the basic concepts are consistent from a theoretical perspective, even if the application of the principles in practice is a weakness and a difficulty. For example, the latest official guideline for ecological conservation and restoration projects issued in 2020 requires projects to be planned and designed at the landscape scale.

However, the general situation for large projects in China is that although the provincial government usually coordinates the main project, the sub-projects are submitted by different departments, resulting in fragmentation with different objectives, which can distract from the overall objective. In some projects, local governments have established joint meeting mechanisms or joint working groups to try to improve coordination between different departments, but the process is still arduous and lengthy.

In general, the majority of ecological projects in China are led by the central government from a top-down approach and implemented by all levels of government, which has the unique characteristic of being designed on a large scale compared to those promoted from the bottom up. These projects therefore have advantages from the outset in terms of scale-up, government recognition and economic viability. For example, the Shan-shui Initiative (which includes cases 3, 4 and 5) was awarded the first 10 Global Restoration Flagships of the United Nations Decade of Ecosystem Restoration, comprising 75 large-scale projects. So far, the initiative has restored 3.5 million hectares out of a target of 12 million hectares by 2030.[33] However, these projects need to attach more importance to improve stakeholder involvement in order to comply with NbS criterion 5.

In addition, adaptive management is an emerging concept for the management system of large-scale ecological projects, and ecological conservation and restoration projects in China still apply the management mechanism of engineering projects. The significance of the NbS concept and the Global Standard is to raise the awareness of adaptive management to deal with the dynamics of ecosystems by decision makers and practitioners to leverage transformative change.

The authors suggest that the NbS Global Standard provides strong supportive framework for ecological projects from both a conceptual and operational perspective. Applying the standard during both design and implementation can highlight where best practice is being achieved and these areas where improvements and corrective actions can help strengthen the ability of the project to address societal challenges. Additional detailed and pragmatic guidance for NbS interventions in China, such as technical guidelines, monitoring standards, effectiveness assessment guidelines and adaptive management standards, are now needed for practical application of the Standard.

In addition to the cases themselves, the publication of this report also represents knowledge management of these projects through a collaboration between IUCN and Ministry of Natural Resources of the PRC. In this way, we promote a deeper understanding of the NbS Global Standard among all interested parties, and share Chinese practices and experiences on a global scale.

[33] United Nations Environment Programme (UNEP) (2023). *Science and tradition drive China-wide effort to restore landscapes*. https://www.unep.org/news-and-stories/story/science-and-tradition-drive-china-wide-effort-restore-landscapes

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