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Original Article

Preserving the Gobi: Identifying potential UNESCO world heritage in Mongolia's Gobi Desert

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ABSTRACT

The Gobi Desert, Asia's largest desert, covers roughly 1,300,000 square kilometers across southern Mongolia and northern China. One of the world's most iconic deserts, the Gobi is a functioning, healthy ecosystem home to spectacular landscapes that support an impressive variety of biological diversity, including many rare and endangered species. Human activity in the Gobi has existed for at least 5,000 years and several culturally and historically significant archeological sites have been documented in the region; the Gobi continues to support an ancient and enduring nomadic lifestyle. Prehistoric traces of ancient life are also widespread, making the Gobi a hotspot for fossil discoveries. Despite a wealth of natural and cultural heritage the Gobi Desert in Mongolia lacks any recognition as UNESCO World Heritage. This article explores the natural and cultural heritage of the Gobi Desert in Mongolia and using UNESCO's framework for "Outstanding Universal Value," identifies several sites with exceptional geological, ecological, and ethnological features that we believe meet the criteria for World Heritage status. In the face of looming threats from human interference and climate change, increased recognition and appreciation of Gobi Desert landscapes is crucial to ensure the long-term protection of these irreplaceable sources of life and inspiration.

Introduction

Arcing across the borders of northern China and southern Mongolia, the remote and rugged landscapes of the Gobi Desert have captured the imagination of adventurers, explorers, scientists, and artists since the age of Marco Polo. Occupying roughly 1,300,000 square kilometers of Inner Asia and spanning 1,600 kilometers long and 500 to 1,000 kilometers wide, the Gobi Desert is Asia's largest and the world's fifth largest desert. In Mongolia the Gobi amounts to as much as one-third of the total territory (Figure 1). Meaning "waterless place" in the Mongolian language, the Gobi is a rain shadow desert, formed on the far side of the Himalayan Mountain Range which blocks moisture and creates the Gobi's characteristically dry, semi-arid climate. Temperatures in the Gobi can be extreme and fast changing, ranging between −15°C and −30°C in winter and between +25°C and +38°C in summer. An average 195 mm of rain falls annually in the Gobi. It is these extreme climate conditions that have influenced the variety of soil composition and color found in the Gobi Desert and the reason why Mongolians speak of 33 different types of Gobi (Magsar et al. 2018). Across its span, the Gobi landscape is a barren patchwork of rocky, hard packed terrain including desert basins, mountain ranges, and sand dunes, but also spectacular and unique landforms including canyons, oases, and natural rock formations. Vegetation, while sparse, is diverse and includes rare and endemic species many of

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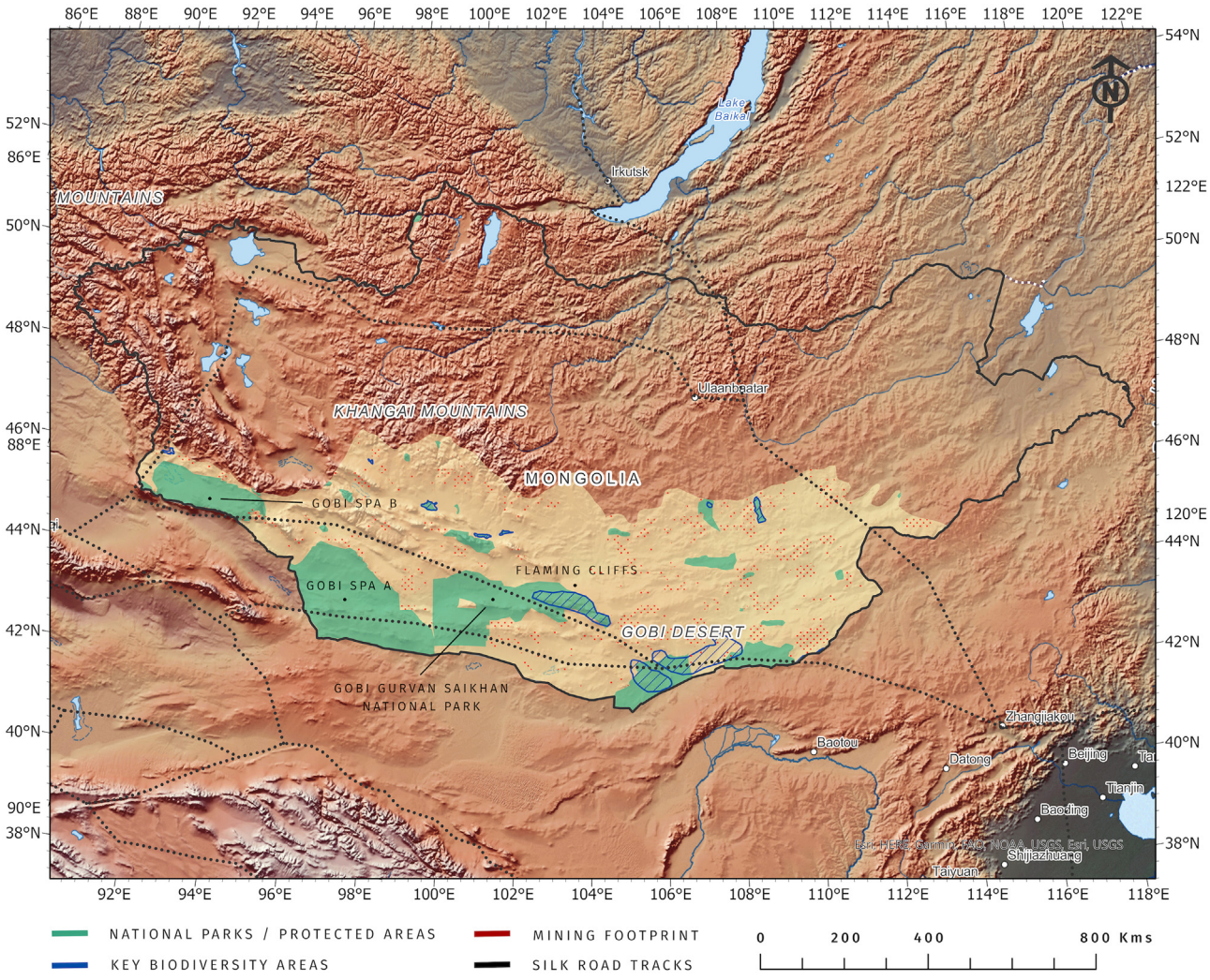

Figure 1. Map showing the extent of the Gobi Desert in Mongolia. Meaning "waterless place" in the Mongolian language, the Gobi amounts to as much as one-third of the total territory of Mongolia.

which have adapted over millennia to conditions of drought and water scarcity (Tsendeekhuu and Black 2005). Several plant species have been identified for their important medicinal value and have been used for centuries by local therapists and healers to treat illness and disease (Samdan and Batsukh 2020). Geologically, the Gobi has preserved a rich and varied paleo-environment and is considered a hot spot for fossil discovery. The Djadochta Formation, one of many highly fossiliferous geological formations located in the Gobi, has produced invaluable fossil specimens with important ecological and evolutionary significance. More than 80 genera, or one-fifth, of the over 400 known dinosaur genera are found in Mongolia's Gobi Desert (UNESCO 2022a).

The vast open space of the Gobi Desert – the level of human influence is among the lowest in the world – makes it an important global refuge for wildlife that supports a large assemblage of native fauna including important keystone and migratory species; 33 animals listed as threatened or endangered live in the region. The Mongolian population of the endangered Khulan (*Equus hemionus*), Goitered gazelle (*Gazella subgutturosa*), the Mongolian gazelle (*Procapra gutturosa*), Siberian ibex (*Capra sibirica*), and wild Bactrian camel (*Camelus ferus*) are the largest in the world (Buuveibaatar et al. 2017). The Gobi is a Key Biodiversity Area (KBA) that contributes "significantly to the global presence of biodiversity." To conserve and protect biodiversity in the Gobi the Mongolian Government has established several protected areas, including Gobi Gurvan Saikhan National Park and Great Gobi Strictly Protected Area A and B, the latter which encompasses roughly 62,000 square kilometers, making it one of the largest terrestrial protected areas in the world.

Despite the harsh climate and difficult terrain, human occupation in the Gobi has existed for thousands of years creating a cultural landscape that has influenced Inner Asian identities into modern times (Vanwezer et al. 2021). While the Gobi is most notable in history as part of the great Mongol Empire (1206–1368), from the 3rd to 2nd millennium BC nomadic tribes and mobile pastoralists thrived across Inner Asia's drylands, steppe, and montane regions, grazing their animals and fostering long-standing interactive spheres that connected ancient trade centers across Asia (Taylor et al. 2020). Early settlements dating to the Eurasian Bronze Age (3000 BCE to 1200 BCE) attributed to the nomadic peoples of the Xiongnu empire, unearthed in the eastern and western parts of the Gobi, reveal iconographic evidence and material culture that suggest long-range connections and shared architectural traditions; some of which can be traced to northern Europe and the

Figure 2. Roy Chapman Andrews at the nest of an Oviraptor. Photo Credits: American Museum of Natural History (AMNH)/D. Finnin.

Figure 3. A fossilized oviraptor (Citipati osmolskae) on its nest found at the Flaming Cliffs. Photo Credits: American Museum of Natural History (AMNH)/D. Finnin.

Mediterranean (Honeychurch 2017). The complex network of nomadic tracks that crisscrossed the Gobi later formed the network of ancient caravan routes that linked up with the Silk Roads of China allowing for the transmission of commercial goods and sociocultural and religious ideas between Mongolia and its neighbors (Frachetti et al. 2017). Tibetan Buddhism, which spread across these Inner Asian tracks in the 13th century, flourished in the Gobi landscape; hundreds of monasteries and temples were built in the desert by the 18th century (Documentation of Mongolian Monasteries 2022). Evidence of the Gobi as a spiritual landscape can be traced back to an even more ancient past. *Oboos*, a rocky cairn structure used to mark sacred territories, still dot hilltops and mountain ranges, indicating that the Gobi has long been a sacred and spiritual landscape in ancient Mongolian cosmology (Dal Zovo et al. 2014).

By the 19th century the reputation of the Gobi as a mystical and spectacular landscape, rich with undiscovered scientific treasures, had reached the Western world. Adventurers, explorers, scientists, and artists set out for the Gobi, some to search for ancient civilizations, some to document the native flora and fauna, and others in search of the fabled kingdom of Shangri-la. Many of these early explorers including the Russian Imperial Geographer Nikolay Przhevalsky, Soviet explorer Pyotr Kozlov, Russian-American artist Nicholas Roerich, British explorer Sir Aurel Stein, and the American Roy Chapman Andrews, made some of their most important archeological and scientific discoveries in the Gobi Desert, including the Magao Caves at Dunhuang in China, the ancient city of Khara-Khoto in present day Inner Mongolia, and the exquisitely preserved dinosaur eggs at Bayanzag, also known as the Flaming Cliffs (Andrews and Osborn 1926).

As the aforementioned illustrates, the Gobi Desert, far from the barren image as an arid badland, is in fact, a diverse ecosystem home to spectacular natural landscapes and an abundance of wildlife, people, ancient customs and traditions, and a storied geological and paleontological past. Today, nomadic pastoralists continue to practice their traditional way of life in the Gobi, grazing their animals with the seasons. However, nomadism, a vestige of ecological wisdom, is a vanishing culture threatened by the same expansion of human activity and climate change that is putting at risk the integrity of the Gobi's unique and ancient natural and cultural landscapes (Enkhjargal 2021; Uddin and Kebreab 2020). Within the last 20 years, privatization of the livestock industry has resulted in a doubling of livestock that has contributed to overgrazing and competition with wildlife for the Gobi's already scarce resources (McLaughlin 2019; Sternberg 2008). Mineral resource exploration and exploitation is rampant; 26% of Mongolia's total terrestrial area has been leased for exploration and the mining industry is rapidly encroaching on the open spaces of the Gobi, which

Figure 4. The Flaming Cliffs (Bayanzag) in Omnogobi Province, south Mongolia. The surrounding areas are a distinctive Gobi landscape and remain of pristine environmental quality with limited impairment or human interference. Photo Credit: Wikimedia Commons (CC BY-SA 4.0).

Figure 5. Yolyn Am gorge at Gobi Gurvan Saikhan National Park. In years past the ice field at Yolyn Am remained year-round, however because of climate change, the ice tends to disappear by September. Photo Credit: Wikimedia Commons (CC BY-SA 4.0).

presents an urgent threat for migratory species as transportation infrastructure fragments environments and creates barriers to movement (Enkhjargal 2021). Complaints about mining's disproportionate use of water in the Gobi are commonplace, and many nomadic families protest that their livelihoods are at risk. Oyu Tolgoi, one of the world's largest gold and copper mines located in Omnogobi province uses up to 20 million gallons daily (870 liters per second) and has already drained local aquifers that nomadic families and wildlife have depended on for generations (Jackson 2018). Several mining companies have been accused of encroaching on protected lands (Farrington 2005). The challenges stemming from human influence in the Gobi are

Figure 6. The Khongoryn Els sand dunes at Gobi Gurvan Saikhan National Park exhibit exceptional eolian features for a desert landscape. Photo Credit: European Geosciences Union.

Figure 7. Khermen Tsav in Gobi Gurvan Saikhan National Park contains some of the largest and best developed weathering features in the Gobi. Photo Credit: Wikimedia Commons (CC BY-SA 4.0).

compounded by the threat of climate change – the Gobi is a climate hotspot – accelerating faster than elsewhere (Sternberg et al. 2015). Extreme weather events including prolonged summer drought and severe winter snow known as “dzud” are becoming more common, more intense, and further degrading vital pastureland and jeopardizing the livelihoods of the local

Figure 8. Traditional nomadic life is still practiced within Gobi Gurvan Saikhan National Park. Photo Credit: Wikimedia Commons (CC BY-SA 4.0).

Figure 9. The Great Gobi SPA is a critical habitat for several endangered animals including the Gobi bear (*Ursus arctos gobiensis*) for which only around 30 adults are known to exist. Photo Credit: Mazaalai Foundation Mongolia.

pastoralists. Desertification, the result of a multiplicity of factors, including overgrazing of livestock and climate change, is accelerating the spread of the Gobi Desert, making it the fastest growing desert in the world, and contributing to environmental regime shift in neighboring steppe and grassland ecosystems (Sofue et al. 2018).

Despite its iconic, unique landscapes and wealth of natural and cultural heritage, the Gobi Desert in Mongolia lacks any sites

Figure 10. The size of the Great Gobi SPA serves as an important wildlife corridor and transit zone for important populations of migratory ungulates such as the wild Bactrian camel (Camelus ferus). Photo Credit: Wikimedia Commons (CC BY-SA 4.0).

Figure 11. Shar Khuls Oasis in Great Gobi SPA A is a critical water source for many of the protected area's keystone species including the Gobi Bear (*Ursus arctos gobiensis*), wild Bactrian camel (*Camelus ferus*), Mongolia wild ass (*Equus hemionus hemionus*), and several bird species. The oasis also served as a resting point for caravans moving along ancient silk road tracks. Photo Credit: C. McCarthy.

designated as UNESCO World Heritage. In hopes of filling this gap, this article explores the natural and cultural heritage of the Gobi Desert in Mongolia and using United Nations Educational, Scientific and Cultural Organization (UNESCO)'s framework for World Heritage nomination identifies three sites that we believe meet UNESCO's criteria for "Outstanding Universal Value" and World Heritage as defined by the World Heritage Convention (UNESCO 2021). As human activities and climate change threaten the integrity of the Gobi Desert's natural and cultural spaces, World Heritage status offers necessary resources to ensure the protection of this unique and diverse desert landscape and its ecosystem services. Thus, the purpose of this study is to inform and advise policy makers, stakeholders, and those interested in learning about the natural and cultural heritage of the Gobi, on the potential and priorities of designating the Gobi Desert as World Heritage with Outstanding Universal Value. It discusses issues pertaining to the integrity and management of these sites, the value of safeguarding these sites for food security and climate change mitigation, and strategies to ensure the long-term preservation of these irreplaceable natural and cultural areas in Mongolia's Gobi Desert.

Several sites in Mongolia's Gobi Desert have already been nominated for World Heritage and included on the Tentative World Heritage List in 2014, including "Desert Landscapes of Mongolian Great Gobi" and "Cretaceous Dinosaur Fossil Sites in the Mongolian Gobi"; however, since 2014 our understanding of conservation has evolved and continues to evolve, and new scientific discoveries, academic research, and urgency has arisen. In this article, we bring attention to these issues and offer further evidence for the Gobi's global significance and the urgent need to safeguard these unique landscapes for all of humanity. We argue that Mongolia should prioritize sites as World Heritage that provide the most value in terms of biological, cultural, and geological protection, and that would contribute to preventing the rapid loss of biodiversity and ecological services for which the sites are so important.

The World Heritage Convention & UNESCO World Heritage

The origins of UNESCO World Heritage date back to 1959 when Egypt requested assistance from the United Nations (UN) to help protect and rescue endangered monuments and sites. The success and popularity of the initiative to salvage and protect priceless monuments and support the preservation of ancient cultural sites spurred UNESCO into further action. By 1972 UNESCO had created the Convention Concerning the Protection of the World Cultural and Natural Heritage and drafted a charter "to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity". Since then, the number of world heritage sites have grown globally. To date there are 1153 UNESCO World Heritage sites, including 218 natural and 39 mixed World Heritage sites. Sites are inscribed on the World Heritage List for having Outstanding Universal Value (OUV)—"cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity"—and meet one or more of the 10 World Heritage criteria, the corresponding conditions of integrity and/or authenticity (only cultural sites) and protection and management requirements (Table 1). World Heritage has become the most prestigious value any site can attain and provides a wide range of direct and indirect benefits, including biodiversity conservation, water provision, prevention of floods, carbon sequestration, cultural and spiritual values, as well as opportunities for research and education (Osipova et al. 2014; Wells 1996). World Heritage sites also contribute to the well-being of wider human society, including local communities and regional and national economies, through job creation and tourism opportunities (Gould and Burtenshaw 2020). World Heritage Sites are classified into one of four categories: Natural Properties, Cultural Properties, Mixed Properties, and Cultural Landscapes. While many properties may only meet some natural or cultural criteria, mixed properties will meet some natural as well as some cultural criteria. Depending on the type of property a nominated site is evaluated by an independent advisory body mandated by the World Heritage Convention: International Union for Conservation of Nature (IUCN) for natural properties, International Council on Monuments and Sites (ICOMOS) for cultural properties, and International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) which provides advice on the conservation and monitoring of cultural sites as well as capacity development.

Table 1. Ten criteria for World Heritage inscription identified in *Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO 2021).

Criterion	Type of property	Description
i	Cultural	represent a masterpiece of human creative genius
ii	Cultural	exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design
iii	Cultural	bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared
iv	Cultural	be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history
v	Cultural	be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change
vi	Cultural	be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria.)
vii	Natural	contain superlative natural phenomena or areas of exceptional natural beauty and esthetic importance
viii	Natural	be outstanding examples representing major stages of Earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features
ix	Natural	be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals
x	Natural	contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation

Desert Landscapes, UNESCO World Heritage, and Sustainable Development Goals

The world's deserts and arid regions cover up to one-third of the Earth's terrestrial area and occur in every continent. Made up of a wide range of distinctive and unique landforms and geomorphological processes, including wind-shaped dunes, alluvial fans, natural arches, etc., desert landscapes comprise a variety of complex biomes and ecosystems with diverse and fragile flora and fauna. Many desert organisms have shown exceptional adaptations to the complex, radiant environment characterized by water scarcity and nutritional stress and exhibit traits and characteristics unlike any species found elsewhere in the world (Rocha et al. 2021). Roughly 2.1 billion people live in deserts and desert margins making them important zones of cultural and economic activity (Goudie and Seely 2011). Despite the great diversity of unusual and spectacular landforms, unique biodiversity, and cultural significance there are large gaps in existing World Heritage Lists and desert landscapes. Among the 878 UNESCO World Heritage sites globally, only 13 have been officially designated as desert landscapes with Outstanding Universal Value; with only 2 sites classified as mixed (natural and cultural properties) (Goudie and Seely 2011). A further 15 desert sites have been recommended by the State Parties on their Tentative List, including 11 natural properties, 2 cultural properties, and 2 mixed properties, however inclusion on the World Heritage List is pending review of the nominations. Given the considerable importance of desert landscapes and ecosystems we believe UNESCO World Heritage can provide greater recognition, appreciation, and protection for the world's fragile desert areas.

Adopted in 2015, the UN's 17 Sustainable Development Goals (SDGs) are increasingly recognized as a key tool in setting national development priorities for conserving biodiversity (Sachs et al. 2019). These SDGs include objectives like: no poverty; food security/zero hunger; good health and well-being; quality education; gender equality; access to clean water and sanitation; affordable and clean energy; decent work and economic growth; sustainable development-industry, innovation and infrastructure; reducing inequality within and among countries; sustainable cities and communities; efficiency in use and management of natural resources; climate action; conservation and use of the seas and marine resources; life on land: to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; peace, justice, and strong institutions; and vision for improved and more equitable trade. SDG 15, Life on Land, was created in reference to the Convention on Biological Diversity's (CBD) 2020 target to protect at least 17% of terrestrial area worldwide (UNEP-WCMC and IUCN 2021); the CBD is an international legally binding treaty signed by 191 parties. However, within the context of the SDGs, protected areas and natural world heritage recognition provide additional benefits that go beyond nature conservation. Protected areas and natural world heritage have linkages to important ecosystem services such as food security (SDG 2) by maintaining "the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species"; good health and well-being (SDG 3) by providing access to natural environments for improved human mental and physical health; access to clean water (SDG 6) by protecting and restoring water-related ecosystems; and climate action (SDG 13) by protecting areas to store and sequester carbon and "strengthen resilience and adaptive capacity to climate-related hazards and natural disasters" (UNEP-WCMC and IUCN 2021). The role of protected areas and natural world heritage has evolved to serve as a safeguard measure that protects ecosystem services deemed critical for the survival of all life on Earth (Lopoukhine et al. 2012). The benefits of the Earth's ecosystem services are valued at an estimated US $33 trillion, nearly twice the global gross national product (GNP) (Costanza et al. 1997; Holzman 2012). By recognizing the central role that protected areas and natural world heritage play in managing ecosystem services we can encourage decision-makers to strengthen and support the World Heritage network globally.

Data and Methodology

To identify and assess sites in Mongolia's Gobi that meet the rigorous threshold of UNESCO's World Heritage Committee, including a strong body of evidence and adequate protection and management, we first identified and classified important natural and cultural features of the Gobi from existing datasets including oral history, published archeological evidence, maps, conservation history, scientific assessment, tourism data, planning regulations, etc.; this formed a preliminary shortlist of sites of interest. We then assessed these features as they pertain to the standards of Outstanding Universal Value using the definition framework and criteria presented in the *Operational Guidelines for the Implementation of the World Heritage Convention* and *Outstanding Universal Value, Standards for Natural World Heritage* (Badman et al. 2008). Table 1 shows the 10 criteria for World Heritage inscription. Criteria (i) to (vi) relate to cultural properties, and the remaining criteria (vii) to (x) relate to natural properties. In addition, we ranked the sites based on their ability to contribute to the achievement of Sustainable Development Goals (Table 2). Finally, by means of survey of existing literature, undertaking interviews, field visits, and performing remote sensing reconnaissance we conducted a risk profile and threat assessment to identify issues related to the integrity and management of these areas including human encroachment, infrastructure development, natural resource extraction, and managerial capacity; integrity and management are integral elements for World Heritage nomination. Based on our analysis we identified three sites that we believe meet the threshold for Outstanding Universal Value, a strong linkage to the SDGs, and adequate protection for consideration as UNESCO World Heritage (Table 3).

Results

This study identifies three sites, considered by the authors after a review of the available literature, interviews, field visits, and

Table 2. Interlinkage of Gobi World Heritage properties and Sustainable Development Goals (UNEP-WCMC and IUCN 2021).

SDG	Focus	Description
2	Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3	Good Health and Well-Being	Ensure healthy lives and promote well-being for all at all ages
6	Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
13	Climate Action	Take urgent action to combat climate change and its impacts
15	Life on Land	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Table 3. Gobi Desert sites in Mongolia identified by the authors as having Outstanding Universal Value and high potential for inclusion on the UNESCO World Heritage List.

Name	Criterion	Category	Outstanding Universal Value	SDGs	Property area	Coordinates
Flaming Cliffs (Bayanzag)	(vii) (viii)	Natural	High	3	<1 sq. km	44°08'11.1" N 103°43'24.0" E
Gobi Gurvan saikhan National Park	(iii) (vii) (viii) (x)	Mixed	High	2, 3, 6, 13, 15	27,000 sq. km	43°46'14.1" N 101°34'16.1" E
The Great Gobi Strictly Protected Area A/B	(vii) (viii) (ix) (x)	Natural	High	2, 3, 6, 13, 15	53,000 sq. km (Gobi A)	43°24'21.2" N 97°43'81.3" E
					9,000 sq. km (Gobi B)	45°41'89.1" N 92°66'03.1" E

remote sensing reconnaissance to represent a selection of the most significant natural and cultural heritage sites in Mongolia's Gobi Desert. Each site was determined to exhibit an excellent case of Outstanding Universal Value and meet, with some exceptions, the standards and criteria for integrity and authenticity for inclusion on the UNESCO World Heritage List. The list is not exhaustive; and while Mongolia's Gobi is home to many sites of important natural and cultural heritage, our attempts to analyze whether other sites met the necessary conditions of integrity and authenticity was limited due to changing information, lack of detail in existing research, and sheer scope of the area being studied. We believe a strong case can be made that our sites have superlative natural and cultural value and include many distinct features for which there are no regional comparisons on the World Heritage List. We find some of these sites qualify to be considered as mixed sites (natural and cultural) and/or cultural landscapes. It is our opinion that these sites will provide the greatest value from World Heritage recognition in terms of preventing biodiversity loss, safeguarding ecological services, preserving a vanishing culture, and contributing to the achievement of the Sustainable Development Goals.

Unfortunately, the severe and real threat of human influence, natural resource extraction, and climate change, which may drastically impact these sites, is prevalent across the region, furthering the risk to these already fragile environments. We recommend urgent action is taken to provide the strongest international safeguards to protect these areas from ruin. The sites are: (1) the fossil sites at the Flaming Cliffs at Bayanzag; (2) Gobi Gurvan Saikhan National Park; and (3) Gobi Protected Area A/B (Table 2). Boundaries for each of the sites are based on existing boundaries, or if not previously established, were considered based on the extent of features that convey potential Outstanding Universal Value.

Flaming Cliffs (Bayanzag) | 44°08'11.19" N, 103°43'24.00" E

Category. Natural
Outstanding Universal Value. High
World Heritage Criteria. (vii) (viii)

Situated in Ömnögovi Province in southern Mongolia, the Flaming Cliffs at Bayanzag—the cliffs get their name from the reddish-orange color sediments in the sandstone cliffs—is part of the Djadochta Formation, a highly fossiliferous geographic formation in the Gobi Desert dating from the Late Cretaceous period (75 to 71 million years ago) (Berkey and Morris 1927). The earliest documented fossil discoveries here can be traced to the 1920s when the American explorer Roy Chapman Andrews discovered the site during his paleontological expeditions to the Gobi Desert for the American Museum of Natural History [AMNH] (Andrews 1932; Andrews and Osborn 1926) (Figure 2). Natural erosion had exposed layers of sandstone which allowed for Andrews and his team to identify and excavate the fossil rich area. The exhibition resulted in the world's first discovery of fossilized dinosaur eggs (a partial nest of Oviraptor), one of the most important fossil discoveries of the 20th century (Norell et al. 1994) (Figure 3). Subsequent expeditions by Andrews would unearth further extraordinary fossil specimens including a fully articulated Titanothere skull, a species which was only thought to exist in North America at the time. Within a comparably small area, the Flaming Cliffs contain unique geological and paleontological phenomena from the Late Cretaceous period of the Earth's history (Novacek et al. 1994). Several outstanding dinosaur species have been discovered here and published research and documentation characterizes the area as having a great abundance, diversity, concentration, and preservation of fossil terrestrial vertebrates (reptiles, birds, mammals) that match or exceed all other known Cretaceous sites. To date more than 32 species including 8 families of dinosaurs dating from 75-71 million years ago have been documented at the Flaming Cliffs, including complete skeletons of Protoceratops and Pinacosaurus and remains of Oviraptor, Velociraptor and Saurornithoides, giving us vital scientific understanding of the history of life on Earth (Dashzeveg et al. 2005). Scientific reporting has been extensive, and in our opinion serves as an exceptional body of evidence for World Heritage nomination.

Justification of Outstanding Universal Value

Criterion (vii). The Flaming Cliffs (Bayanzag) within the Djadochta Formation is an outstanding example of an extraordinary geological formation created by eolian processes and wind works (Hasegawa et al. 2009; Lefeld 1971). Characterized by an arid habitat of sand dunes and reddish-orange sandstone with little freshwater, the Djadochta Formation occurs in the Late Cretaceous period of the Campanian stage and was deposited during a time of rapidly changing polarity roughly 75 to 71 million years ago; its known thickness is over 90 meters (300 feet) (Naugolnykh and Kuleshov 2020). The surrounding desert and habitat are of high quality and virtually undisturbed, presenting one of the last remaining large-scale desert landscapes of exceptional esthetic importance and natural beauty in the world (Figure 4).

Criterion (viii). The Flaming Cliffs is outstanding in the prominent abundance of well-preserved fossils representing the group of Cretaceous dinosaurs (Lefeld 1965). The diversity of fossils affords excellent opportunities for paleontology that is both comparative and chronological (Norell et al. 1994). Over 44 species from the Flaming Cliffs including a large number of exceptionally well-preserved fossils, several of which are complete specimens, now reside in major museums throughout the world (Timmins 2019). The site is of paramount importance because it has one of the largest numbers and the best-preserved fossil specimens discovered in the desert landscapes of Inner Asia; a vast majority of specimens found here are in near-complete articulation (Longrich 2010). In addition to the significant number of high-quality fossil specimens, the Flaming Cliffs and adjacent properties contain an abundance of diverse small vertebrates like lizards and mammals

(Keqin and Norell 2000). Although other fossil sites in the Gobi region have been discovered, some with richer deposits of dinosaur remains, the Flaming Cliffs is the first site where two new dinosaur groups were detected as well as the first Asian representatives of groups known previously from discoveries on other continents (Currie and Padian 1997). Notably the Flaming Cliffs unearthed the first known dinosaur hatchlings (*Protoceratops andrewsi*) and first known dinosaurian eggs, discoveries that played an important role in the development of paleontological science and our understanding of ancient organisms (Makovicky et al. 2007).

Integrity.

The fossil sites at the Flaming Cliffs at Bayanzag encompass roughly one square kilometer in size yet cannot be disassociated from its natural surroundings. The surrounding areas are a distinctive Gobi landscape and remain of pristine environmental quality with limited impairment or human interference. The desert landscape contains exceptional features as well as formations of outstanding esthetic value, including extensive sand plains, dunes, and alluvial desert; the area is punctuated by views of open vistas. Few if any signs of development outside of a small number of tourist camps are visible, and the high natural esthetic qualities of the area are largely intact. Vegetation is scarce, characterized by desert shrubs, yet many plants have been identified as having medicinal properties. Several native and characteristic animal species are also found within the surrounding habitat. Human inhabitation is low, and few nomadic families inhabit the vicinity resulting in low human disturbance from pastoral activities such as grazing.

Protection, Management, Challenges.

All aspects of protection and management are under the control of Mongolia's Ministry of Environment and Tourism. As a tourist destination the Flaming Cliffs is a star attraction for visitors to Mongolia, however, we find that while illegal to remove fossils from the area without the appropriate permits, enforcement is difficult, and fossils are often collected from the site without any restriction. Increasing the presence of rangers and improving signage could help. In addition, public access to the most sensitive areas is not adequately controlled. Boundaries and buffer zones are also inadequately defined. Without proper controls, the increase in visitors and land use activities may have an impact on the surrounding environment. Climate change, desertification, and encroachment of mining activities also pose risks.

Special attention should be given to monitoring the proposed development in neighboring territories, particularly the construction of infrastructure and facilities, livestock grazing, mining, and tourism which can create irreversible ecological disturbance, littering, and wildlife road kills. The illegal removal of paleontological resources should also be effectively controlled. The long-term protection and management of the property should include mitigating the impacts derived from existing or proposed roads which may jeopardize the integrity of the surrounding areas.

Comparative Analysis.

While other World Heritage Sites acknowledge Cretaceous dinosaur fossil discoveries (Dinosaur Provincial Park, Canada), the Flaming Cliffs and the Djadochta Formation remain one of the only sites in the desert landscapes of Inner Asia that contain such a rich fossil heritage recognized by the scientific community for the large number of exceptionally well-preserved fossil specimens that have contributed to our understanding of ancient life on Earth. In addition, the area around the cliffs is one of the world's remaining intact large-scale desert landscapes that still produces new dinosaur species. Several localities within the Djadochta Formation have also provided notable fossil discoveries, such as those at Ulaan Sair and Ukhaa Tolgod (Dashzeveg et al. 1995). Nearby, the Vayan Mandahu Formation in Inner Mongolia is also considered fossil rich, however, the scientific and historical significance of the Flaming Cliffs at Bayanzag is unrivaled (Dong and Currie 1996).

Gobi Gurvan Saikhan National Park | 43°46'14.18" N, 101°34'16.19" E

Category. Mixed
Outstanding Universal Value. high
World Heritage Criteria. (iii) (vii) (viii) (x)

Located on the northern edge of the Gobi Desert in Mongolia's Omnogobi Province, Gobi Gurvan Saikhan National Park is notable for its variety of desert landforms, rare and endangered animal and plant species, and communities of nomadic herders. Meaning the Gobi's Three Beauties in the Mongolian language and named after the Gurvan Saikhan mountain range, the park is roughly 27,000 square kilometers, stretching 380 kilometers from east to west and 80 kilometers from north to south. Elevations range between 2,800 meters at Erdenetsogt Ovoo and 706 meters at Ingen Khuuvuriin Hooloi. Geologically, the region is characterized as a high upland with dry stream beds punctuated by mountain ranges, mountain massifs, hummocks, rocky outcrops, canyons, and sand dunes. Devonian rocks testify to the formation of an arc complex system from relatively calm tectonic conditions to large volcanic activity (Hanžl et al. 2020). The park is home to several sites of high geomorphological value including the ice field at Yolyn Am (Figure 5), sand dunes at Khongoryn Els (Figure 6), and geoformations at Khermn Tsav (Figure 7); sites that attract thousands of visitors each year. Also known as the Valley of the Vultures, Yolyn Am, is a deep narrow gorge notable for its ice field that is several meters thick and several kilometers long. In past years the ice field remained year-round, however because of climate change, the ice tends to disappear by September. The Khongoryn Els sand dunes, commonly referred to as the Singing Sands for the sound it makes when moved by wind, is notable for its size and natural esthetic beauty. The dunes occupy over 965 square kilometers in area, drawing comparisons to the dunes in Egypt. Khermen Tsav, meaning wall and fissure, is a 100-200-m deep 10-km-wide canyon formed from millions of years of wind and water erosion. Several impressive geoformations including spires and pinnacles punctuate the landscape. The large area of Gobi Gurvan Saikhan National Park plays an important role in protecting a variety of the Gobi's important biodiversity and is designated as a Key Biodiversity Area (KBA). Several mammal species of conservation concern inhabit the park including the Siberian ibex (*Capra sibirica*), Snow leopard (*Panthera uncia*), Argali sheep (*Ovis ammon*), Eurasian lynx (*Lynx lynx*), Pallas cat (*Otocolobus manul*), and Stone marten (*Martes foina*). The park also supports globally threatened bird species including the endangered Saker falcon (*Falco cherrug*), vulnerable Lesser kestrel (*Falco naumanni*), and near threatened Cinereous vulture (*Aegypius monachus*).

Over 1,000 nomadic families graze their animals on the pastures within Gobi Gurvan Saikhan National Park, making Gobi Gurvan Saikhan a site of high cultural value (Bedunah and Schmidt 2004) (Figure 8). Inner Asian nomadic communities date back at least 5,000 years and research demonstrates the tremendous transformative impact nomadic peoples have had on global prehistory (Gibbons 2015). Nomadic cultures helped create a connected world system, spreading plants and animals, commercial goods, ideas and information, religious beliefs, and even major diseases across the

ancient world for the first time (Bower 2017). Mongolia's nomads have retained many of their original cultural practices and concepts, including their noble way to live in harmony with the landscape. However, environmental and socioeconomic factors are forcing many Mongolian nomads to abandon their nomadic traditions for a modern urban lifestyle, threatening this ancient way of life and the survival of a living library of ecological knowledge and wisdom (Enkhjargal 2021).

In addition to traditional nomadic culture, Gobi Gurvan Saikhan contains important historical and cultural heritage artifacts including archeological sites, ruins of ancient cities, temples, monasteries, ancient tombs, burial mounds, petroglyphs, rock paintings and inscriptions (Jacobson 1990). Excavations at nearby burials and cemeteries have revealed western artifacts, including Mediterranean glass and beads, which has provided scholars with evidence that steppe and silk road tracks passed through the region (Honeychurch 2017). More research is needed to assess the significance of these ancient caravan routes in shaping Inner Asian identities.

Justification of Outstanding Universal Value.

Criterion (iii). Gobi Gurvan Saikhan is an exceptional showcase of the ecological wisdom and traditions of Mongolia's unique nomadic culture. The park's pasture areas are witness to an ancient cultural tradition and transhumance system which has existed for millennia. Nomadic communities continue to practice their ancient traditions here, however, socioeconomic, and environmental forces, such as climate change, are threatening the nomadic way of life across Mongolia. Petroglyph sites provide evidence of the social, cultural, and spiritual beliefs of Bronze Age nomadic tribes.

Criterion (vii). Gobi Gurvan Saikhan contains superlative natural phenomena including Yolyn Am ice field, Khongoryn Els sand dunes, and striking geoformations at Khermen Tsav. As a desert landscape the park exhibits exceptional natural beauty and esthetic importance, offering an extraordinary representation of the diverse Gobi ecosystem.

Criterion (viii). The exceptional combination of landforms at Gobi Gurvan Saikhan offers an impressive laboratory for geological and geomorphological research. Khongoryn Els sand dunes and the geoformations at Khermen Tsav, especially, demonstrate ongoing geological processes of remarkable interest.

Criterion (x). The Gobi Gurvan Saikhan ecosystem contains a unique combination of beautiful nature, and rare, very rare, and endangered plants and animal species. Twelve species listed in the Mongolian Red Book of Endangered Species live in Gobi Gurvan Saikhan, including the Snow leopard (*Panthera uncia*), Argali sheep (*Ovis ammon*), Siberian ibex (*Capra sibirica*), Goitered gazelle (*Gazella subgutturosa*), Mongolian gazelle (*Procapra gutturosa*), Eurasian lynx (*Lynx lynx*), wild Bactrian camel (*Camelus ferus*), and Rock marten (*Martes foina*) (IUCN 2021). More than 350 species of tubular plants have been documented, which make up more than 60% of the region's flora (Wesche et al. 2005).

Authenticity and Integrity.

Gobi Gurvan Saikhan National Park, Mongolia's largest national park, is an invaluable cultural and natural resource with high levels of authenticity and integrity and attributes necessary to express Outstanding Universal Value. The traditional pastoral management systems employed by the nomads have continued since ancient times. Families living in the park continue to practice intangible and tangible traditions associated with the nomadic way of life including the sustainable use and effective management of the surrounding environment. Nomadic families live in traditional "ger" dwellings; a portable, circular felt tent with at least a 3,000-year history. Other cultural elements include several archeological sites, ruins of ancient cities, temples, monasteries, ancient tombs, burial mounds, petroglyphs, and inscriptions. In terms of natural heritage, the park's large scale (27,000 square kilometers) and limited infrastructure development make it an important habitat for protected and endangered species. Few paved roads exist and most travel is done over dirt tracks. The lack of infrastructure buildup, apart from the occasional tourist camp and small settlement, maintains the park's integrity as an important untouched habitat for a variety of biodiversity. Several rare and important plants and animals are found in the park, including migratory species such as the Mongolian gazelle (*Procapra gutturosa*); more than 100 species of birds, 20 species of reptiles and 340 invertebrates have been recorded.

Protection, Management, Challenges.

In 1965 the Mongolian Government, recognizing the significant natural resources of the South Gobi Ecosystem, designated Yolyn Am as a Strictly Protected Area in order to "protect, recognize, use and ensure the sustainable development of the region's natural and cultural heritage" (Beket and Knapp 2012). In 1995 the State Environmental Protection Agency officially designated Gobi Gurvan Saikhan as a national park and protected area and confirmed the boundaries of the park encompassing roughly 27,000 square kilometers. Current management of Gobi Gurvan Saikhan National Park is under the auspices of the Ministry of Environment and Green Development of Mongolia whose aim is "to preserve Gobi Gurvan Saikhan's biodiversity, ecological balance and their originality and pass them on to future generations." A total of 31 staff, including 21 rangers, 5 specialists and 1 director oversee the park's operations. While visitor numbers can be considered high, impacts are concentrated in the relatively small part of the property that is developed and has road access. Several government resolutions have been passed to ensure the preservation and sustainable use of natural resources; the government has also supported initiatives that increase the participation of local people in environmental protection. The increasing pressure of climate change and human activity pose a threat to the natural environment creating an urgent need to reinforce conditions concerning protection, planning, and management to respond to these growing challenges. Strengthening the role that local communities play in the management of the park is necessary to ensure the long-term sustainable development of the area. A clearly defined buffer zone would ensure the integrity of the park is not impacted by the encroachment of the mining industry and other human activities.

Comparative Analysis.

Gobi Gurvan Saikhan is Mongolia's largest national park encompassing more than 27,000 square kilometers. The park is home to some of the Gobi's most impressive geological and natural features and is rich in cultural heritage. Despite the Gobi's unique desert ecosystem, which embodies several attributes of Outstanding Universal Value, including areas of exceptional natural beauty and esthetic importance, as well as rare and precious plants and endangered species, we find no comparative World Heritage sites within Inner Asia. While Mongolia has 5 World Heritage Sites, including the Orkhon Valley and Uvs Nuur Basin, Gobi Gurvan Saikhan is distinctive

from the others in that it is a desert landscape with unique flora, fauna, and landform features that have evolved in a harsh and water scarce arid environment making it a landscape of great international significance.

Great Gobi Strictly Protected Areas A/B | 43°46'14.18" N, 101°34'16.19" E

Category. Natural
Outstanding Universal Value. high
World Heritage Criteria. (vii) (viii) (ix) (x)

Established in 1975, Great Gobi Strictly Protected Area (Great Gobi SPA), located in the southwestern areas of Mongolia, encompasses 62,000 square kilometers of varied desert habitat, making it one of the country's largest protected areas. In 1991, Great Gobi SPA was registered as a UNESCO International Biosphere Reserve, a designation given to a site for "testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity." Since 1996, Great Gobi SPA has been on UNESCO's tentative list for World Heritage consideration for its natural heritage, however, Mongolia has been unable to advance its application for formal inclusion; the Mongolian submission focuses primarily on the biological value of the site, although we find a significant range of desert landforms of superlative geomorphological value worthy of recognition. Two distinct areas make up Great Gobi SPA; Great Gobi A, which encompasses 53,000 square kilometers, located in Bayankhongor province and Great Gobi B, 9,000 square kilometers, in Khovd and Gobi Altai provinces. Both Great Gobi A and Great Gobi B share a border with the northwestern areas of China. Combined, the total territory of Great Gobi SPA is larger in size than the country of Switzerland, making it one of the largest terrestrial protected areas in the world.

Vast, remote, and difficult to access, Great Gobi SPA is characterized as an extreme arid desert area with a continental climate and mean annual rain fall of 100 mm per year. The area is a critical habitat to some of the Gobi's most rare and critically endangered species of flora and fauna including ungulate migratory species such as the wild Bactrian camel (*Camelus ferus*), Mongolian wild ass (*Equus hemionus hemionus*), and the Gobi bear (*Ursus arctos gobiensis*), for which only around 30 adults are known to exist (Luvsamjamba et al. 2016) (Figures 9 and 10). In spite of the harsh and arid conditions a relatively high diversity of life has been documented including nearly 410 species of plants, which include 204 species of plants in 135 different genera in Great Gobi B (von Wehrden et al. 2006). Many of these desert plants exhibit unique physiological and behavioral adaptations (Shukherdorj et al. 2019b, 2019a). Twenty plant species are endemic to the region and several plants are used for their medicinal properties by local people. Notable critically endangered plant species include the desert poplar (Populus diversifola), desert broomrape (Cistanche deserticula), Anabasis eriopoda, Artemisia tomentella, and Spongiocarpella grubovii (Nyambayar et al. 2011). Forty-nine species of mammals, 15 species of reptiles and amphibians, and over 150 bird species have also been recorded. More than 50 oases, which serve as critical water sources for biodiversity, have been documented within the SPA (Figure 11).

Geomorphically, Great Gobi SPA includes a vast variety of desert habitats such as rugged plains, rocky outcrops, impressive mountain ranges, as well as highly important quaternary (e.g. ancient river systems) and fluvial phenomena, including alluvial fans. Several former and current lakes of major scientific value are found in Great Gobi SPA many of which have potential as important archives of past pluvial eras and climate change. The extraordinary arid environment of Great Gobi SPA continues to attract domestic and international research scientists across various academic fields which has contributed to the development of a large body of supporting evidence.

Justification of Outstanding Universal Value

Criterion (vii). As one of the largest protected areas in Asia, Great Gobi SPA is a showcase of unique and diverse desert biomes and landscapes including desert plains, plateaus, dunes, oases, and mountain ranges. The remarkable assemble of features results in a visually stunning desert landscape with exceptional natural beauty and esthetic value.

Criterion (viii). The varied desert landforms at Great Gobi SPA provide a geologic record across Earth's evolutionary history. Fossil lakes and other pluvial evidence offer a window into environmental and climatic change and are of great scientific interest with universal importance in relation to geosciences.

Criterion (ix). Great Gobi SPA is the last refuge for wildlife in Inner and Central Asia. The remoteness and vast size of Great Gobi SPA, and very low human presence, are the main contributing factors for the survival of numerous plant and wildlife species, including ungulate migratory species, that have been eliminated from other regions of the Gobi. The property contains a wide variety of still largely intact semi-arid desert habitats and ecosystems (dunes, stony gravel desert, cliff valleys, high plateaus, mountains, oases, etc.) necessary for the conservation of the Gobi's unique and varied biological diversity.

Criterion (x). Great Gobi SPA contains important natural habitats for some of Inner Asia's most unique, rare, and threatened species, several of which are on the IUCN's Red List, including the Mongolian wild ass (*Equus hemionus hemionus*), argali (*Ovis ammon*), Siberian ibex (*Capra sibirica*) and Gobi bear (*Ursus arctos gobiensis*). The size of the property serves as an important wildlife corridor and transit zone for important populations of migratory ungulates such as the wild Bactrian camel (*Camelus ferus*), Przewalski horse (*Equus ferus przewalskii*), snow leopard (*Panthera uncia*), saiga antelope (*Saiga tatarica tatarica*), and goitered gazelle (*Gazella subgutturosa*). In total, 49 species of mammals, 150 species of birds, and 15 species of reptiles and amphibian species have been identified in the territory. However, due to the remoteness and large size of the protected areas population numbers are often hard to estimate and inaccurate. Regarding flora, Great Gobi SPA contains notable critically endangered plant species including the desert poplar (*Populus diversifola*), desert broomrape (*Cistanche deserticula*), *Anabasis eriopoda*, *Artemisia tomentella*, and *Spongiocarpella grubovii*. At oasis sites where water is more abundant, a very specific habitat has developed associating a dense ligneous and herbaceous stratus. As a result of the range of rare and endangered species the importance of the Great Gobi SPA for science and conservation is exceptional.

Authenticity and Integrity.

Great Gobi SPA is one of the largest protected areas in Asia covering terrestrial area of more than 62,000 square kilometers, with Great Gobi SPA A encompassing 53,000 square kilometers and Great Gobi SPA B encompassing 9,000 square kilometers, respectively. The large size and remoteness make Great Gobi SPA a last bastion for wildlife in Asia; no other protected area of this size exists in Asia. Roughly 110 families with close to 60,000 livestock live within the SPA (Kaczensky et al. 2007); however, human disturbance is relatively low resulting in an outstandingly high level of physical integrity and protection. Hunting and exploitation of natural resources are forbidden and access to the SPA generally requires a permit. In 1975 Great Gobi SPA was designated as a national Strictly Protected Area and in 1991 included in the World Network of Biosphere Reserves as one of the world's largest

biosphere reserves. The property is especially important for the Mongolian wild ass (*equus hemionus hemionus*), wild Bactrian camel (*camelus ferus*), and Gobi bear (*ursus arctos gobiensis*), as it is one of the only locations where these rare animals can be found.

Protection, Management, Challenges.

Great Gobi SPA was designated a Strictly Protected Area in 1975 and benefits from the full protection of the Law on Special Protected Areas (1995), including provisions from the annual state and local budget for protecting, repairing, and monitoring protected area resources (Tserendavva 2008). Gobi SPA is managed by a staff of 10 full-time rangers who conduct continuous monitoring and preventive conservation of biological diversity. The headquarters for the Great Gobi SPA is located in Bayantooroi, about 20 km north of the Great Gobi SPA A. Border patrol stations at the southern border of the Gobi SPA support SPA rangers when needed. However, despite adequate resources a comprehensive survey and inventory of the SPA's natural and biological resources is lacking. Poaching and illegal grazing are minimal; however, from time-to-time poaching does occur, and improved surveillance and awareness raising activities are necessary to ensure long-term protection of the property. Mining has occurred outside the SPA boundaries and is governed by the Special Protected Areas law that limits any mining activity. The mining industry is expanding quickly in the Gobi and future developments will need to be carefully observed to ensure protection of the property's Outstanding Universal Value.

Comparative Analysis.

Combined, Gobi SPA A and Gobi SPA B make up one of the largest protected terrestrial areas in the world, and the largest protected desert landscape in Asia. As a major desert the Gobi SPA is one of the best examples of a relatively high altitude, cold desert with superb examples of desert geomorphological phenomena making it a world class site. In relative terms, the Gobi SPA is biodiversity hotspot, home to some of the world's rarest and important plant and animal species giving it important biological value. The sheer size and remoteness, and display of low levels of human disturbance, of Gobi SPA make it one of the world's last bastions for wildlife including important migratory species. Comparatively, the Gobi SPA is rivaled in size and scope only by Niger's Air and Ténéré Natural Reserves making it of great regional and international significance.

The Great Gobi SPA as a Transboundary UNESCO World Heritage Property.

While the purpose of this article was to identify properties within the Mongolian Gobi, the greater Gobi Desert presents an opportunity for Mongolia and China to collaborate on the shared protection of a single property, which can result in the mutual benefit of enhanced long term conservation goals (Osipova et al. 2014). Although challenges can emerge in the form of institutional coordination and cooperation, and varied protection and management approaches, shared heritage protection can also inspire international and peaceful cooperation between countries, and a sharing of resources in the face of financial constraints or natural disaster (Stanton-Geddes and Soz 2017). Current examples of transboundary heritage properties include Muskauer Park in Germany and Poland, Mosi-oa Tunya/Victoria Falls in Zambia and Zimbabwe, and the Kvarken Archipelago in Sweden and Finland. We find that the Great Gobi SPA, which shares its border with China, would serve as an ideal candidate of a transboundary World Heritage property. On the Chinese side is the Lop Nur Wild Camel National Nature Reserve (IUCN category V) a 61,200 square kilometer reserve established in 1986 dedicated to the protection of wild Bactrian camels (*camelus ferus*). A critically endangered species, the wild camel population at the Lop Nur reserve has been estimated at roughly 600. In Mongolia, between Gobi Protected Area A and B there are roughly 350 wild camels; however, true population numbers are unknown (Kaczensky et al. 2014). Shared management of Gobi World Heritage could enhance protections for the wild Bactrian camel and other rare and endemic species unique to Inner Asia.

Discussion

Covering up to one-third of the Earth's terrestrial area, deserts are of some of the world's most important ecosystems, yet we find desert landscapes to be underrepresented as UNESCO World Heritage. Earlier research has found that only 13 World Heritage properties are classified as desert sites despite many of the world's deserts landscapes having superlative geomorphological, natural, and cultural value (Badman et al. 2005; Goudie and Seely 2011). Of these 13 sites two are in South America (Ischigualasto/Talampaya Natural Parks, Valdés Peninsula), two are in North America (Dinosaur Provincial Park, Grand Canyon National Park), three are in Australia (Purnululu National Park, Uluru-Kata Tjuta National Park, Willandra Lakes Region), and five are in Africa (Aïr and Ténéré Natural Reserves, Banc d'Arguin National Park, Lake Turkana National Parks, Tassili n'Ajjer, Wadi Al-Hitan (Whale Valley)). Only one, Uvs Nuur Basin, classified as a cold steppe desert, is in Asia. Mongolia's Gobi Desert, one of the world's intact large-scale desert landscapes, boasts an extraordinary variation of desert types, unique and spectacular geomorphic features, diverse biological life, and important ecological services, characteristics that match if not exceed the desert properties inscribed on the World Heritage list. The Gobi's rich species diversity includes locally endemic and medicinal plants and rare and endangered species. Historical, cultural, and spiritual importance of the Gobi landscape are reflected in an enduring nomadic lifestyle, countless artefacts and archeological sites, and in contemporary life in the form of songs, stories, and legends that have been shared among the local and indigenous communities for generations.

We identify 3 sites; the fossil sites at the Flaming Cliffs at Bayanzag, Gobi Gurvan Saikhan National Park, and Great Gobi Strictly Protected Areas A/B, as sites of high potential Outstanding Universal Value that meet several natural and cultural criteria required to be granted World Heritage status. Inclusion of these sites as UNESCO World Heritage also interlink with the Sustainable Development Goals, specifically SDGs 2, 3, 6, 13, and 15. While the Flaming Cliffs and Great Gobi Strictly Protected Area have previously been included on Mongolia's Tentative List for World Heritage in 2014, further scientific evidence and documentation has emerged, as has our understanding of conservation evolved, to which we believe makes the case for inscription even stronger. It's important to note that a property on the Tentative List can be removed as a candidate for World Heritage consideration at any time and this research aims to provide further supporting evidence for nomination. In conducting our study, we also reviewed issues related to the integrity and management of these areas and the improvements that can be made to increase the likelihood of nomination and enhance long-term conservation outcomes.

An important requirement for a property to be granted World Heritage status is that it must "meet the conditions of integrity and/or authenticity and must have an adequate protection and management system to ensure its safeguarding." In general, we find that the authenticity of our recommended sites to be supported by a large body of evidence on the scientific, cultural, and historical

value. The Government of Mongolia has made clear that it recognizes the cultural and natural value of these properties as an important part of Mongolia's heritage; the Great Gobi Strictly Protected Area and Gobi Gurvan Saikhan National Park are protected under the highest levels of the national law, specifically the Laws on Special Protected Areas (1994). However, while the inherent value of these sites as potential World Heritage is clear, we find evidence that the integrity, i.e. site management and community inclusiveness, is still limited by unclear policy frameworks, vague and poorly enforced regulations, lack of management planning, and weak financial, human, and technical capacity. Failing to meet the standards of integrity and authenticity has been one of the main reasons why properties have failed to meet the threshold for inscription on the World Heritage List (Badman et al. 2008).

We find buffers zones, an integral component to the protection, conservation, and management of World Heritage properties, to be loosely defined and enforced. Buffer areas not only provide critical habitat adjacent to conservation areas and have the benefit of protecting soil resources, improving air and water quality, enhancing wildlife habitat, creating wildlife corridors, and beautifying the landscape, but these zones also provide an array of economic opportunities for local communities. Poorly defined buffer zones can contribute to the failure of conservation strategies in the long run. Recognition of the legitimate needs of the local population must be taken into consideration for buffer zones to succeed (Martino 2001). There is evidence that indigenous groups and local communities around Mongolia's national park network are not included in park management operations and decision making (McCarthy et al. 2018).

Inscription of a property on the World Heritage List will undoubtedly bring increased awareness and curiosity along with an increase in visitors. While the prospect of increased tourism is important, particularly in the developing world where it can create jobs, help preserve traditions and customs, reduce poverty, and contribute to the achievement of SDGs we acknowledge that policies must be developed and enforced to ensure a balance between tourism and conservation (Giliberto and Labadi 2022; Labadi et al. 2021). Greater linkages with local stakeholders are necessary to support a sustainable tourism industry, yet we identify a number of challenges that currently prevent this (Budeanu 2005). Indigenous communities in Mongolia have reported being excluded from the benefits of the tourism industry (McCarthy et al. 2018). Research shows that conservation outcomes are enhanced when combined with opportunities to generate revenue and with active engagement of local communities (Brooks et al. 2013); however, in Mongolia, current government policies do not encourage redistribution of economic and social benefits of tourism to the local levels. The current structure of tourism taxation is centralized with benefits flowing to government agencies in the capital city Ulaanbaatar. When economic benefits are redistributed back into the local communities, local management and preservation of protected areas is more likely to succeed (Niedzialkowski et al. 2012).

World Heritage status alone will not ensure the preservation of natural and cultural resources and should not be considered as the main safeguard or replacement for long-term protection. Simply increasing protected area coverage by protecting the cheapest land, even if ecologically representative, only provides marginal protection for threatened species (Pimm et al. 2018; Rodrigues et al. 2004). In fact, climate change, human activity, and a growing mineral resource extraction industry pose immediate and existential dangers to the long-term protection of the Gobi's landscapes. The problem is not unique, nearly one-half of UNESCO World Heritage sites are under threat by development, and one-third of natural world heritage sites are threatened by climate change, emphasizing the need for increased resource allocation and stronger protections across the World Heritage network (Lambertini 2018; Osipova et al. 2020). Thus, in parallel with World Heritage designation the Mongolian Government should strengthen its partnerships for conservation between government agencies, the public and private sector, and local communities as we believe future challenges will be no match for the limited human and financial resources currently designated to manage these areas and ongoing threats from human activity and climate change. This includes providing sufficient funding and strengthening the capacity of site managers. Building partnerships with local communities for enhanced conservation can also ensure that surrounding communities see value in protecting areas for long-term sustainable use.

Looking Ahead

As human activity threatens the world's natural habitats at an unprecedented rate, the landscapes of the Gobi Desert provide an excellent opportunity to protect land, safeguard ecosystem services, and give biodiversity room to roam. Considering that just 3% of the world's ecosystems remain intact, with more than 1 million species at risk of extinction, the case and urgency to enhance protections of the Gobi landscapes is greater than ever (Brondizio et al. 2019; Plumptre et al. 2021). Climate change magnifies all these ecological uncertainties (Tol 2009). The value of natural habitat and landscapes is now well understood in all parts of the world and preservation of the Gobi's desert landscapes not only exceeds the idea of national and regional importance but has exceptional Outstanding Universal Value with relevance to all of humanity. Including Mongolia's Gobi as UNESCO World Heritage can help build awareness of desert landscapes and enhance conservation efforts, however, how well these sites protect ecosystem services depends on how effectively they are managed and supported by local communities. Ensuring sustainable management and resilience to human activities over the long term will require a suite of conservation activities that are inclusive and diverse. We recommend a consideration of the following actions that address the strategic objectives of the World Heritage Convention and contribute to the development of sustainable conservation outcomes.

1. Incorporate the rights of indigenous and local people

Strengthening the role of communities in the management of and benefit from World Heritage properties can result in greater sustainable conservation outcomes (Berkes 2007). Several case studies of participatory management systems have shown that when local communities and public institutions are partnered in the management of World Heritage, there is a greater share of economic benefits and management is more efficient and sustainable (Levin and Poe 2017). Establishing participatory management mechanisms that lead to local community involvement in the decision-making process is more likely to ensure sustainable conservation of World Heritage and its transmission to future generations. At Banc d'Arguin National Park in Mauritania public institutions have incorporated local communities as a major player in the conservation and management of World Heritage resulting in more active and effective participation in the management, promotion, and protection of the property (UNESCO 2022b).

2. Develop and refine management policy to incorporate leading conservation science

Systematic conservation planning based solely on international recommendations has been shown to fail at achieving optimal levels of conservation protection (Woodley et al. 2019). Conservation management policy and practice should be guided by the best available information and adequate conceptual frameworks that

include social and natural dimensions. Conservation social science provides the tools for understanding the social, cultural, and historical contexts of World Heritage preservation efforts and the political and economic factors at play in possible intervention scenarios (Bennett et al. 2017b). Conservation social science methods for on-the-ground data collection and analysis can be used for predictive and comparative assessments of results and consequences (Mascia et al. 2003; Sandbrook et al. 2013). Incorporating human dimensions of conservation into management policy can enhance conservation policies, actions, and outcomes (Bennett et al. 2017a).

Long-term monitoring programs are essential to modern ecological research and policies that can have disproportionate benefits for conservation outcomes (Hughes et al. 2017). Numerous new technologies, such as camera traps with cellular capabilities, remotely sensed imagery from drones and satellites, and artificial intelligence (AI)-supported image recognition tools, have brought down the cost of monitoring and the quantity and quality of the data collected, to previously unimaginable levels (Lahoz-Monfort and Magrath 2021). Utilizing innovative technologies can assist in achieving resilience in World Heritage preservation (Elabd et al. 2021). At the UNESCO World Heritage serial site Ancient and Primeval beech forests of the Carpathians and other regions of Europe located in Southern Italy researchers have used drones to provide a cost-effective way to build a ground-up picture of old-growth forests and monitor other natural resources (Solano et al. 2022). Drones have also been used successfully at the World Heritage site Niokolo Koba National Park, the world's third largest bird sanctuary and important habitat for Great Apes, in Senegal to improve surveillance and ecological monitoring (UNESCO 2022c).

3. Improve enforcement of rules and regulations

Weak enforcement of rules and regulations is generally acknowledged as a widespread and significant problem for protected areas (Fischer 2008). Often the full complexity of the underlying causes of this weakness is not fully understood (Bennett and Dearden 2014; Nolte 2016). Increasing the likelihood of compliance is usually best improved by incorporating preventative and enforcement-strengthening measures together; the most commonly applied solutions are overly simplistic (Akella and Cannon 2013). In addition to ensuring personnel have adequate equipment, staffing, and funding on a permanent basis, co-management approaches that involve local communities in enforcement activities in a way highly tailored to local issues have been found to improve compliance with environmental and conservation laws (China ASEAN Environmental Cooperation Centre 2014). Research has found that the perceived likelihood of community-level sanctions plays a more significant role than the fear of arrest by rangers in influencing observance of the laws (Atuo et al. 2020). By incorporating local communities in planning enforcement interventions conservation outcomes may be enhanced and contribute to stronger protections (Cooney et al. 2017).

4. Support environmental education and knowledge transfer activities

Research has shown that when young people engage with environmental education their attitudes, values, and knowledge of the environment is enhanced and they develop skills that prepare them to collaboratively undertake positive environmental action within their communities (Ardoin et al. 2020; Bennett et al. 2017a). The importance of providing students with interaction and inquiry opportunities with local conservation issues cannot be overstressed; education provides students with the knowledge, skills, and experiences to make intelligent decisions pertaining to the management of their natural and cultural resources (Kuo et al. 2019). Incorporating conservation knowledge and skills in curricula is a proven link for promoting conservation behavior in youth (Ardoin et al. 2020). Recognizing the transformative power of education to improve our relationship with nature, UNESCO has set the target to make environmental education a core curriculum component in all countries by 2025 (UNESCO 2022d).

5. Promote international collaboration

Conservation of the world's cultural and natural heritage costs money and takes collective effort. Increased international collaboration has been proposed as the most promising near-term mechanism to develop active and comprehensive conservation efforts (Hind et al. 2015). Research on land management, for example, has shown that collaborative research can mobilize science to improve conservation practice effectiveness and enhance conservation and management outcomes in the long-term (Bestelmeyer et al. 2019). International collaboration can contribute to the development of more effective capacity building measures including improved access to data, information and knowledge, equipment, and training (Harden-Davies and Snelgrove 2020). The longevity of such collaborations can be strengthened when research alliances involve multiple stakeholders, especially non-scientists (e.g. indigenous groups, local communities, NGOs) (Hind et al. 2015).

Conclusion

Desert landscapes account for up to 41% of the Earth's land surface, and are currently home to around 2 billion people, or roughly 26% of the global population. Deserts also harbor rich ecosystems, contain superlative geomorphic and physiographic features, and provide critical and viable habitat for rare and endangered species. Despite this, deserts are widely underrepresented as sites of World Heritage. The Gobi Desert, Asia's largest desert, is a functioning, healthy, natural ecosystem that offers a unique combination of exceptional natural beauty and varied biological diversity; the Gobi is classified as a key biodiversity area. Research in the Gobi has advanced our knowledge of the history of life on Earth and the traditional nomadic culture found in the Gobi continues to inspire us with their "noble way to live in harmony with the landscape." To preserve the natural and cultural heritage of Mongolia's Gobi, this study identified the fossil sites at the Flaming Cliffs, Gobi Gurvan Saikhan National Park, and the Great Gobi Specially Protected Area A/B as three world class sites that meet UNESCO's definition of Outstanding Universal Value and which we believe are worthy of UNESCO World Heritage nomination. However, we note that Mongolia must make several efforts to increase the likelihood of inscription and enhance long-term conservation outcomes, including: incorporating the rights of indigenous and local people in management decisions, refining management policy to reflect current conservation science, improving enforcement of rules and regulations through community involvement, supporting education initiatives that promote conservation knowledge and action, and promoting international collaboration and research partnerships. In a period when human activity and climate change pose serious threats to the integrity of the world's unique desert ecosystems, UNESCO World Heritage status of Mongolia's Gobi Desert, along with strengthened cooperation through partnerships with State Parties, the international community, and civil society, will provide increased recognition, appreciation, and safeguarding of desert landscapes, crucial to ensure long-term protection of these fragile and irreplaceable sources of life and inspiration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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