Sacred natural sites classification framework based on ecosystem services and implications for conservation

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1 INTRODUCTION

Sacred natural sites (SNSs) are areas of land and water with spiritual significance to peoples and communities (Wild & McLeod, 2008). SNSs have existed throughout the history of human civilization for thousands of years and are still widely distributed in local communities around the world (Dudley et al., 2010; Furuta & Verschuuren, 2016; Verschuuren, Wild, McNeely, & Oviedo, 2010; Wild & McLeod, 2008). SNSs have played an irreplaceable role in safeguarding the well-being of local communities (Kothari, 2006; Liljeblad & Verschuuren, 2019), and served as an essential community-level governance scheme for the sustainable management of natural resources (Alieu, 2010; Berkes, 2004); as such, SNSs are uniquely poised to greatly benefit nature conservation (Bhagwat & Rutte, 2006;
Lowman & Sinu, 2017; Verschuuren et al., 2021). In fact, some studies showed that SNSs are more effective than formally protected areas (PAs) in conserving biodiversity (Brandt, Butsic, Schwab, Kuemmerle, & Radeloff, 2015; Shen, Li, Wang, & Lü, 2015). For this reason, SNSs were officially recognized as a form of Community Conservation Areas (Borrini-Feyerabend, Kothari, & Oviedo, 2004).

Early research on SNSs began in the mid-19th century with a focus on religious and cultural behavior of local communities, providing ethnological documentation of traditional ecological knowledge, but neglecting conservation perspectives (Tylor, 2012). Studies on the role of SNSs in conservation date back to the latter part of the last century and indicate that SNSs based on traditional culture and local beliefs could promote nature conservation (Hamilton, 1993; Ramakrishnan, Saxena, & Chandrashekara, 1998). With an empowerment process facilitated by the United Nations and international conservation organizations such as the International Union for Conservation of Nature (IUCN), the wisdom and rights of indigenous people have been receiving increasingly more attention; furthermore, ways to integrate SNSs into PA systems have become an important research topic (United Nations, 2014; Verschuuren & Brown, 2019).

Most of the characteristics of SNSs across the globe align with the IUCN definitions of PAs, and can meet at least one of the standards of the six IUCN PA categories (category I to VI) (Berkes, 2009; Wild & McLeod, 2008). In IUCN's newly published guidance for protected and conserved areas, SNSs, which due to their local community management generally fall under Indigenous Community Conserved Areas and Territories (ICCAs), may be attributed either to PAs or Other Effective Area-based Conservation Measures (OECMs) (Dudley et al., 2018; Verschuuren et al., 2021). It is estimated that indigenous peoples manage or have tenure rights over at least 38 million km² of land across all of the inhabited continents; this represents over a quarter of the world's land surface, overlapping with approximately 40% of all terrestrial PAs and ecologically intact landscapes (Fa et al., 2020; Garnett et al., 2018). Global coverage by SNSs has not been accurately quantified, but their extent is likely to be vast (Wild & McLeod, 2008).

During recent decades, indigenous peoples and local communities have continued to gain recognition of a broad range of land use and management rights across multiple laws and policy statements at international and national levels (Jonas, 2012; Jonas, 2016). In Australia, the Indigenous Protected Areas (IPAs) program was established in 1997. Currently, 78 IPAs make up over 46% of Australia's National Reserve System, and over 60% of IPAs are managed by Australian government-funded indigenous ranger groups ( Muller, 2003; NIAA, 2021). In the Philippines, traditional land tenure has been recognized and ICCAs have been supported within the PA system (Pedarosa, 2012). In Nepal, failure of state-controlled forest policies rejuvenated the concept of community-based natural resource management (CBNRM), and the national government formally adopted CBNRM with the objectives of nature conservation and improvement of livelihood (Gurung, Karki, & Bista, 2011). The Forest Right Act of India recognized and vested in secure community tenure of “community forest resources” (MTA & UNDP, 2014).

Although increasingly more countries attempt to facilitate the legislation process of ICCAs, there are only a few reported cases of relevant government agencies or leading conservation organizations effectively integrating SNSs into mainstream conservation practices (IUCN, 2019; Jonas, Barbuto, Jonas, Kothari, & Nelson, 2014; Verschuuren & Brown, 2019; Wild & McLeod, 2008; Worboys, Lockwood, Kothari, Feary, & Pulsford, 2015). In fact, much recent SNS research is limited to acknowledging the biodiversity conservation function of SNSs (Avtzis et al., 2018; Frascaroli, 2013; Gao, Ouyang, Chen, & Koppen, 2013). For instance, quantitative analyses of the geographic overlap between SNSs and distribution of biodiversity showed that SNSs could significantly contribute to biodiversity conservation, and possibly protect biodiversity elements better than formal PAs (Brandt et al., 2015; Li, Wang, Hang, Duojie, & Lü, 2013; Wood, Brandt, Pidgeon, & Radeloff, 2015). Unfortunately, most of these studies lacked appropriate counterfactuals that could attribute differences to SNSs (Boraiah, Vasdeva, Bhagwat, & Kushalappa, 2003). In addition, it has not been considered that some culturally important SNSs have been preserved in local communities for their cultural values only with no relationship to biodiversity conservation (Bishop, 2016; Gulliford, 2000; Xu et al., 2019).

In recent years, a new paradigm has emerged for conservation studies in PAs and OECMs that emphasizes governance, and ICCAs were classified under the governance type of “indigenous peoples and local communities”. Indigenous people or local communities are the major decision-makers in SNSs and have de facto and/or de jure capacity to develop and enforce relevant regulations that lead to the conservation of biodiversity, ecological functions, and associated cultural values, regardless of original or primary motivations (Furuta & Verschuuren, 2016; IUCN, 2019; Studley, 2019). Reinforcement of the central role of communities not only in management (what to do) but also in governance (who decides) is greatly needed (Maxwell et al., 2020; Salerno et al., 2021; Worboys et al., 2015). Governance should be entrusted to relevant local governing bodies with the capacity to take care of the SNSs (Dudley et al., 2018;
In this study, we developed an SNS classification framework based on the analysis of initial reasons for SNS creation, which are typically rooted in the relationship between people and nature. Our study aims to address the following questions: (1) What are the key motivations for SNS creation? (2) How should SNSs be categorized for conservation purposes? (3) What are the major considerations of the proposed framework in conservation management of SNSs? We used the Khawa Karpo, an important sacred area in the Tibetan region of northwestern Yunnan in China (Data S1), as a case study. The results of this study will support relevant government agencies, conservation organizations, and practitioners particularly in the Tibetan region with their efforts to develop strategies and initiatives to conserve SNSs by respecting local spiritual and material needs, and by facilitating effective integration of science-based conservation approaches with local wisdom.

2 | METHODS

2.1 | Conceptual framework

Development and implementation of differentiated rather than one-size-fits-all strategies will significantly enhance the outcomes from conservation actions across SNSs. Therefore, classification of SNSs based on their individual characteristics should be a prerequisite for planning and implementing meaningful actions to conserve local ecosystems. An SNS classification system can start by analyzing key motivations for SNS creation. IUCN’s definition suggests that SNSs are, at their core, a cultural phenomenon (Wild & McLeod, 2008). In fact, the emergence of all prehistoric cultures has been closely linked to ecosystems on which such cultures relied (Wang, 2015), and the fundamental reason why human cultures emerged in early human history was largely to sustain survival. To sustain survival, humans required two elements: essential resources, which provided material services such as food, shelter, and clothing; and social institutions, which provided spiritual services such as religions, social norms, rituals and regulatory systems (Stevens, 1997).

Human needs for material services from SNSs, which is a component of the local ecosystem, vary with social material production systems. In early human societies and traditional communities, most essential resources were produced and obtained locally through a subsistence livelihood. With the development and expansion of commercial activity, essential resources could be shipped from region to region, enabling livelihoods to be more flexible, and making it possible for people to rely less on their locally produced resources (Barbour, 2017). At the same time, people’s needs for spiritual services from SNSs changed with changing local belief systems (Liljeblad & Verschuuren, 2019). The exchange of information expanded with the development of human history, and human belief systems evolved from animistic (i.e., nature worship, totem worship and ancestor worship) to institutionalized religions ( mainstream religion; Xia, 2005). Worship of nature (or natural objects) was commonplace during eras of animistic religions (Gulliford, 2000). In the era of institutionalized religions, most people no longer worshiped nature or natural objects, and religions became more institutionalized spiritual beliefs characterized by supernatural beliefs (Xia, 2005). In general, people’s needs from SNSs for particular material and spiritual services changed with changing production and belief systems, becoming less localized and more intangible; accordingly, the roles that different SNSs played in sustaining a given community also changed over time (Figure 1a).

For the purpose of conservation, SNSs can be categorized based on their material or spiritual services linked to specific areas and time periods, and different strategies should be adopted for the conservation for these distinct types. Ecosystem services are categorized as supporting, provisioning, regulating, and cultural, as described by the foundational Millennium Assessment (MA, 2005). Provisioning and regulating ecosystem services provide material services, while cultural services encompass key spiritual services (MA, 2005; Rutte, 2011). In terms of SNS conservation governance, differentiated levels of intervention from leaders of mainstream and local animistic religions (religious intervention) and intervention from local administrative villages, government departments/bureaus, and traditional secular authorities such as councils of elders (secular intervention) can be critical
for conservation action (Figure 1b). In this way, an understanding of specific ecosystem services obtained from SNSs enables classification of all SNSs into four categories that support conservation actions. These four defined SNS categories are: category-I, SNS provides high levels of both spiritual and material services; category-II, SNS provides high levels of spiritual services but limited levels of material services; category-III, SNS provides high levels of material services but limited levels of spiritual services; and category-IV, SNS provides limited levels of both spiritual and material services (Figure 1c).

2.2 | Data collection

We conducted a case study in the Khawa Karpo area, located in Deqin County in northwestern Yunnan, China (Figure 2; Data S1). Historical data of local socio-economic conditions were obtained using local documents in the Tibetan language kept in the Deqin library and published books either in Tibetan or Chinese (Data S2). Conservation-oriented field surveys on SNSs were conducted during 2000–2004 and 2015–2017 (see Data S3 for details). From 2000 to 2004, we surveyed approximately 120 sacred rocks, 15 sacred caves, some family-worshiped sacred trees, and lakes. Some opportunist sampling of sacred mountains was conducted after 2004. A follow-up intensive field survey of SNSs was held from 2015 to 2017, focused on sacred mountains and Ri Vgags (means “closing mountains” in Tibetan, detailed in Table 1). Since sacred rocks, caves and trees were physically small, serving limited beneficiaries, and were mostly distributed in residential areas or along a pilgrimage route, we did not conduct specific surveys for these forms of SNSs.

The second field survey (2015–2017) included six regular team members (three with natural science background and three local culture specialists). Field work involved three main steps. Step 1: Seminar for planning the field survey (described in detail in Data S4). Based on our understanding of SNSs gained in the first field survey in this region from 2001 to 2004 and from irregular visits in the following years, we invited three representatives of community leaders, who were familiar with the local socio-economic situation, and two local religious leaders to participate in a 1.5 day seminar to identify the main contents and key indicators of the field survey. Step 2: Community-level field survey (detailed in Data S5). We determined whether to conduct group surveys according to the size of the surveyed communities, with the larger communities divided into 2–3 groups, and the smaller ones not divided into smaller groups. In each group, we ensured that at least one community leader familiar with local natural resources and one spiritual leader familiar with local religion could participate in the survey. Step 3: Community workshop (detailed in Data S6). A community workshop was held after we completed our field survey of a specific community. In addition to our team members, participants included members of community...
administration, religious leaders and representatives from each household. The main purposes of a community workshop were to: (1) confirm our field survey results with the participants; (2) understand resources use in SNSs by individual households; and (3) religious activities of individual households as well as whole community. The latter two were mainly realized through structured and semi-structured interviews (detailed in Data S6).

### 2.3 Data analysis

During the process of categorizing SNSs, we followed the agreed upon understanding reached with local experts at the outset of the field work (Data S4). We first identified an SNS based on its name and local stories/legends. Once an SNS was identified, we then assessed the level of spiritual services, followed by identification of types and levels of material services. If the religious status of an SNS was recognized by mainstream religion, or collective worship was conducted on the first day of every new year, the level of spiritual service of this SNS was assessed as “high” (see detailed reasons in Data S4); otherwise, if the religious status of an SNS was only recognized by local animistic belief, and no collective worship occurred on the first day of every new year or other traditional fixed religious holidays, the SNS was regarded as having a “low” level of spiritual services.

Material service analysis included most sacred mountains, all Ri Vgags, and sacred lakes that could provide

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**FIGURE 2** The spatial distributions of SNSs in the Khawa Karpo area, China. Shaded relief shows topographic conditions, including slope, elevation, and topographic position, on which SNSs are located; relief data derived from the shuttle radar topography Mission 90 m digital elevation model (USGS, 2004)
direct and significant material services in the form of regulating services, such as water supply and ecological security (e.g., prevention of debris flows and landslides), and provisioning services in the form of substantial livelihood resources, such as fuelwood, medicinal plants, mushrooms, and grazing land. Springs, lakes, and rivers that were present within or near the SNS were considered to provide a water supply service. Referencing Zhou’s approach, sacred mountains with a slope of >50% within 1 km distance of a specific community settlement were considered as providing an ecological security service (mainly referring to prevention of landslides and mud-flow, or others). Mostly identified and established by eminent monks based on the needs of local villagers. Appeared in recent history of Khawa Karpo area. Religious rituals conducted only with the declaration of a place as a Ri Vgags.

SNSs such as sacred caves, sacred rocks, and barren sacred mountains, which could provide limited material provisions, were assumed to provide “low” levels of material services. We empirically determined vegetation cover as <20, 20–60, and >60%, and defined vegetation status, respectively, as “low”, “moderate”, and “high.” Because biodiversity has no clear direct relationship with local livelihood, it was not included in the assessment of material services for local communities.

3 | RESULTS

3.1 | SNSs and ecosystem services

The major physical types of SNSs in Khawa Karpo consisted of sacred mountains, Ri Vgags, sacred lakes, sacred rocks, sacred caves, and sacred trees (Table 1), with the majority distributed around the corresponding communities (Figure 2). There were 95 sacred mountains, 30 Ri Vgags and seven sacred lakes, 300–400 estimated sacred rocks (120 surveyed), 15 sacred caves, and 300–500 estimated sacred trees based on random household interview (Table 1). Sacred mountains and Ri Vgags were primarily located upstream of associated human settlements. These areas had higher elevations and steeper slopes, and played a critical role in safeguarding ecological security of local communities by preventing landslides, reducing debris flows, supplying water resources, and conserving soil (Figure 2).

Khawa Karpo (the main peak) is the most important sacred mountain, representing one of the 21 gods known in the entire Tibetan area since the early 6th century (Dorje & Qi, 1999). Most of the followers of this god inhabit Tibetan villages along the upper reaches of the Mekong River. The other 14 neighboring peaks, almost all above 5000 m in elevation, are believed to be subordinates of Khawa Karpo, and also regarded by Tibetan
| Service levels | High | Khawa Karpo and 14 other regional sacred mountains | Low | Seven sacred lakes | 120 sacred rocks and 15 sacred caves | Sacred trees |
|----------------|------|--------------------------------------------------|-----|--------------------|--------------------------------------|-------------|
| **SNS types**  |      |                                                  |     |                    |                                      |             |
| Cultural significance | Highly respected by specific communities and usually representing the identity of an individual community | Highly respected by all communities in the region, and cultural influence reaches beyond the region | Respected by specific local communities | Traditional protected areas recognized through religious declarations | Only related to legends and generally regarded as “mother water” | Only related to cultural memories and legends; some are almost forgotten by locals | Significant for specific families and representing the fortune of family members |
| Scope of believers | Believers from specific local communities and sometimes from neighboring communities | Believers from the region and increasing from neighboring areas | Believers from specific local communities and sometimes from neighboring communities | Believers from specific local communities | Worshipped by specific groups of locals such as old people and herdsmen | Worshipped by specific groups of locals such community members and pilgrims | Worshipped by specific families |
| Ritual practice | Sacred mountains belong to the “Zan” god (the local god), but most of them do not belong to the dharma guardian god of Tibetan Buddhism. These gods are thought to be irritable, and the local community usually chooses the first day of the New Year to burn incense and pray to the god for peace and a good harvest in the village. | In Tibetan Buddhism, most category II SNSs are legendary incarnations of various Dharma guardian god with a clear religious status. Every mountain has its own scriptures with pray and praise. In the scriptures, the origin and history of this god are usually recorded, and the main content is to praise him with flowery language. On important festivals, some families would invite famous monks to recite scriptures, and people in nearby villages would gather and burn incense to pray for good fortune | Sporadic worship by locals | Irregular collective worship | Only religious storytelling | Only religious storytelling | Incense lighting for family’s luck |
| Service levels                          | High                                      | Low                                      |
|----------------------------------------|-------------------------------------------|------------------------------------------|
| **SNS types**                          | 24 central community sacred mountains    | Khawa Karpo and the other 14 regional sacred mountains |
|                                        | 41 common community sacred mountains     | 120 sacred rocks, 15 sacred caves and all sacred trees |
|                                        | 30 Ri Vgags                               | 15 common community sacred mountains    |
|                                        | 7 sacred lakes                            |                                          |
| Water resource                         | 15                                        | No (not directly provide)                |
|                                        | 28                                        | no                                       |
|                                        | 19                                        | no                                       |
|                                        | 7                                         | no                                       |
| Safeguarding ecological security       | 12                                        | No (not directly important to the local community, but important for a larger landscape scale) |
|                                        | 17                                        | no                                       |
|                                        | 21                                        | no                                       |
|                                        | no                                        | no                                       |
| More than one livelihood resources     | 17                                        | no                                       |
|                                        | 24                                        | no                                       |
|                                        | 27                                        | no                                       |
|                                        | Pastoral land                             | no                                       |
| Vegetation cover                       | >60%, 20–60% and <20% for 5, 13, and 6 sacred mountains, respectively | Mountain peak covered with snow, and high vegetation cover at landscape scale |
|                                        | >60%, 20–60% and <20% for 18, 14, and 9 sacred mountains, respectively | no |
|                                        | >60%, 20–60% and <20% for 12, 14, and 4 Ri Vgags, respectively | 20–60% and <20% for four and 11 sacred mountains, respectively |
| Philosophy of resource management      | Religious norms, customary law as supplementary | Religious norms, usually without clear regulations of resource use |
|                                        | Customary law with a combination of religious norms as supplementary | Open-access |
|                                        | Customary law with religious norms as supplementary | Open-access |
|                                        | Forbidden to pollute water bodies         |                                         |
believe residents to be protective gods with regional influence. In addition to these 15 regional deities, 80 sacred mountains are worshiped at the community level in local animistic religion (Tables 2 and S1). Only special groups with strong spiritual backgrounds conduct ritual activities at sacred lakes, rocks, caves, and trees (Table 2). Ri Vgags were declared mostly by eminent monks (Tables 1 and 2). Among all 95 sacred mountains and 30 Ri Vgags, 43 sacred mountains and 19 Ri Vgags provided water resources, 29 sacred mountains and 21 Ri Vgags maintained ecological security services (Tables 3 and S2). Of the 95 sacred mountains, 47 were used for grazing, 28 for collecting medicinal plants, 23 for harvesting mushrooms, and 30 for collecting firewood (Table S1). Of the 30 Ri Vgags, 28 were used for grazing, and 10, 5, and 22 for collecting medicinal plants, mushrooms, and firewood, respectively (Table S2). All seven surveyed sacred lakes were located in summer pastures of local communities and provided water sources for livestock. Of all sacred mountains surveyed, 41, 31, and 23 had “low”, “moderate” and “high” vegetation cover, respectively (Tables 3 and S1). Of all Ri Vgags, 4, 14, and 12 had “low”, “moderate” and “high” vegetation cover, respectively (Tables 3 and S2). Other types of SNSs, with an individual form, such as sacred rocks, sacred caves, and sacred trees, provide almost no ecological or livelihood services for local communities due to their limited physical size (Table 3).

### 3.2 Classification of SNSs

Category-I SNSs comprised of 24 community sacred mountains. Each community had one sacred mountain where all community members worshiped and which was most important culturally. These mountains were close to the corresponding communities. During early mornings of the first day of the New Year, community members (mostly adult males) visited the mountain and jointly conducted ritual activities, such as burning incense and reading religious scriptures. Among these 24 sacred mountains, 10 were worshiped by several communities, and the other 14 were each worshiped by one specific community. Fifteen sacred mountains were located in areas providing water sources for the community, 12 in areas where landslides were likely, and 17 provided more than one source of livelihood. These sacred mountains generally had good vegetation cover with “high” coverage for five of them, “moderate” for 13, and “low” for 6. Most of the sacred mountains with low vegetation cover were nevertheless important ecological places, such as water sources, but encompassed extreme terrain that also hindered plant growth.

Category-II of SNSs consisted of 15 sacred mountains which included the Khawa Karpo peak and 14 other peaks. Most of these peaks represented corresponding deities in mainstream Tibetan Buddhism, and some were regarded as Khawa Karpo’s subordinates and relatives. Given their religious status in mainstream Tibetan Buddhism, cultural influences of these sacred mountains were not limited to a specific mountain, but extended to the entire region. For this category of SNSs, collective annual worship was conducted by villagers from the region, and an increasing number of people from other areas also conducted pilgrimages to these mountains.

Local communities used almost no direct resources from these mountains because of harsh natural conditions and limited access to these mountain peaks. However, from a landscape perspective, these mountains have ecological importance as the upper watershed of the Mekong River.

The SNSs in category-III included 41 sacred mountains, all 30 Ri Vgags, and seven sacred lakes. The spiritual significance of this SNS category was not as high as that of category-I or -II. Sporadic individual family worship was held at most of these sacred mountains and seven sacred lakes, and irregular (once every 3–5 years) collective worship was held at 30 Ri Vgags. There was no collective New Year annual worship for these SNSs, and all of them belonged to community-level or family-level SNSs (nine sacred mountains were jointly used by several communities, 29 by specific communities, and three by individual families). However, these SNSs played a substantial role in maintaining ecological security and provided an important source of livelihood for local communities. Among the 41 sacred mountains, 28 were located in areas providing water sources for the community, 17 in areas where landslides were likely, and 24 provided more than one source of livelihood. Among the 30 Ri Vgags, 19 provided water sources, 21 were in areas where landslides were likely, and 27 provided more than one source of livelihood. Sacred lakes provided water sources for summer pastures. Vegetation cover was “low” for 9, “moderate” for 14, and “high” for 18 of the 41 sacred mountains. Among the 30 Ri Vgags, 4, 14, and 12 had “low”, “moderate”, and “high” vegetation cover, respectively. The four Ri Vgags with lowest vegetation cover were located in places with high possibility of debris flows and landslides but with difficult environmental conditions for plant growth.

Category-IV SNSs included all sacred rocks, sacred caves and sacred trees, and 15 sacred mountains (four were used by several communities and 11 by individual communities). These SNSs were related to cultural memories and legends, but few ritual activities (except sporadic religious circles) were conducted. Sacred rocks, caves, and trees rarely provided any direct material
services to local communities. Among the 15 sacred mountains in category-IV SNS, most were barren, 11 had vegetation cover of <20%, four had 20–60%, and none had >60%. Seven of these sacred mountains provided only one type of livelihood source.

### 3.3 Governance of SNSs

Category-I SNSs provide key natural resources to the communities, and are important places for conducting spiritual activities; therefore, resource use is well regulated by strong religious consciousness combined with secular management norms. Specifically, local community members are expected to follow basic religious doctrines such as “no killing” (similar to prohibition of hunting and logging). Even though these SNSs are only worshiped by local animists, they are also safeguarded by punishment through secular customary law. The governing body of this category has multiple levels, including local administrative villages, government departments/bureaus (such as the Forestry Bureau, mainly responsible for forest fire prevention and management of timber cutting), traditional secular authorities (e.g., councils of elders, responsible for community management of natural resources that the government cannot achieve), and local animistic authorities (e.g., local shamans, responsible for religious rituals within communities).

Category-II SNSs are object worshipped by regional religious believers. They are different from other types of SNSs which are worshipped only by community members (animistic religion), and religious practices associated with category-II usually relate to mainstream Buddhism. Although this category legally belongs to a corresponding administrative village where this SNS is geographically located, its religious adherents often come from other areas beyond the administrative boundaries. Many religious activities related to category-II, such as pilgrimages, are difficult to be effectively managed by local governments and local animistic leaders; however, mainstream religious authorities have considerable influence over them. For instance, intervention by local government proved time-consuming and laborious with issues such as littering and random plant picking in SNSs during pilgrimage seasons, but eminent Lamas highly respected in mainstream Buddhism have played significant roles in preventing these types of acts of nuisance. There is almost no direct resource use by local communities in these SNSs because of harsh natural conditions and limited access to most mountain peaks.

Since Category-III SNSs provide many material services, hunting and logging are usually prohibited under religious norms. However, because of the relatively low religious status of category-III, resource management is enforced mainly through secular customary law. For instance, Ri Vgag, as a means of land management, only emerged <200 years ago as a result of increasing pressure on natural resources. In most cases, individual villages in this area have developed community regulations for the management of natural resource. Religious rituals are only conducted during the declaration or proclamation of a place as a Ri Vgag. All Ri Vgags have clear boundaries with well-developed strict secular regulations of resource use. The governing bodies of this category are the local administrative villages, government management departments/bureaus, as well as traditional authorities of secular affairs management. In contrast to local animistic leaders can play a greater role in coordinating the interests and conflicts of various parties in the community for SNSs in category-I, few of them organize religious activities for SNSs in category-III. As a result, such SNSs often face more complex situations in management.

Because most category-IV SNSs are found in ecologically fragile areas with poor vegetation conditions, and they provide limited services for local communities, management of this category of SNSs was open-access. A prominent phenomenon for this category is the absence of community governance (sometimes even no community management exists for some category-IV SNSs).

### 4 DISCUSSION

#### 4.1 Classification of SNSs

An overly simplistic classification of SNSs is a prominent problem in current SNS studies. Previous research found that vegetation coverage and biodiversity in sacred sites was higher than in nonsacred sites in the Khawa Karpo area (Allendorf, Brandt, & Yang, 2014; Salick et al., 2007). Our study showed that the relationships between SNSs and vegetation cover/biodiversity were much more complex and cannot be explained only by a simplistic division into SNS vs. non-SNS; for example, our study found that vegetation cover of most SNSs category-II and category-IV were “low”, compared with some non-SNSs with high coverage in this region (Ou, Zhang, Wang, & Wu, 2006).

Some scholars have observed that sacred mountains in the Tibetan region can be classified at different levels (i.e., recognized by the entire Tibetan region, regional, and/or community levels) due to their religious influence at different spatial scales (Allendorf et al., 2014; Ma & Chen, 2005; Shen et al., 2015). However, the understanding of SNSs in these cases was mainly from a religious
According to Tibetan Buddhist principles, the conflict over community rights to collect the mushroom worshiped by two communities may be a source of conflict over community rights to collect the mushroom. Communities may differ in their use of natural resource within SNSs, and this may result in various conflicts in terms of ownership and benefits (Doffana, 2017; Sheppard, 2021; Verschuuren et al., 2010). In some of the conflicting circumstances, intervention of religious powers (e.g., advising on the sharing of resources equally based on the Buddhist doctrine of “all beings are equal”) may not achieve the desired effect, but that of secular forces (e.g., enacting administrative provisions to regulate resource use) may be more effective. For instance, a sacred mountain which grows matsutake mushrooms (an important source of income for Tibetan communities) and commonly worshiped by two communities, may be a source of conflict over community rights to collect the mushroom. According to Tibetan Buddhist principles, the two communities are equal and they should benefit equally. However, conservation practitioners may desire to balance the distribution of benefits based on economic conditions and natural resource endowment for avoiding conflict in mushroom collection and thus facilitating regulation of mushroom collection management agreed by both communities. In this case, local county government could be involved because it can reallocate use rights of the mountain in favor of the community with less resource endowment to promote poverty alleviation and social stability through this region’s autonomous law. Greater economic opportunity reduces wanton and uncontrolled use of mushrooms.

Dividing SNSs into four categories based on institutional economic theory (Rutte, 2011) and considering common-pool resource management may facilitate SNS conservation (Samakov & Berkes, 2017). Our results showed that both category-I and category-III SNSs exhibited features of common-pool resources, but their governing bodies differed (category-I mainly related to animistic religion and secular powers, while category-III mainly related to secular powers). Therefore, if a sacred mountain is a category-I SNS and a conflict between two communities occurs, intervention of a higher secular administrative authority should be augmented by animistic leaders communicating the idea of a balanced economic opportunity for the two communities, and facilitating resource management plan agreed to by both parties. If this sacred mountain is a category-III SNS, intervention of a higher administrative authority is the most important, and can be supplemented by religious involvement only if necessary.

4.2 SNS classification and conservation governance

Although the dichotomous approach (SNS vs. non-SNS) highlights religious intervention for SNS conservation, a differentiation in religious type (mainstream or local animism) is lacking (Salick et al., 2007). Our study shows that: mainstream Buddhism plays a greater role than local animism in category-II SNS, local animistic religion plays a more important role in category-I and III, while both mainstream Buddhism and local animistic religion play only limited roles in category-IV. This implies that religious groups should be engaged differently in key conservation activities such as conservation planning or direct resource management.

The classification of SNSs based on religious influence recognizes different roles of different religious forces (Shen et al., 2015). However, SNS conservation should not only involve the religious, but also secular sectors linked to community livelihoods. Communities may differ in their use of natural resource within SNSs, and this may result in various conflicts in terms of ownership and benefits (Doffana, 2017; Sheppard, 2021; Verschuuren et al., 2010). In some of the conflicting circumstances, intervention of religious powers (e.g., advising on the sharing of resources equally based on the Buddhist doctrine of “all beings are equal”) may not achieve the desired effect, but that of secular forces (e.g., enacting administrative provisions to regulate resource use) may be more effective. For instance, a sacred mountain which grows matsutake mushrooms (an important source of income for Tibetan communities) and commonly worshiped by two communities, may be a source of conflict over community rights to collect the mushroom. According to Tibetan Buddhist principles, the two communities are equal and they should benefit equally. However, conservation practitioners may desire to balance the distribution of benefits based on economic conditions and natural resource endowment for avoiding conflict in mushroom collection and thus facilitating regulation of mushroom collection management agreed by both communities. In this case, local county government could be involved because it can reallocate use rights of the mountain in favor of the community with less resource endowment to promote poverty alleviation and social stability through this region’s autonomous law. Greater economic opportunity reduces wanton and uncontrolled use of mushrooms.

Dividing SNSs into four categories based on institutional economic theory (Rutte, 2011) and considering common-pool resource management may facilitate SNS conservation (Samakov & Berkes, 2017). Our results showed that both category-I and category-III SNSs exhibited features of common-pool resources, but their governing bodies differed (category-I mainly related to animistic religion and secular powers, while category-III mainly related to secular powers). Therefore, if a sacred mountain is a category-I SNS and a conflict between two communities occurs, intervention of a higher secular administrative authority should be augmented by animistic leaders communicating the idea of a balanced economic opportunity for the two communities, and facilitating resource management plan agreed to by both parties. If this sacred mountain is a category-III SNS, intervention of a higher administrative authority is the most important, and can be supplemented by religious involvement only if necessary.

4.3 Major considerations in conservation management of SNSs

The SNS classification framework proposed in this study is applicable to SNS-related conservation planning, project initiation and management in other regions (especially regions influenced by Tibetan culture) because it is based on analysis of material and spiritual services provided by SNSs. These types of services are commonly provided by SNSs globally though specifics may differ. However, more research is needed across different contexts to demonstrate broader applicability. It should be highlighted that there is a complex relationship between material and spiritual services. Our analysis of the conceptual framework shows that the most basic human needs are based on material services, and many natural features have become SNSs primarily because they provide important material services. The purpose of classifying SNSs by analyzing the different levels of material and spiritual services is mainly to...
simplify the complexity, so as to focus on specific religious and management issues in conservation practice, which means that spiritual and material services of SNSs should be considered together to devise the most strategic conservation management actions.

This study provides an SNS classification framework from an ecosystem service perspective. The effectiveness of this approach in SNS-related conservation practices mainly depends on a more realistic assessment of the spiritual and material services provided by SNSs, and the selection of appropriate indicators and quantitative criteria are two crucial steps in assessing SNSs. The process of conducting this type of assessment, with relevant stakeholder meetings to identify the main foci of spiritual/material services, and community workshops for understanding resource use by individual households and community religious activities in SNSs, is also useful in subsequent steps of designing conservation strategies. Participatory engagement of stakeholders allows conservation practitioners to avoid subjective judgment and determine relevant and meaningful indicators and quantitative criteria.

Rapidly changing economies, technologies, societies, and cultures, in addition to ongoing and future global factors, such as climate change, are likely to alter the conditions within and around SNSs (Baruah, 2014; Kanu, 2018; Ormsby, 2011; Tran, Ban, & Bhattacharyya, 2020). For instance, with changing modes of livelihoods, local material needs from some SNSs may be reduced, changing category-I SNSs to category-III, or category-III to -IV. With rapid globalization, local belief systems are also facing more challenges, and that may influence the religious status of SNSs. Classification based on assessment of current SNS ecosystem services cannot fully take relevant future elements into consideration. Therefore, the use value of this SNS classification framework in conservation is dynamic and further evolution and improvements are needed through future research.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS
Jianzhong Ma and Ruidong Wu conceived the study. Jianzhong Ma, Tianjiang Li, Guanghui Hu, and Feiling Yang implemented SNS field surveys and data collection. Jianzhong Ma, Ruidong Wu, and Junjun Wang conducted data analysis and visualization. Jianzhong Ma, Ruidong Wu, Christine Tam, and Guangzhi Yu wrote the article with substantial inputs from all authors.

ETHICS STATEMENT
All data were collected from field surveys following research ethics. No ethical approval was required for this study.

DATA AVAILABILITY STATEMENT
All data for this study are available as online supporting information.

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