Collaborative Practice-led Research Agenda for the World Heritage property of Mount Huangshan

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I. Background

1. Brief description of the World Heritage property

Mount Huangshan is located in Huangshan City in the southern part of Anhui Province, China, and has a total area of 160.6 square kilometres. Inscribed on the World Heritage List in December 1990 as China's second mixed World Heritage site, Mount Huangshan was inscribed for meeting the criteria (ii), (vii), and (x).

Mount Huangshan is also recognized by UNESCO as a Global Geopark and a Biosphere Reserve, making it one of only eight sites worldwide to hold all three designations.

The natural and cultural landscapes of Mount Huangshan are seamlessly integrated, showcasing the unique charm of the harmonious coexistence of nature and culture. It stands as a quintessential example of both natural beauty and cultural significance.

•Mount Huangshan possesses profound cultural value

Mount Huangshan is renowned for its uniquely shaped pines growing on granite rocks and its spectacular sea of clouds, earning it the title "the most wondrous mountain in China.

The "Huangshan School of Painting," which emerged on this mountain, has had a positive and far-reaching impact on the development of traditional Chinese landscape painting, transforming the natural mountain into a cultural icon of immense brilliance. For visitors, poets, painters, and photographers from around the globe who flock to this scenic wonder, Mount Huangshan holds an eternal allure.

•Mount Huangshan boasts unique natural aesthetic value.

Its complex geological history has shaped its magnificent and picturesque landscapes. It is characterized by towering peaks, uniquely shaped rocks, verdant pines competing in grandeur, and ever-changing seas of mist and clouds. These elements combine to create a spectacular and ever-transforming vista.

Mount Huangshan is renowned for its "Five Wonders": the uniquely shaped pines, the bizarre rocks, the sea of clouds, the hot springs, and the winter snow. Additionally, its transient phenomena, such as sunrise, sunset glow, Buddha's light, rime, and autumn colours, further enhance its allure. With 1,019 natural and cultural scenic spots of extraordinary beauty, Mount Huangshan has earned the reputation of being a "fairyland on earth."

•Mount Huangshan holds significant biodiversity value.

Despite covering only 0.0044% of China's land area, it is home to 6.92% of the country's plant species and 9.55% of its animal species. The mountain boasts 2,385 species of higher plants and 417 species of vertebrates, with 34 plant species named after Huangshan.

The International Union for Conservation of Nature (IUCN) recognizes Mount Huangshan as one of the world's 108 biodiversity hotspots (source). It is also designated as one of China's 35 priority areas for biodiversity conservation, underscoring its immense ecological and strategic importance. According to calculations by the Forestry Institute of the Chinese Academy of Forestry (CAF), Huangshan's ecosystem service value reaches CNY 248,200 per hectare annually, with its total annual ecosystem service value exceeding CNY 10 billion. The primary contributors include soil conservation, forest recreation, and water retention, while other ecological benefits encompass carbon sequestration and oxygen release, biodiversity conservation, atmospheric purification, nutrient accumulation, material resource provisioning, and more.

•Mount Huangshan embodies multidimensional heritage and sustainability significance.

Huangshan is recognized as a National Key Scenic Area and one of China's most famous mountains. It holds significant value as the birthplace of the Huangshan School of painting, which has profoundly influenced Chinese landscape art. Its National Key Cultural Relics Protection Units, including cliff inscriptions and ancient trails, demonstrate a historical reverence for nature and the harmonious relationship between humans and the environment. Mount Huangshan also holds various international and national designations. Active conservation efforts utilize modern technology, including a goal of creating a 'zero-carbon scenic area'.

2. Present priority issues

1) Impacts and pressures on the ecological environment caused by tourism development.

With the increasing number of tourists in Mount Huangshan, one of the most attractive scenic areas, the large influx of visitors has pressured the ecological environment of the heritage site. Over the past several years, the average record is above 3 million visitors annually. After the COVID-19 pandemic, the average annual visitors have risen to above 4 million. According to the management requirement, cleaners should transport garbage outside the heritage area daily. However, too many visitors result in more significant problems with garbage transportation and daily disposal. Too many visitors produce a lot of garbage and sewage daily. There are challenges to the environment of both the heritage area and the buffer zone. At the same time, visitor management is becoming more challenging when there’s a large flow of tourists, there are traffic jams on the trails and limited areas on the top of the mountain, and then potential dangers.

2) Challenges and pressures to the landscape caused by natural hazards.

Ancient and famous pine trees, as a critical component of the natural aesthetic value of Mount Huangshan's OUV, are affected by pine wood nematode disease. This disease is considered a cancer of pine trees and has not yet been eradicated worldwide.

Extreme weather, such as big winds, rainstorms, acid rain, snowstorms, high temperature, etc., impacts Mount Huangshan's attributes, like the ancient trees, geological landscape and the ecological system.

Extreme weather is emerging more often in recent years. According to data from the monitoring system of the Mount Huangshan Management Office from 2017, the average temperature has risen about 0.3-0.5

degrees in these years. The big winds sometimes increased by about 18 days. And the rainstorm days sometimes increased as well. There are possible impacts on extreme weather due to climate change.
As the temperature rises, the growing altitude of Moso bamboo gradually increases, which also affects the growth of pine trees at higher altitudes.
Drought is becoming more frequent because of climate change, which is a high-risk factor. Although there are strict management measures and comprehensive monitoring systems, there is always high pressure from the possibility of forest fire (fire caused by lightning or humans) to the natural aesthetic value of Huangshan, represented by ancient and famous pine trees and other rare flora and fauna in this ecological system with rich biodiversity.
At the same time, extreme weather conditions, such as freezing rain, snowstorms, and thunder and lightning, also pressure pine trees and other rare species. Some trees risk falling or being damaged. After snowstorms, the soil becomes loose, and some trees fall and uproot. Freezing rain and lightning can also cause tree branches to break.

II. Collaborative process

The Research-Practice Team of Mount Huangshan consists of managers from the Huangshan World Heritage Management Office, Huangshan Global Geopark Management Office, and Huangshan World Biosphere Reserve Management Office of Mount Huangshan Scenic Area Committee, and researchers from the School of Landscape Architecture of Beijing Forestry University. For the core area and buffer zone, including the cultural and natural heritage, management and community participation, current time and future, using the framework of the Enhancing Our Heritage Toolkit 2.0 (EOH 2.0) and abundant related reference, the team had sufficient discussion and analysis, and repeated argument, then get the conclusions. Collaborative efforts between site managers and researchers enabled a systematic evaluation of Huangshan's values, attributes, and related factors; and based that then conducted an assessment of the whole management system, the main challenges, and the gaps; furthermore select three research priorities, analysed the impacts and challenges, conclude the management measures and proposed possible development, ensuring a structured interdisciplinary approach aligned with the outlined workflow diagram (Figure 1).

1. Collaborative Work Process Between Huangshan Managers and Researchers

The collaborative process between Mount Huangshan managers and researchers involves an ongoing dialogue to address the pressing issues concerning the site's management. Combining researchers' expertise and heritage site managers' practical insights, the team could analyze Huangshan's current conditions, identify challenges, and formulate solutions. This collaborative effort was supported by tools such as the EOH 2.0 and the Management Framework, which helped structure the discussions and provide a systematic approach to understanding the site's cultural, ecological, and tourism-related challenges.

2. Methods and Tools Used

The Tools 1, 2, 3, 4 and 5 of the EOH 2.0 provided a structured approach for evidence-based decision-making. It allowed the team to assess the challenges of tourism, ecological pressures, and climate change based on Mount Huangshan's OUV. The toolkit facilitated the integration of scientific and local knowledge, ensuring that solutions were context-specific and addressed the site's immediate and long-term needs. This approach encouraged collaboration at all levels, from high-level management decisions to field-based conservation efforts.

3. Benefits of Collaborative Work

The collaboration between managers and researchers led to several key benefits. First, combining research-driven insights and site management expertise ensured the proposed solutions were scientifically grounded and practically viable. This was particularly evident in managing tourism pressure, where flexible visitor

capacity controls and strategic planning are essential for maintaining ecological balance while promoting sustainable tourism. Second, integrating local knowledge, such as traditional ecological customs, into the management strategies can enhance community engagement and ensure culturally appropriate conservation practices.

4. Challenges Encountered

One of the main challenges in the collaborative process was balancing the scientific needs for long-term preservation with the immediate pressures from tourism and environmental factors. Researchers focused on ecological restoration and long-term preservation strategies, while managers had to deal with short-term operational concerns, such as managing visitor flows and the risks posed by natural hazards. Researchers and managers try to find ways to integrate traditional knowledge with modern management practices, which requires careful negotiation and adaptation.

5. Key Issues Identified and Proposed Solutions

Through discussions, the team identified several key issues faced by Mount Huangshan, such as the impacts of tourism development on the ecological environment, the challenges posed by climate change, the risk of degradation of natural and cultural landscapes, and the way to integrate the indigenous and local knowledge and customs within the heritage conservation. Besides the corresponding management instruments, proposed suggestions and solutions include improving research on visitor capacity, management and monitoring systems; developing long term monitoring and research of key species and geological and water landscapes, and preventive conservation strategies facing the challenges climate change; strengthening research on traditional knowledge and practices of ecological and heritage conservation of indigenous communities, and developing related programmes to promote indigenous communities' engagement.

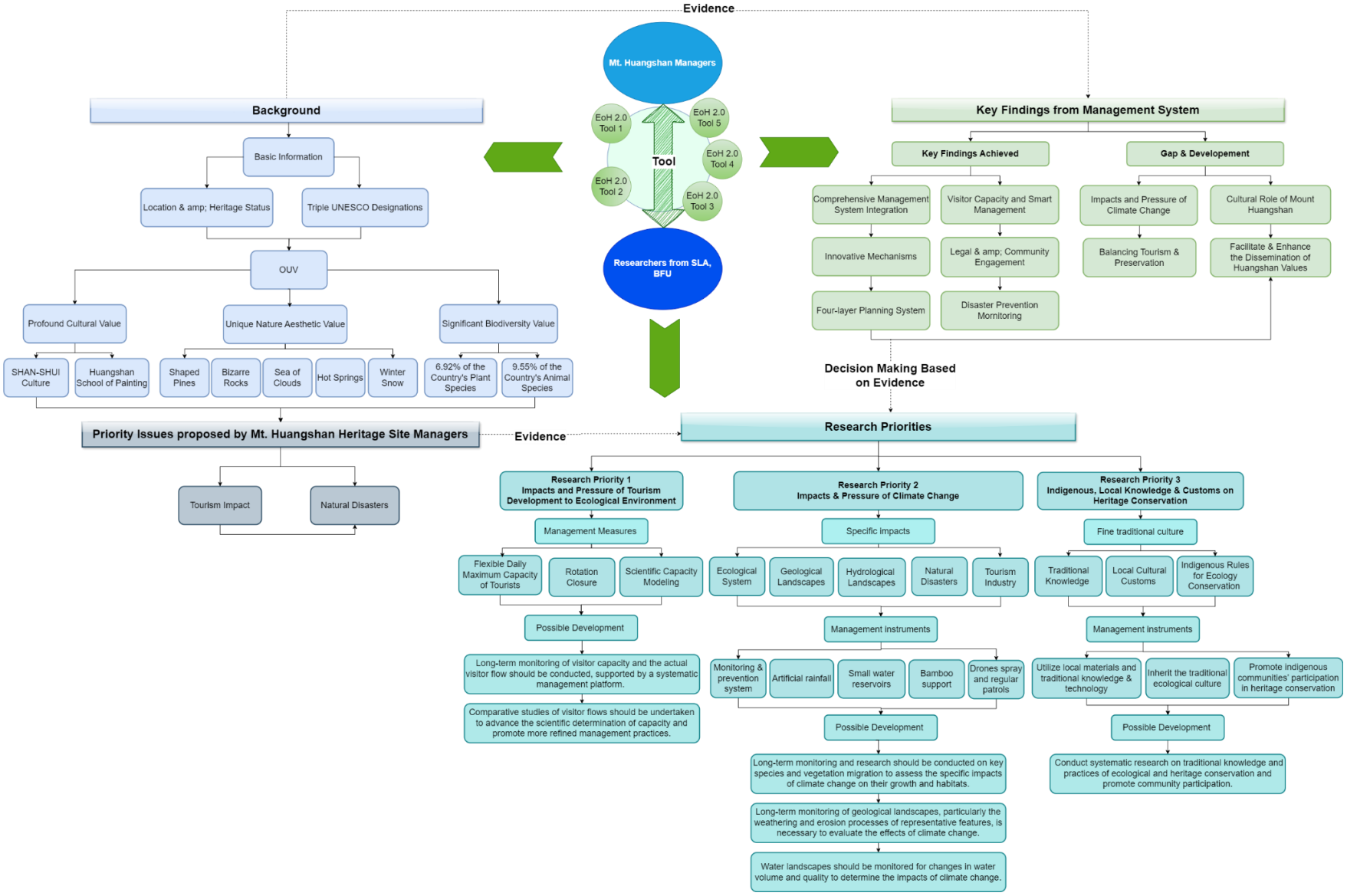

Figure 1. The Framework of Collaborative Process

III. Key findings from the analysis of the management system

1. Management assessment

A. Comprehensive Management System Integration

The management approach has successfully integrated three international protection systems—World Heritage, Global Geopark, and Biosphere Reserve—ensuring coordinated natural and cultural heritage management. This integrated system is supported by robust scientific monitoring mechanisms, including personalized "one tree, one policy, one file" protection plans for ancient trees. To institutionalize these practices, a multi-level legal framework has been established through provincial and municipal regulations, further strengthening the integrated management approach.

B. Innovative Management Mechanisms

Mount Huangshan Scenic Area and Huangshan District jointly operate a "1+8" governance framework. The "1" refers to a unified leadership mechanism coordinating eight specialized task forces, including ecological environmental protection, planning and construction management, cultural tourism economy development, emergency incident management, social security and stability, supply of characteristic agricultural products, food and drug safety supervision, and targeted governance in Tangkou Area.

This collaborative system is complemented by an innovative closed rotation model featuring an "alternating opening" approach that operates on 3-5 year cycles. During closure periods, staff regularly monitor and carry out maintainance activities, ensuring continuous ecological oversight. These measures create a comprehensive ecological protection framework through systematic maintenance and inspection protocols, balancing tourism access with environmental preservation needs.

C. Four-tier Planning System

Mount Huangshan has developed a four-tier planning system comprising master, zonal, site-specific, and specialized plans (including a dedicated Heritage Conservation Special Plan), implementing holistic and systematic conservation while strengthening whole-process supervision over construction projects. This interconnected approach ensures systematic protection through multiple planning levels working in harmony. The system facilitates effective decision-making across both macro and micro scales, allowing for comprehensive management at different levels of detail. Through this scientific planning approach, the integrity of the heritage site is maintained, demonstrating how structured, multi-layered planning contributes to sustainable preservation.

D. Tourist Carrying Capacity and Smart Management

Based on ecological carrying capacity assessments, Mount Huangshan's daily maximum tourist carrying capacity has been adjusted from 50,000 person-times to 30,000 person-times, establishing a foundation for sustainable tourism management. To implement this capacity control effectively, a smart management platform has been introduced for real-time vehicle and visitor flow monitoring. This technology includes a reservation system that activates control measures when visitor numbers reach 80% of capacity. The management system demonstrates flexibility by adjusting capacity limits based on seasonal variations and weather conditions. Overseeing this comprehensive approach is a unified command center that ensures integrated resource management across the site.

E. Legal Framework and Community Engagement

Mount Huangshan has pioneered legal protection through China's first mountain-specific legislation, the Mount Huangshan Scenic Area Regulations. This legal framework is complemented by regular community consultation mechanisms that ensure local voices are heard in management decisions. To encourage active participation, performance evaluation and reward systems have been implemented for community involvement in heritage protection. Community collaboration is further strengthened through the "1+8" mechanism, which coordinates efforts between the main site area and surrounding areas. These structured approaches have successfully enhanced local awareness and participation in heritage protection activities.

F. Disaster Mitigation and Monitoring

A comprehensive disaster mitigation system for meteorological monitoring has been established at Mount Huangshan, anchored by the Guangmingding Weather Station. To reduce vulnerability to biological threats, a 4-kilometer biological isolation zone has been created to mitigate pine wood nematode infestation, supported by a rigorous 24-hour quarantine system. The site has implemented strategic measures to reduce impacts from ice and snow disasters, including installing bamboo support structures to protect historic and valuable trees during severe winter. Modern technology enhances these mitigation efforts, with drone technology utilized for biological pest control, demonstrating an innovative approach to reducing environmental risks while preserving the site's natural and cultural heritage.

2. Gaps and development

Through its comprehensive management system, Mount Huangshan has successfully balanced conservation and development. While facing challenges in visitor management and climate change impacts, the site demonstrates strong adaptive management capabilities. Future priorities include strengthening smart management systems, enhancing climate resilience strategies, deepening community engagement, and continuous improvement of legal frameworks.

A. Balancing Tourism Development and Ecological Conservation

With increasing visitor numbers, Mount Huangshan faces challenges in balancing ecological protection with tourism management. Despite reducing maximum daily visitor capacity from 50,000 to 30,000 and implementing the "Smart Huangshan" monitoring platform, maintaining ecosystem integrity while meeting visitors needs remains challenging.

B. Threats from Climate Change and Natural Hazards

Pine wood nematode disease threatens the iconic Huangshan pines despite a 4km biological isolation zone and 24-hour quarantine system. Extreme weather events, such as ice frostbite, impact the natural landscape. Long-term climate change is affecting the ecosystem, evidenced by the gradual elevation of bamboo growth habitats, which indicates species migration and presents new biodiversity conservation challenges.

C. Coordinated Management of Multiple International Designations

As a site simultaneously holding World Heritage, Global Geopark, and Biosphere Reserve designations, Huangshan faces challenges in coordinating multiple management systems. Despite establishing a "Three Major Designations Collaborative Management Mechanism" in 2020, interdepartmental coordination requires improvement. Finding a balance between ensuring conservation and enabling sustainable development for surrounding communities remains critical.

D. Promoting Huangshan Cultural Heritage Values and their Dissemination

Deepening research on Huangshan's cultural significance, developing innovative heritage interpretation frameworks, utilizing modern technology for cultural dissemination, and strengthening community participation remain important visions for management authorities and researchers. These efforts will ensure Huangshan serves not only as a natural wonder but also as a significant carrier and transmitter of traditional Chinese landscape culture.

IV. Practice-led Research Agenda

Based on the analyze of the value, related main attributes and the factors affecting, the systemic assessment of the management of Mount Huangshan, and the discussion about the gap, challenge and potential development of the conservation, and the principal contradiction and problems, the research priorities are found: impacts of tourism development on the ecological environment; impacts and pressure caused by climate change on natural values; integration of indigenous and local knowledge and customs within the heritage conservation. And other issues, such as some approaches, need to be researched in the future to enhance the linkage between humans and nature, which is the most essential characteristic of this mountain, for example, to develop the research on evaluating and improving the infrastructure within the heritage area of Mount Huangshan.

1. Research Priority 1: The impacts of tourism development on the ecological environment

With the increasing number of visitors to Mount Huangshan, one of the most attractive scenic areas in China, the large influx of visitors has pressured the ecological environment and management of the heritage place. The ecological protection of this site and the management of tourists require scientific and systematic strategies to balance tourism development and environmental conservation.

Management responses already in place

A. Scientific and Adaptive Visitor Capacity Management

Mount Huangshan has implemented various measures to manage visitor numbers and reduce ecological pressure. These include setting a flexible daily maximum capacity based on seasonal and climatic conditions, and conducting more precise calculations of visitor capacity. The management covers the overall daily limit, the instantaneous capacity of key scenic spots, and limits during peak seasons or extreme weather. In the future, Mount Huangshan aims to further refine these figures through updates to its overall planning framework, ensuring more scientific and adaptive visitor management.

B. Rotational Closure of Scenic Spots

Since the 1980s, Mount Huangshan has implemented a "rotational closure" policy for key peaks and scenic areas, allowing sensitive ecological environments to recover over time and reducing long-term environmental stress.

Opportunities for further research :

- **Long-term monitoring of visitor capacity and the visitor flow** should be conducted over an extended period, supported by a systematic management platform, in order to identify trends, improve crowd management strategies, minimize ecological impact, and enhance the overall visitor experience.
- **Comparative studies of visitor flow** during different time periods, seasons, and special events should be undertaken to advance the scientific determination of the carrying capacity and promote more refined management practices.

2. Research Priority 2: The impacts and pressure caused by climate change on the Natural Values

Mount Huangshan faces various impacts and pressures related to climate change. Global climate change has impacted the ecological environment of Mount Huangshan, such as increasing extreme heat, changing precipitation patterns, and facilitating the spread of invasive species like the pine wood nematode which threatens local forests, etc. If the temperature rises and the precipitation pattern changes as projected by the Beijing Climate Center's Climate System Model (BCC-CSM1.1 model)under the IPCC/CMIP5 framework, which simulates changes in maximum, minimum, and average temperatures as well as precipitation from 2020 to 2100, it is inferred that rising temperatures and altered precipitation patterns may affect vegetation growth and animal habitats in the Mount Huangshan region, thereby impacting the balance of the entire ecosystem. Extreme weather conditions, such as droughts and extreme storm conditions, have certain impacts on the natural landscapes and tourism within the heritage site. The specific impacts are as follows:

A. **Ecological System**

Climate change leads to shifts in the habitats of plants and animals, primarily driven by rising temperatures, altered precipitation patterns, and an increase in extreme weather events. These factors affect species' suitable living conditions, leading to vertical migration and habitat redistribution. For example, Moso bamboo's growing altitude gradually increases, affecting the bamboo forest ecosystem and the pine tree forest growing at higher altitudes. Additionally, climate change can impact wild animals' habitats and food sources. For instance, the early or delayed ripening of fruits may negatively affect the living environment of the Huangshan short-tailed monkeys.

B. **Geological Landscapes**

Rising temperatures can accelerate the expansion and contraction cycles of rocks, especially in areas with large diurnal temperature variations, which contributes to physical weathering. Changes in precipitation patterns, including increased rainfall and humidity, can enhance chemical weathering and surface erosion, especially during extreme weather events such as heavy storms.

C. **Hydrological Landscapes**

Climate change may alter the precipitation patterns, particularly by causing a decrease or increase in rainfall, thus affecting the availability and distribution of water resources. A decrease in rainfall could reduce the volume of water in waterfalls, pools, rivers and other water bodies, which may affect the water landscapes of Huangshan. Moreover, reduced water resources also threaten the growth of vegetation and the survival of wildlife, destabilizing the entire ecosystem. Increased precipitation may cause landslides and flooding, which may affect the hydrological landscape and the habitats of fauna and flora.

D. **Disasters risks management**

Extreme weather events such as drought, heavy rainfall, snowstorms, and freezing rain can severely impact the ecological environment, particularly the Huangshan pine, a species closely associated with the natural aesthetic value of the site. Ancient and famous trees, such as the Huangshan pine, have long been affected by pine wood nematode disease, which is considered the "cancer" of pines and has yet to be fully eradicated. Forest fires also pose significant challenges to preserving Huangshan's natural aesthetic value, particularly as they affect ancient trees, other rare species, and the ecological system.

E. **Tourism Industry**

Climate change could lead to the closure of certain park areas, directly affecting the visitor experience and resulting in economic losses. Damage to scenic resources and changes in the landscape can also negatively impact the sustainable development of tourism in the region.

Management responses already in place

A. **Monitoring and prevention system**

Huangshan has implemented control measures focused on heritage monitoring and inspection, while also employing technological methods for necessary reactive artificial interventions. For example, regular drone patrols are conducted to monitor vegetation coverage and geological stability, and sensor-based systems are used to detect early signs of landslides or rockfalls in key scenic areas.

B. **Artificial rainfall**

Huangshan uses artificial rainfall and snowmaking techniques to reduce the risk of forest fires.

C. **Small water reservoirs**

Many small rainfall water reservoirs are set up along roadsides, with each reservoir numbered, to store water reserves in case of sudden droughts or fire risks. These reservoirs are designed to collect and store rainwater during precipitation events, serving as a buffer against climate-induced drought and wildfire hazards.

D. **Bamboo support**

During freezing rain or heavy snow, Moso bamboo is used to support and protect the ancient trees and other vegetation from damage. This represents a soft adaptation measure that utilizes locally available and culturally significant materials, aligning climate adaptation with traditional ecological knowledge.

E. **Drones spray and regular patrols**

Drones are employed to spray insecticides. Regular patrols are conducted to inspect forest fire hazards, ensuring ecological safety. Climate change may increase the risk of biological infestations, such as pest outbreaks, due to warmer temperatures and disrupted seasonal cycles, which makes such drone-based interventions increasingly important.

•Opportunities for further research:

A. **Long-term monitoring and research** should be conducted **on key endemic species** (e.g., Huangshan pine, Huangshan short-tailed monkeys) and vegetation migration (e.g., Moso bamboo) to assess the specific impacts of climate change on their growth and habitats. **Predictive climate modelling and risk assessments** should also be integrated within comprehensive climate risk assessments to identify future threats and **develop proactive conservation strategies**. Since biodiversity is a key component of Huangshan's OUV, research should explore how these ecological changes may affect its heritage significance.

B. **Long-term monitoring of geological landscapes**, particularly the weathering and erosion processes of attributes such as the peculiar peaks and rock formations, is necessary to evaluate the effects of climate change on these geological features.

C. Similarly, **water landscapes** such as Huangshan's waterfalls, pools, and streams should be **monitored for changes** in water volume and quality to determine the impacts and long-term trends of climate change on these hydrological features. Incorporating climate modelling alongside historic and present monitoring will help predict future water resource trends, supporting **adaptive management.** As these hydrological features contribute to the OUV, studies should also consider their role in maintaining the site's ecological and visual integrity.

3. Research Priority 3: Integration of indigenous and local knowledge and customs within the heritage conservation

There is abundant local material, as well as Indigenous knowledge and technology, which have been used for a long time to build and maintain the infrastructure in Mount Huangshan.

In the area surrounding Huangshan, which is called the Huizhou Region, there are very good local cultural customs and indigenous rules for protecting the ecological environment, which has a long history.

A. Traditional knowledge

Native bamboo has enough elasticity to support the branches and trunk of big trees. Local craftsmen still use traditional bamboo construction technology to build the support frame to protect the ancient trees.

The trails in Mount Huangshan are in good condition and appropriate for the natural environment. Most of the existing trails were built and repaired in various historical periods. They have a long history, the earliest part of which was initially constructed in the Tang Dynasty. Thirty percent of the existing trails have preserved their original features. Local stones and technology are used to build the trails, steps, and small infrastructures (like benches, desks, balusters, rails, etc.).

B. **Local cultural customs**

Planting trees when a daughter is born is one of the **important customs that benefit the environment**. According to local communities' customs, when a daughter is born, her families plant some fir or camphor trees. When their daughter gets married, they use these trees as a dowry for her. Because of this tree-planting traditional custom, more and more trees are planted, more woods emerge, and then there are healthy environments around yards and villages. This has played an essential role in protecting the surrounding area and buffer zone of Mount Huangshan for a long historical time.

C. **Indigenous rules for ecological conservation**

There are some traditional village rules protecting the environment of the surrounding area, buffer zone and core area of Mount Huangshan, for example: striking the gong to close hills for tree growing; eating cakes to close hills for tree growing; eating pork to close hills for tree growing; Ban of bamboo shoot on cutting boards(prohibiting digging bamboo shoots during the bamboo growing season).

Eternal Forbidden Steles were erected at some places during the Qing Dynasty to prohibit deforestation, a permanent ban on logging, and they still exist in surrounding villages.

These indigenous rules play a vital role in conserving the large area around Mount Huangshan. That not only benefits the ecological environment but also enhances the natural aesthetic value of Mount Huangshan.

•Management responses already in place:

A. Utilize local materials and traditional knowledge & technology

The perfect elasticity of native bamboo is harnessed to support ancient and famous trees during extreme weather conditions, especially freezing rain or snowstorms, to alleviate stress on the ancient and famous trees in the heritage site.

When maintaining, restoring and building the trails and other constructions, the Moso bamboo is also used to construct the temporary aisle and scaffold through traditional technology.

The local stones are used to construct the trail, steps, and small infrastructures as was done in history.

B. Inherit the traditional ecological culture

The traditional ecological culture of the local area around Mount Huangshan has an influence on the modern management. To protect the ecological environment of the heritage site and promote the green and low-carbon tourism, Huangshan Scenic Area has launched the "**Public Welfare Points Supermarket**" **project**, advocating that tourists bring their own garbage down the mountain, sort and dispose of it at designated points, and earn public welfare points to exchange for discounted products. Through public welfare points, it aims to advocate civilized fashion and ecological tourism, to decrease the intervention of human beings to the nature heritage.

C. Promote indigenous communities' participation in heritage conservation

Job vacancies are provided to indigenous communities (Tangkou Town, Tanjiaqiao Town, Jiaocun Town, Gengcheng Town, Sankou Town) for forest fire prevention, flora and fauna protection, and monitoring. So far, many rangers are local villagers. **The local rangers play a vital role in ecological conservation and systemetic monitoring**, especially for some rare species of birds, amphibians, reptiles, and mammals, such as Leiothrix lutea, Syrmaticus ellioti, Lophura nycthemera, Andrias davidianus, Manis pentadactyla, Capricornis milneedwardsii, Muntiacus crinifrons, Macaca thibetana, etc. Their work also facilitates heritage conservation awareness in the surrounding communities of Mount Huangshan.

Opportunities for further research:

To conduct **systematic research on traditional knowledge and practices， culture and customs of ecological and heritage conservation** of indigenous communities around Mount Huangshan, learning the traditional wisdom to respond and prepare to climate change and disasters, seek the practical way of the harmony between the nature and human beings, enhance the cultural identity of the local communities; exploring the effectiveness of these practices, and also how useful will these also be in contributing to potential climate action at the site, whether these practices, knowledge and tradition are being transmitted or maintained within the community, how that is being done, is anything threatening this knowledge and tradition, what is being or could be done to support its use and inheritance continually?

Furthermore, to **develop some related initiatives and programmes**, and then to **promote indigenous communities' engagement** in the protection actions, foster the awareness of heritage conservation and the sense of responsibility as owners of this typical mixed heritage site.

Conclusions and next steps：

Based on the analysis of the practice-led research priorities, there're three aspects could be developed: the long-term monitoring and research of visitor capacity and the visitor flow, to balance the natural conservation and the huge need of the tourism for this hot heritage site; Long-term monitoring and research on the key species, geological landscapes, water landscapes under the pressure of the climate change and natural hazards, to evaluate the impacts on the attributes of the natural aesthetic value, develop the preventive conservation instruments; systematic research on traditional knowledge and practices and cultural customs of ecological and heritage conservation of indigenous communities, to learn from the traditional wisdom for the harmony between people and nature, and develop the related programme, promote indigenous people involved in the conservation actions to face the challenges of the heritage site.

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VI. Annexes

Annex the analysis, gaps and conclusions identified during the collaborative work, including the use of the EOH 2.0 Toolkit. Other material produced (graphics, tables, completed worksheets) that are useful to understand the work process of the Research-Practice Team can be annexed here as well.

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