Building sustainability into the Belt and Road Initiative Traditional Chinese Medicine trade.

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Abstract

A little-known aim of China's Belt and Road initiative (BRI) is 'people-to-people cultural exchange,' including active promotion of Traditional Chinese Medicine (TCM) in BRI countries. On a global scale this will likely increase both TCM demand and sourcing of wildlife-based TCM ingredients from new areas. Any rapid increase in wildlife demand risks exacerbating illegal and unsustainable trade but, with careful management, BRI-TCM could also present opportunities for well-governed supply chains, creating sustainable livelihoods for rural harvesters. With China reaching out to BRI countries to cooperate on the marketing, registration, and promotion of TCM products there is now a critical, short-term window to identify these risks and opportunities, and ensure that sustainability is built into these markets from the start.

The Belt and Road initiative (BRI) is projected to directly connect China to over 130 countries[1], creating a network covering approximately 62% of the world's population and 30% of current global GDP[2]. High-profile road, rail and maritime infrastructure projects form a key part of the BRI, and the enhanced connectivity that they will provide is likely to facilitate trade and economic development for China and the countries it is linking to[3]. However, physically building links between BRI countries and China is only one of the Initiative's five main goals, with others focusing on coordinating policy, removing barriers to trade, integrating financial systems, and developing closer "people-to people ties"[4]. This final goal refers to cultural exchange between China and BRI countries, with specific reference to areas such as education, tourism and development aid, as well as medicine and health. Mentioned specifically is the cultural export of Traditional Chinese Medicine (TCM)[5,6], the promotion of which in BRI countries will build on wider efforts by the Chinese government to strengthen the reach and importance of TCM within China[7]. The use of TCM outside of China has been taking place for some time[8–11], but the BRI is providing a structure through which to expand TCM markets further and more rapidly via the official TCM Belt and Road Development Plan[5]. This expansion is likely to be supported by the inclusion in 2019 of TCM in the World Health Organization's International Classification of Disease, which is used by doctors and medical insurance companies around the world[12]. Since the BRI was announced in 2013, 43 TCM cooperation centres have been established in 35 countries[4], and according to self-reported Chinese government figures, there was a 54% increase in TCM sales in BRI countries between 2016 and 2017[7]. This is likely to be just the beginning, as China plans to expand the building of TCM hospitals and cooperation centres to new BRI regions, including Europe and the Middle East[5].

As TCM demand grows, there will be an opportunity for TCM companies to develop new sources of ingredients, derived from the natural plant, animal and fungal resources of BRI countries[6]. This increased TCM supply and demand presents a potentially major but unexplored biodiversity conservation threat[13], especially as many planned BRI land 'belts' and marine 'roads' pass through important biodiversity hotspots[14]. Further, in several cases the BRI will overlay existing illegal wildlife trade (IWT) routes, along which wildlife is trafficked from regions such as Southeast Asia, Central Asia, and East Africa[15]. However, if managed carefully, emerging TCM supply-chains and markets may also represent an opportunity for sustainable development, if they are shaped by evidence-based strategies, and accompanied by nurturing of robust and equitable governance arrangements, as well as social and environmental safeguards. Whilst broad strategies for sustainability of BRI projects have been explored in the scientific literature[16,17] the potential effects of the expansion of TCM demand and supply have not yet been recognized, and there have been no explicit commitments from policy-makers on TCM sustainability planning. Nevertheless, broader commitments to sustainability have been made, including an MOU between China and UN Environment on a "Green BRI", and separate agreements with over 30 BRI

countries for local ecological protection[4]. With the first phase of the BRI almost completed, and plans for the next phases underway, there is a critical, but narrow, window for China to work collaboratively with its BRI partners to consider the wildlife impacts of expanding TCM markets and turn possible threats into opportunities. This aligns well with realizing China's domestic vision of achieving ecological civilization and balancing people's well-being and environmental protection[18].

Potential BRI-TCM risks to biodiversity

BRI-TCM promotion will lead to expanding demand for TCM, which has the potential to threaten wild populations of harvested species, as previous increases in demand have shown[12]. Existing studies of TCM expansion outside of China, such as in Kenya, have shown that it is likely to involve both a formal sector, represented by well-trained professional practitioners using official products, and an informal sector of opportunistic traders and untrained practitioners[10].

Whilst examples of farmed ingredients do exist, (e.g. musk deer *Moschus* spp.[19]), plants comprise around 80% of TCM products, and an estimated 70-90% of these are wild-harvested[20]. Wild animal products are also used in some cases, including illegally harvested products from threatened species, as identified by molecular analysis of traded TCM products[21]. The current sustainability of wild-harvesting for most TCM ingredients, whether for official formal medicines or for the trade in illegal or unofficial treatments is unknown. However, illegal and unsustainable harvesting to supply these markets has been reported for orchids (Orchidaceae spp.) and other medicinal plants[22,23] and animals ranging from rhinos (Rhinocerotidae spp.) to sea cucumbers (Holothuroidea spp.)[24,25] both within and outside of China. The BRI is likely to increase connectivity along existing IWT routes, including for species used in TCM such as pangolins (Manidae spp.) along the BRI's Maritime Silk Road between Indonesia and Southern China , and saiga (*Saiga tartarica*) horn from Central Asia to Singapore[27]. Few of these risks have been explored in any detail, but the China-Pakistan corridor has been noted as likely to increase illegal trade of large carnivores to Southeast Asia, including for use in medicinal products[28].

Although increasing pressure on existing resources can be predicted to some degree, the expansion of harvesting to new areas and even new species presents a novel and unknown threat that is more difficult to plan for. The emergence of a trade in bones from captive lions in South Africa to substitute for tiger bone in health tonics was unexpected[29].The ensuing strong response against the use of captive lion bones has the potential to back-fire and lead to increased illegal hunting of large felids worldwide, including jaguars and wild lions.

Chinese pharmaceutical companies plan to shift some of their sourcing and production closer to new BRI consumer markets, to reduce shipping costs and increase the volume of supply[6]. As Convention on International Trade in Endangered Species of Wild Fauna and

Flora (CITES) regulations only apply to international trade, there will be no CITES oversight of the sustainability and legality of trade where sourcing and supply are within the same country. Although this may streamline supply-chains, there is also the risk that harvesting of target species will not be adequately regulated by domestic laws in different BRI countries, especially if trade in that species has not been a threat in the past. In other contexts this has already been demonstrated, such as in the case of sea cucumbers, the demand for which increased too rapidly for effective management responses to be implemented concurrently in many places[24].

One factor that may reduce the risk of new unregulated supply-chains developing for these species is the importance of geographical origin to TCM practitioners and consumers, linked to the notion of 'daodi' of TCM ingredients. Daodi is a Chinese concept that links place of origin to the quality of the final medicinal product, meaning that an ingredient derived from the same species may be judged to be of higher quality if it is sourced in a certain place in its native range, compared to elsewhere [30]. Whilst several TCM species cultivated in Europe and the USA are still judged to be of good quality by TCM practitioners[31] the role of daodi should be carefully considered when assessing the likely risks and opportunities for species outside of China. In addition, the risk of increased harvesting for daodi species within China itself should be considered, as consumers in BRI countries may show preferences for these products even when locally-sourced alternatives are available.

Existing examples of TCM use outside of China, such as in Tanzania and Malaysia, have illustrated that these markets can be extremely heterogenous, focusing on different forms of medicine and specific products tailored to local contexts[8,11]. In Cameroon, TCM and local traditional medicine are sometimes combined, and medicinal plant research has been carried out by joint Cameroonian-Chinese teams[9]. It is therefore possible that in these situations, local species may be incorporated into treatments, either as substitutes for TCM ingredients that are not accessible, perhaps due to CITES, or as novel ingredients. The risks of this occurring are complex and difficult to predict, especially as many TCM treatments have their origins in Chinese traditional medicines that have been developed over thousands of years. Studies of other Asian traditional medicines, such as Tibetan medicine, have shown that practitioners readily adapt treatments to include local plants, both related and unrelated to the original ingredient[32]. For TCM, even when entirely new ingredients may be unlikely to be incorporated easily into official and endorsed treatments, local species that are very similar to well-established ingredients could be used as substitutes more readily in informal or illegal markets. This may be especially likely in cases where demand outstrips legal supply, as has happened with the use of African pangolin scales as a substitute for those from the Asian species[33]. This could mean that specific threats will vary between different BRI countries and species, complicating risk assessments, and requiring a careful evaluation of potential biodiversity conservation impacts in different contexts.

Opportunities for greening BRI-TCM

While they raise considerable risks, expanding TCM markets may also represent an opportunity for scaling up sustainable development that could bring real benefits to BRI countries, and in particular rural harvesters. While not possible in every case, many TCM products are based on wild ingredients that could be sourced sustainably or replaced with sustainable alternative products. Countries in the BRI have both diverse environmental conditions and specific local capacities, as well as forms of expertise that would suit different potential sustainability solutions. In some cases, wild-harvesting can be carried out sustainably, and can offer multiple benefits, including engaging local communities in management, and incentivizing conservation of species' habitats. For example, in the case of the high-value TCM trade in caterpillar fungus (*Ophiocordyceps sinensis)*, sustainable wild-harvesting has been shown to be challenging to achieve[34], although there is broad agreement that strong national, sub-national or community-based management is a key step towards sustainability[35,36]. Use of rigorous standards in TCM supply chains may promote sustainability, such as the internationally recognized FairWild Standard, which has already been applied to the harvest of wild plants used in TCM, including Southern schisandra (*Schisandra sphenanthera*) in China[37]. For this species, even before certification, the formation of a village cooperative to manage the trade led to increased yields, and engagement with TCM companies from the start ensured that there was a stable market for the product[37]. Despite past successes, careful assessments must take place in order to determine whether wild-harvesting is suitable for a species within its governance context[38]. However, for TCM, efforts so far to assess wild-sourced plant ingredients have concluded that several important species, such as eleuthero (*Eleutherococcus senticosus*) and Mongolian dandelion (*Taraxacum mongolicum*)*,* could be harvested sustainably on a commercial scale if appropriate standards were applied[39]. Other examples include saiga harvesting, which is also potentially sustainable and could provide income to rural people in Kazakhstan ; sustainable use is a long-term goal of the species' range states[41].

Where wild-harvesting is not viable, farming or other ex-situ production may be an option. For example, wild-harvest of certain species used in TCM may be prohibited by law whereas farmed products of the same species may be legal to trade. This includes CITES Appendix I species traded internationally, as well as some captive-bred species such as lions and bears, which are traded in legal domestic markets in certain countries. There are also TCM species where the sustainability of commercial-scale wild-harvest is unknown or unlikely, including many orchids such as tianma (*Gastrodia elata)*[22]*.* Farming to produce TCM ingredients has been taking place for decades in China, and takes many forms, from the captive breeding of animals such as musk deer[19], to large-scale cultivation and semi-wild cultivation of *Dendrobium* orchids[22]. Whilst farming may be able to supply large volumes of TCM ingredients, there are several issues that must be considered before farming is used as

a sustainability strategy. For example, farming may shift benefits of trade away from poor rural communities to wealthier people who own land and infrastructure, and in plant examples it has been shown to increase wild-harvesting where founder-stock is needed to establish a farm[42]. Whilst there is very little clear evidence linking farming with either increases or decreases in illegal harvest of wild populations for most species, it has been proposed as a risk and further research into these links is needed for different species and local contexts. Further, the farming of animals to supply TCM markets is often controversial due to concerns about animal welfare[43].

Finally, in some cases, neither farming nor wild-harvest may be possible on a commercial scale. This may include threatened species that are currently difficult to breed in captivity or for which farming is unlikely to be feasible such as pangolins[44], or those for which farming is banned, as in the case of the bear bile trade, where legal farming exists in China but is being phased out in Laos, Vietnam and South Korea[45]. In these cases, where it is not possible to source a product legally and sustainably, there may be opportunities to identify sustainable alternative ingredients. This may include the use of products from domesticated species, which may either already be recognized within the TCM pharmacopeia (e.g. water buffalo horn rather than rhino or saiga horn[46]), or which could be identified based on analysis of their shared properties with threatened TCM species (e.g. similar protein content[47]). Whatever the source, any potential alternative ingredients should be identified carefully, in collaboration with TCM experts, and with consideration of how likely consumers and practitioners will be to use them.

A strategy for sustainability

With the first BRI phase due to be completed in 2020, there is now a critical, but short-term, window of opportunity to implement strategies to mitigate the potential negative effects on biodiversity, and turn them into opportunities for sustainable development. However, considering the diversity of different potential approaches to sustainable TCM supply-chains, it is clear that careful planning is needed to ensure that they fit specific species and local contexts. In particular, attention must be paid to the strength of governance, as this may undermine efforts to promote sustainability. We propose a four-step approach to developing robust sustainability strategies for BRI-TCM markets (Fig. 1).

Figure 1. Four step approach to evidence-based sustainability strategies for BRI-TCM development, illustrated with examples of key species that are likely to be involved in these discussions, either because they are currently in IWT, are likely to become threatened if unsustainable TCM trade increases, because they could act as a substitute product, or because they represent an opportunity for sustainable use (clockwise from top left: *Dendrobium* orchid, saiga antelope, Indian pangolin, water buffalo, Southern schisandra, caterpillar fungus, tianma, and white rhino).

Image sources: A and G: A. Hinsley; B: Andrey Giljov and Karina Karenina; F: William Rafti; all others public domain.

Our approach could be applied to specific taxonomic groups across national borders, or focus on all TCM species within a country or region. Whatever the framing, the approach at each step should be based on robust scientific research, as well as collaboration across sectors and disciplines. This will allow the development of evidence-based sustainability strategies that are tailored to real-world situations. It will also allow strategies to be based on current best practice in sustainable wild-harvesting, farming, or propagation, focusing on those approaches that contribute to local livelihoods and provide important economic benefits.

For instance, Nepal is a key BRI country with potential risks from BRI-TCM due to existing high levels of harvesting of multiple species for TCM trade[23,48]. However, opportunities for

the development of sustainable medicinal trade are great, and similar initiatives have been welcomed by the Nepali authorities[49], partly due to the significant development benefits they present for harvesters in rural areas, who are disproportionately poor and marginalized compared to the general population[50]. Determining the best ways to develop sustainable BRI-TCM trade in Nepal using our four steps would require data on the current, and potential future patterns of TCM supply and demand, as well as the legal frameworks that regulate harvest and trade of different species. This could be obtained from the literature on current TCM trade in Nepal, from trade and seizure databases, and through engagement with key stakeholders including governments, NGOs and other experts in Nepal and China, and Community Forest Users Groups in rural areas of Nepal where TCM products are currently harvested. Through an evidence-based and expert elicitation approach, it is possible to sort species and areas into three categories; those that are already threatened by harvest; those that would be at-risk if demand increased; and those that represent the best opportunities for sustainable use. These lists would then be used to prioritize species and areas for further action in Steps 2-4, particularly to develop sustainable-sourcing guidelines in collaboration with the TCM private sector, and inform management decisions for specific species in Nepal.

Our proposed approach is highly collaborative and involves cross-border cooperation, which, as the architect of the BRI, China is in a unique position to lead on, further demonstrating its commitment to green BRI development[17]. This is especially important as, after years of receiving criticism from the international community for its environmental issues, China is showing increasing domestic policy commitments to sustainable economic development, as part of its ecological civilization plan[16]. Suggestions that the BRI will be used to 'outsource' unsustainable or environmentally damaging practices to other countries have been made[15], and there are calls for all BRI projects and policies to be regulated in the same way as domestic development[16]. As China prepares to host the 15th Conference of Parties to the Convention on Biological Diversity in Kunming in October 2020, it has the opportunity to use the expansion of TCM markets as a flagship project to demonstrate its commitment to ensuring ecological civilization principles are applied on a global scale, and position itself as a global leader in sustainable development.

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Competing Interests statement

The authors declare no competing interests.

Author contributions

AH and TML came up with the initial idea, which was refined in discussions with all other authors. AH drafted the first version of the manuscript, which was then edited and revised with input from all authors. TML produced the figure. with input from all authors. All authors approved the final version.