Awareness of the Convention on Biological Diversity and provisions regarding access and benefit sharing among multiple stakeholder groups in Bhutan

Sonam Wangyel Wang, Woo Kyun Lee, Jeremy Brooks and Chencho Dorji

Abstract As part of the Convention on Biological Diversity (CBD), the Nagoya Protocol on Access and Benefit Sharing calls for 'fair and equitable sharing of benefits' derived from the use of genetic resources and traditional knowledge. However, implementation of the Convention and the Nagoya Protocol has been challenged by the inadequacies of existing policies, lack of national-level frameworks, and inadequate knowledge among stakeholders. We used focus group meetings and structured interviews with rural communities, government representatives, researchers and Members of Parliament in Bhutan to collect data on awareness, knowledge and perceptions of components of the CBD related to access and benefit sharing. Our study indicated generally low levels of awareness about most components of the Convention, particularly among rural residents. Although local people in rural communities feel that benefits derived from local biological resources and traditional knowledge should be shared, there is uncertainty about who owns these resources. These results indicate that there is an urgent need to develop educational and awareness programmes, using a variety of media, to target particular stakeholder groups, with emphasis on residents in rural communities. This could empower local communities to participate meaningfully in decision-making processes to develop Bhutan's national access and benefit sharing framework, and to allow them to benefit from the conservation and sustainable use of local resources.

Keywords Access and benefit sharing framework, awareness, Bhutan, biodiversity, CBD, Convention on Biological Diversity, Nagoya Protocol, natural resources

Supplementary material for this article is available at https://doi.org/10.1017/S0030605318000819

Sonam Wangyel Wang, Woo Kyun Lee* (Corresponding author) and Jeremy Brooks† Bhutan Institute of Himalayan Studies, Wang Simu, Meewang Gewog, Thimphu, Bhutan. E-mail leewk@korea.ac.kr

Chencho Dorji National Biodiversity Centre, Thimphu, Bhutan

*Also at: Division of Environmental Science and Ecological Engineering, Korea University, Seoul, Korea
†Also at: School of Environment and Natural Resources, Ohio State University, Columbus, Ohio, USA

Received 31 January 2018. Revision requested 14 February 2018. Accepted 16 May 2018. First published online 13 February 2019.

Introduction

Conservation and sustainable use of natural resources are increasingly urgent, especially for biodiversity-rich nations in South Asia (SAWTEE, 2006; Chettri & Sharma, 2016), where many people depend directly on biodiversity and ecosystem services for their livelihoods and well-being (Pant et al., 2012; Chettri & Sharma, 2016). Biodiversity loss and the degradation of ecosystem services affect communities in various ways (Rosendal, 2010; Mfunda et al., 2012; Davis et al., 2015). Usually, rural custodians of biological diversity lose access to resources and ecosystem services, whereas commercial interests benefit from exploiting biodiversity and the traditional knowledge of local peoples (Vernooy & Ruiz, 2013). Commercialization can result in inequitable distribution of benefits, such that local communities receive few or no benefits whereas more affluent business communities and more developed countries reap maximum benefits (Rosendal, 2010; Mfunda et al., 2012; West, 2012). Recognition of the disparity in the receipt of benefits has led to efforts to protect local communities and their traditional knowledge (Secretariat of the Convention on Biological Diversity, 2002), including the Convention on Biological Diversity (CBD; United Nations, 1992), which aims to conserve biodiversity and ensure sustainable use of biodiversity.

The Nagoya Protocol on Access and Benefit Sharing is a supplementary agreement to the Convention on Biological Diversity that is intended to address inequity (Greiber et al., 2012). The Protocol was adopted to facilitate the implementation of the third objective of the CBD (fair and equitable sharing of the benefits arising out of the utilization of genetic resources) by providing a strong compliance mechanism. The protocol aims to ensure that benefits from research and commercial use of genetic and biological resources and traditional knowledge are shared with the countries and communities from which the resources and knowledge originated. Under the Access and Benefit Sharing protocol, provider states shall facilitate access to genetic and biological resources and user states shall share benefits arising from fair and equitable use. Signatories to the Convention have unconditional rights over the genetic resources in their territories and, under the Convention, ownership rights ought to be with the local communities. These rights and privileges are established through provisions of prior informed consent and benefit sharing. The adoption of the Nagoya Protocol requires both user and

provider states to develop appropriate laws and regulatory access and benefit sharing frameworks.

Bhutan became a party to the CBD in 1995 to address concerns about biodiversity loss, and subsequently developed policies to strengthen biodiversity conservation, including the Forest and Nature Conservation Act 1995 and Biodiversity Act of Bhutan 2003 (MoA, 2003). Environmental conservation is embedded in Bhutan's governance, as one of the four pillars of the country's development philosophy, Gross National Happiness (Rinzin, 2006). In addition, Bhutan's Constitution requires the country to maintain at least 60% of its territory under forest cover in perpetuity. As a signatory to the CBD and the Nagoya Protocol, Bhutan is also required to establish laws and a national access and benefit sharing framework to implement the substantive obligations of the Convention.

However, commercial use of biological resources is the main concern for sustainable resource extraction in the country, and there is increasing concern about the unsustainable harvest of resources of high economic value, including the caterpillar fungus *Ophiocordyceps sinensis* and plant species of the genera *Fritillaria*, *Saussurea* and *Picrorhiza* (Wang, 2016). The unsustainable harvest of *O. sinensis* may be driven by illegal extraction by outsiders (Cannon et al., 2009), and likewise *bows* (a local term for a defect in wood that forms attractive grains) are often collected by skilled individuals from outside local communities, to craft into highly priced cups and bowls (SWW, pers. obs.).

Responsibility for Bhutan's biodiversity lies with the National Biodiversity Centre, under the Ministry of Agriculture and Forests. The National Biodiversity Centre implements the programmes of work for thematic areas such as agricultural biodiversity, biodiversity information management, access to genetic resources and benefit-sharing, the global strategy for plant conservation, invasive alien species and traditional knowledge. The Centre is also mandated to help the country meet the objectives of the CBD, in part by coordinating the implementation of biodiversity conservation and sustainable resource utilization programmes.

Bylaws are necessary for the sustainable use and development of resources. Article 7 of the Nagoya Protocol (Secretariat of the Convention on Biological Diversity, 2011, p. 7) notes that user states should act '. . .in accordance with the aim of ensuring that traditional knowledge associated with genetic resources that is held by Indigenous and local communities is accessed with the prior and informed consent or approval and involvement of these Indigenous and local communities, and that mutually agreed terms have been established.'

The development of a comprehensive access and benefits sharing framework requires awareness of the current system of access and user rights to biodiversity. The lack of knowledge and awareness of the general public has been noted as a major challenge for the successful implementation of the CBD (Chandra & Idrisova, 2011). However, no previous studies have ascertained the perceptions, practices and awareness levels of stakeholder groups in Bhutan. The absence of such information impedes informed decision-making, especially the development of a legal framework and action plans. Our primary goals are to (1) describe the perceptions and awareness levels of the CBD and components of the Convention (including the Nagoya Protocol on Access and Benefit Sharing, prior informed consent, and mutually agreed terms) amongst residents in rural communities, university and government researchers, and Members of Parliament in Bhutan; (2) identify needs for capacity building and awareness programmes to increase understanding of matters related to access and benefit sharing; and (3) offer recommendations for policy formulations related to the access and benefit sharing framework.

Study area

The study was conducted in 2016 in five of Bhutan's 202 *gewog*s (subdistricts): Dagala, Langthel, Lingshi, Lokchina and Soe (Fig. 1). These *gewog*s were selected to capture diversity in ecosystems and local communities. Bhutan has a diverse set of ecosystems, including subtropical forests, cool broadleaf and conifer forests, alpine meadows and glaciers. Langthel and Lokchina are characterized by lower elevation, subtropical, cool broadleaf and mixed conifer forests, whereas Dagala has more temperate ecosystems, with conifers, alpine meadows and snow. Lingshi and Soe are covered by alpine vegetation, snow and glaciers. These five subdistricts also include a variety of livelihood systems. Communities in the lower elevation subdistricts of Langthel and Lokchina depend mainly on paddy cultivation, potatoes and other cash crops, whereas at higher altitudes the communities of Dagala, Lingshi and Soe depend on livestock and yak herding, and also have access to *O. sinensis*, which fetches a high price in international markets.

Methods

Data collection, focus group discussions and interviews

Background information was collected by SWW, by reviewing documents related to the CBD, the Nagoya Protocol, and acts, rules and policies related to access and benefit sharing in Bhutan. We collected data from three stakeholder groups: (1) residents of rural communities in the five study *gewog*s, (2) Members of Parliament, who may ultimately shape the regulatory environment related to access to biodiversity, and (3) university and government researchers who communicate with local residents and policy makers.

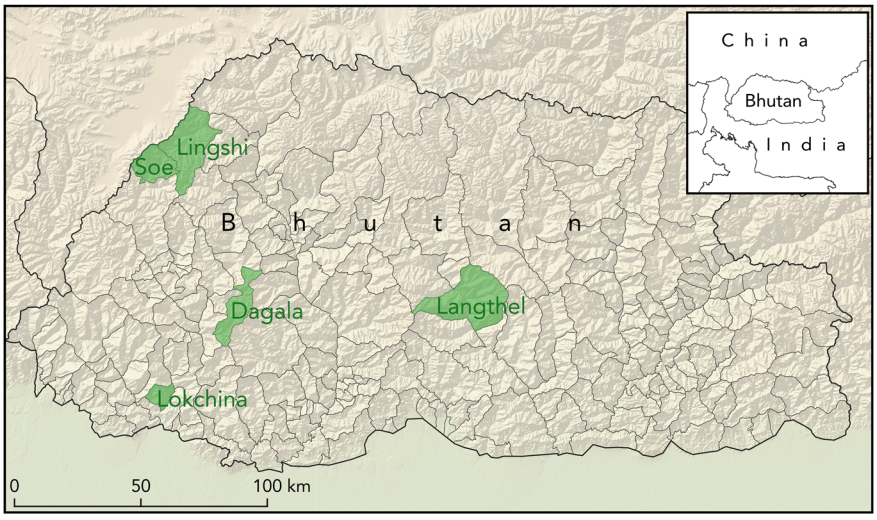

FIG. 1 Location of the five study *gewogs* in Bhutan.

We conducted focus group discussions and face-to-face interviews guided by a structured questionnaire (Supplementary Material 1). Anonymity was maintained by using household codes for each respondent. The mean duration of focus group discussions and interviews was c. 20 and 30 minutes, respectively. These were designed primarily to explain the purpose of the study and ensure common understanding of scientific terms. In addition, focus groups provided information on access and benefit sharing, the use of natural resources, traditional knowledge, and awareness of government policies and rules regarding local natural resource use. SWW and research assistants conducted one focus group discussion in each of the study *gewog*s and one with Members of Parliament. No focus group discussion was conducted with the researchers in the sample because they were well acquainted with the subject matter. Residents from each of the study *gewog*s were invited by the local government to attend focus group meetings, and it was requested that at least one member of each household attend (as is common for community meetings in Bhutan).

Focus group discussions were followed by face-to-face interviews. The questionnaire that guided the interviews included open-ended and fixed questions, and covered (1) demographic information (age, gender, education, occupation) and household socio-economic activities, (2) levels of awareness about biological diversity and user rights pertaining to biological and genetic resources and traditional knowledge, and (3) perceptions, awareness and expectations relating to access and benefit sharing, the Nagoya Protocol, the CBD, mutually agreed terms, and prior informed consent. Other information not directly relevant to this study was also collected. In each study *gewog* a sample of respondents who had attended a focus group meeting was selected randomly using the list of taxpayers obtained from the local government administration. A total of 321 community members (at least 30% of the participants from each *gewog*) participated in the study and this group included farmers (289), local business owners (22) and local government officials (10).

Sixteen Members of Parliament participated in the study. The Parliament of Bhutan consists of the King and a bicameral parliament composed of the upper house (the National Council) and the lower house (the National Assembly). The National Assembly is composed of 47 members elected by the citizens. The National Council is composed of one elected member from each *dzongkhag* (district) and five eminent members selected by the King. Members of Parliament from each of the five study *gewog*s and a random selection of 23 other Members of Parliament were invited to participate. Of the 28 invited, 16 participated, including the five from the study *gewog*s.

Forty-five researchers were selected randomly from relevant Ministries and Divisions in the Royal Government of Bhutan, and relevant colleges at the Royal University of Bhutan. Of the 45 researchers who were invited to participate, nine returned completed questionnaires (face-to-face interviews were not conducted with researchers).

In total, 346 respondents participated in the study (Table 1). Interviews were carried out by the authors, assisted by six trained enumerators.

Data analysis

Responses to most open-ended questions were coded as 'yes' or 'no'. This coding was done by two researchers to ensure accuracy when interpretation of responses was necessary. When coders disagreed, they discussed the response in question and reached an agreement on the correct coding category.

TABLE 1 Gender, age, and education level of participants in focus group discussions and interviews in a study to ascertain their awareness of the Convention on Biological Diversity and provisions for access and benefit sharing in Bhutan.

Variables	No. of farmers (%)[1]	No. of researchers (%)	No. of parliamentarians (%)	Total no. of respondents (%)
Gender				
Male	168 (52)	7 (78)	15 (94)	190 (55)
Female	153 (48)	2 (22)	1 (6)	156 (45)
Age				
≥ 40	167 (52)	1 (11)	5 (31)	173 (50)
< 40	154 (48)	8 (89)	11 (69)	173 (50)
Education				
None	213 (66)	0	0	213 (62)
Non-formal education	37 (12)	0	0	37 (11)
Primary	49 (15)	0	0	49 (14)
High school	18 (6)	0	0	18 (5)
College	3 (1)	3 (33)	7 (38)	13 (4)
Masters	1 (< 1)	3 (33)	8 (50)	12 (3)
PhD	0	3 (33)	1 (6)	4 (1)

[1]Includes rural respondents whose primary livelihood depends on agriculture and livestock, local government officials (farmers who were elected to serve in local government office), and local business owners.

Results

Demographic characteristics of respondents

Of the 346 study participants, 45% were women and 55% men (Table 1). The median age was 40 years. All respondents from the parliament and the research group had earned at least a college degree; however, the majority of respondents (72%) had no formal education and were illiterate.

Awareness and perceptions of biodiversity and genetic resources

Almost 69% of respondents believed that their locality was rich in biodiversity (Table 2). Generally, respondents attributed this richness to the effect of community forestry programmes (which they felt provide better quality wildlife habitat; n = 136), restrictions on shifting cultivation (n = 33), strict rules governing forest and nature conservation (n = 43), and forest conservation programmes (n = 20). Seventy-two per cent of all respondents indicated they did not know of any genetic resources or traditional knowledge from their locality that has been used for research or commercial purposes. Respondents from local governments (40%) and the parliament (44%) were more aware of such resources being used than farmers (27%) or business owners (18%).

Awareness and perceptions of access to biodiversity and benefit sharing

The majority of respondents (88%) believed that permission is needed from individuals or the community to take genetic or biological resources and/or traditional knowledge from their locality for research and development (Table 3). With respect to benefit sharing, respondents from all stakeholder groups agreed that the benefits from commercialization of genetic resources should be shared (Table 3). Eighty-nine per cent of respondents justified their agreement by noting that community resources are being used and therefore communities must have rights to benefits accruing from such resources. When asked who owns biological resources, 57% responded that the state owns them, followed by user groups (8%). Only 4% reported that local communities own genetic resources. A considerable proportion of the respondents (25%) had 'no idea' who owns genetic resources in Bhutan; the majority of these respondents were farmers and local business owners.

Awareness of the CBD and the Nagoya Protocol

Almost 40% of all respondents knew about the CBD. Parliamentarians were most knowledgeable and farmers were least knowledgeable about the Convention (Table 3). Many respondents (43%) mentioned that they learned about the CBD from the National Biodiversity Centre. Respondents also learned about the CBD from *gewog* (22%) and *dzongkhag* (17%) officials, and the media (18%). Although many respondents knew about the CBD, most were not aware of its objectives, and a majority (96% of farmers, 100% of business owners, 60% of local government officials and 50% of the researchers) did not know whether Bhutan was a member of the CBD. There was an even greater lack of awareness of the Nagoya Protocol. Only 8% of respondents had heard about it, 7% were aware of its purpose and 8% were aware that Bhutan is a signatory of the Protocol

TABLE 2 Percentage of responses to the question 'From your observation, how rich is your locality in terms of biodiversity?' in each stakeholder group in Bhutan.

Response	Farmers (289)	Business owners (22)	Local government officials (10)	Researchers (9)	Parliamentarians (16)
Rich	77.2	86.4	70.0	77.8	81.3
Poor	22.2	13.6	30.0	22.5	12.5
Don't know	0.3	0.0	0.0	0.0	6.2

TABLE 3 Percentage of respondents in each stakeholder group that responded 'yes' to each of the survey questions.

Question	Farmers (289)	Business owners (22)	Local government officials (10)	Researchers (9)	Parliamentarians (16)
Is permission required if someone wants to take genetic resources from your locality for research & development?	88	91	81	89	87
Are you aware of the CBD?	8	0	40	56	93
Are you aware of the objectives of the CBD?	3	0	30	56	94
Do you know that Bhutan is a member of the CBD?	4	0	40	50	100
Are you aware of the Nagoya Protocol?	1	0	20	78	88
Are you aware of the purpose of the Nagoya Protocol?	1	0	22	56	88
Are you aware that Bhutan is a party to the Nagoya Protocol?	2	0	20	67	88
Are you aware of access & benefit sharing?	3	5	20	78	81
Are you aware of prior informed consent?	11	9	20	67	53
Are you aware of mutually agreed terms?	8	9	10	56	53
Should benefits from resources or traditional knowledge be shared?	85	96	81	89	94
Do you think it is necessary to regulate access to genetic resources &/or associated traditional knowledge when it is used for research & commercial purposes?	92	100	90	100	93

(Table 3). More parliamentarians and researchers were knowledgeable about the Nagoya Protocol and its purpose than farmers or business owners (Table 3).

The majority of respondents (92%) were unaware of the term 'access and benefit sharing' (Table 3). Awareness was highest among Members of Parliament and researchers (Table 3) and was lowest among farmers and business owners. The majority of those who had heard about access and benefit sharing mentioned the National Biodiversity Centre as the source of information, with others reporting that the media and other outlets were their main sources. Similarly, few respondents had heard of prior informed consent or mutually agreed terms (11 and 8%, respectively; Table 3). Farmers and business owners were the least aware and parliamentarians most aware. Many researchers were unaware of mutually agreed terms.

Despite the low levels of awareness about prior informed consent and mutually agreed terms, a majority of the respondents agreed that permission is required if anyone wants to use genetic resources and/or associated traditional knowledge from their locality. From the range of communication choices for disseminating information on access and benefit sharing, meetings and workshops were the most preferred options, followed by video and radio. Farmers preferred meetings and workshops, whereas parliamentarians and researchers preferred video, probably because they have access to televisions.

Awareness and expectations of the national agencies responsible for access and benefit sharing

Respondents were asked to identify the competent authority for implementing access and benefit sharing and the CBD. The majority of respondents (89%), including 96% of farmers, 95% of business owners and 78% of local government officials, were unaware of the relevant authority. Similarly, most respondents did not know that the National Biodiversity Centre is the focal point for implementing access and benefit-sharing protocols, and were unaware of the enactment of the Biodiversity Act of Bhutan in 2003. In contrast, 88% of parliamentarians knew the competent authority for the CBD. The same proportion correctly identified the National Biodiversity Centre as the focal point for

implementing access and benefit-sharing protocols and were aware of the Biodiversity Act of Bhutan.

A large number of respondents (84%) indicated they would like workshops and meetings to increase awareness of access and benefit sharing. However, few respondents preferred training to improve their awareness or skills in identification and utilization of biological resources (17%). A large proportion of respondents (93%) supported the idea of having regulations to manage access to genetic resources and/or associated traditional knowledge when used for research and commercial purposes (Table 3). Even farmers who had little knowledge of access and benefit sharing supported regulation because it would control excessive extraction, which could jeopardize their livelihoods.

Discussion

This study was designed to establish a baseline for perceptions and levels of awareness of biodiversity and components of the Convention on Biological Diversity among key stakeholder groups in Bhutan. This baseline is important for identifying needs for awareness programmes and outlining policy recommendations. Without a basic understanding of levels of awareness and perceptions of these international agreements, Bhutanese policy makers may find it difficult to prevent citizens from being exploited.

Our first objective was to describe perceptions and levels of awareness of the CBD and its components. As a precursor to this, we ascertained that Bhutanese citizens believe that environments within and around their communities are rich in biodiversity. However, some respondents assessed biodiversity levels based on good forest cover and frequent sightings of a few species of wildlife rather than more reliable indicators. Regardless of the accuracy of respondents' perceptions, many Bhutanese residents have the sense that they are surrounded by rich biological and genetic resources, some of which may be of high value and of commercial or research interest. Thus, there is a general sense of the potential economic value of local biodiversity.

However, our findings indicate there is a lack of local-level knowledge and awareness about critical components of the CBD that are meant to safeguard communities against exploitation and the theft of resources and knowledge. Although many Members of Parliament and researchers were aware of the Nagoya Protocol, access and benefit sharing, and prior informed consent and mutually agreed terms, awareness levels were considerably lower among rural respondents. The CBD appears to be largely unknown among this group, and the majority of farmers, business owners and local government officials were unaware of its key components. The low level of awareness at the local government (*gewog*) level is a serious concern for future programmes on access and benefit sharing, as *gewogs* are the second most popular source of information on the CBD and access and benefit sharing. In addition, nearly half of the researchers surveyed were not aware that Bhutan is a member of the CBD, a matter that should be addressed by information campaigns developed by the National Biodiversity Centre.

The lack of awareness among local respondents may be a result of the high levels of illiteracy. Some studies have reported that low levels of education can hinder discussion about scientific concepts (Pant et al., 2012), which could include information on genetic resources and access and benefit sharing. Efforts to increase knowledge, awareness and a sense of empowerment in local communities will need to be tailored for illiterate residents.

Most respondents, especially from rural communities, suggested that genetic or biological resources had not been extracted from their locality. This finding seems to suggest that exploitative use of resources is not a problem. However, at least 40% of respondents from local governments and the parliament were aware of the use of resources or traditional knowledge. This suggests that there is the potential for exploitation, which is likely to increase as Bhutan's economy becomes more globally integrated (ITC, 2014). It would be preferable to address the issue prior to any exploitation, and Bhutan has a history of acting preemptively to protect biodiversity and natural resources before they become overexploited, as evidenced by its biodiversity action plans (e.g. MoA, 2003) and the constitutional provision for maintaining forest cover.

There was also a sense that access to biological and genetic resources requires local permission and that benefits from the use of local resources should be shared with local communities. However, there was confusion about who owns such resources. Although the majority of respondents of all types felt that permission was required for use of resources or knowledge, over half of respondents believed the state owned such resources. This disparity is problematic if it leads to uncertainty about whether local users, local governments or the national government have the authority to grant permission for access (Nijar, 2011). It is also of concern that 19% of local government officials felt that permission was not required. This finding points to the need for increased awareness among leaders who should be protecting local livelihoods and may be susceptible to exploitation from outside interests. There is an extensive literature on the promise and perils of community-based natural resource management (e.g. Blaikie, 2006; Ribot et al., 2006; Larson & Soto, 2008), including studies in Bhutan (Brooks & Tshering, 2010). This literature notes the challenges that emerge when communities defer to the national government (Brooks & Tshering, 2010), and how insecure tenure over land and resources can lead to the exploitation of local communities (Larson & Soto, 2008). There are currently no specific rules and regulations that require

community permission for access to resources for research and development. Although such regulations are required by the CBD, most countries are still in the process of developing such rules. The Biodiversity Act of Bhutan (2003) requires merely that communities be consulted about the extraction and commercialization of resources.

Our second objective was to identify needs for capacity building and awareness programmes. We recommend that Bhutan's access and benefit sharing framework should include workshops, training and inclusive participation of local people in local resource management and policy formulation. Local respondents indicated that meetings and workshops were their preferred method for raising awareness about the CBD, access and benefit sharing, prior informed consent, and mutually agreed terms. Face-to-face interactions through meetings and workshops are likely to be the most effective means of communication when the target group is illiterate. Television programmes can also be effective for information sharing, but televisions are an expensive luxury for many farmers. Mobile phones could also be used for sharing information because they have excellent reach in rural villages in Bhutan, and there is evidence that mobile technologies and messaging services can increase environmental awareness (Uzunboylu et al., 2009). Although evidence of the effect of mobile technologies on environmental awareness come from studies in degraded environments, such an approach could be modified to increase awareness of policies and appropriate actions with regards to biodiversity and resource extraction. Increased knowledge and awareness may also empower local community members, which has been found to be important for successful local resource management and community-based conservation (Brooks et al., 2012).

We sought to use this study to make policy recommendations. The majority of participants who were aware of the CBD and access and benefit sharing mentioned the National Biodiversity Centre as their information source. As such, we recommend that the National Biodiversity Centre develop and deliver programmes that increase the general awareness and knowledge of access and benefit sharing for stakeholder groups. These programmes could be delivered through meetings, workshops, radio or mobile technologies, and should be targeted to specific stakeholder groups. There should be an emphasis on educating local residents and members of local governments who may be particularly prone to exploitation, given their uncertainty and lack of awareness about ownership of resources. We also recommend that the Government of Bhutan and the National Biodiversity Centre develop an access and benefit sharing framework that regulates bioprospecting, provides guidance on access to, and conservation of, resources, and establishes a simple mechanism for benefit sharing between local communities and commercial entities.

The shortcomings of this study include, firstly, the gender composition of the sample (45% female, 55% male), which is not reflective of Bhutan's national gender ratio (51% female, 49% male). This imbalance is attributable to there being fewer women in parliament (6% female). Secondly, the response rate amongst researchers was low, and therefore general conclusions about the perceptions of researchers in Bhutan should be treated with caution. Thirdly, the wording of the question 'Do you know Bhutan is a member of the Convention on Biological Diversity?' could lead participants (particularly highly educated participants who do not want to appear to lack knowledge) to answer 'yes' untruthfully. Many participants answered 'no', but the wording of this question could lead us to underestimate the lack of knowledge and awareness of the CBD, access and benefit sharing, and other components of policies, regulations and agreements aimed at protecting biodiversity in Bhutan. As such, there may be an even greater need for awareness campaigns than our study suggests.

This study highlights an important challenge to full and successful implementation of the Convention on Biological Diversity in Bhutan and, more specifically, to components related to access and benefit sharing. The low levels of awareness about many aspects of the Convention among farmers, businessmen and local government officials suggest that local communities are potentially at risk of exploitation. Greater knowledge and awareness of the CBD and access and benefit sharing, as well as clear recognition and a shared understanding of resource ownership, are pre-conditions for protecting the rights of communities and farmers in Bhutan. We recommend that the Bhutanese Government and National Biodiversity Centre develop programmes to ensure that these conditions are met.

Acknowledgements We thank the National Biodiversity Centre of Bhutan and Korea University's BK21+ and RS/GIS for supporting the study, and the survey enumerators for collecting data in remote areas.

Author contributions Study design and coordination, data analysis, writing: SWW; technical input: WKL; data analysis and interpretation and writing: JB; design and implementation of field survey: CD.

Conflicts of interest None.

Ethical standards This research complied with the *Oryx* Code of Conduct and the law of Bhutan.

References

Blaikie, P. (2006) Is small really beautiful? Community-based natural resource management in Malawi and Botswana. *World Development*, 34, 1942–1957.

Brooks, J.S. & Tshering, D. (2010) A respected central government and other obstacles to community-based management of the

matsutake mushroom in Bhutan. *Environmental Conservation*, 37, 336–346.

Brooks, J.S., Waylen, K.A. & Borgerhoff Mulder, M. (2012) How national context, project design, and local community characteristics influence success in community-based conservation projects. *Proceedings of the National Academy of Sciences of the United States of America*, 109, 21265–21270.

Cannon, P.F., Hywel-Jones, N.L., Maczey, N., Norbu, L., Tshitila, Samdup, T. & Lhendup, P. (2009) Steps towards sustainable harvest of *Ophiocordyceps sinensis* in Bhutan. *Biodiversity and Conservation*, 18, 2263–2281.

Chandra, A. & Idrisova, A. (2011) Convention on Biological Diversity: a review of national challenges and opportunities for implementation. *Biodiversity and Conservation*, 20, 3295–3316.

Chettri, N. & Sharma, E. (2016) Reconciling the mountain biodiversity conservation and human wellbeing: drivers of biodiversity loss and new approaches in the Hindu–Kush Himalayas. *Proceedings of the Indian National Science Academy*, 82, 53–73.

Davis, K., Smit, M.F., Kidd, M., Sharrock, S. & Allenstein, P. (2015) An access and benefit-sharing awareness survey for botanic gardens: are they prepared for the Nagoya Protocol? *South African Journal of Botany*, 98, 148–156.

Greiber, T., Moreno, S.P., Ahren, M., Carrasco, J.N, Kamau, E.C., Medgalia, J.C. et al. (2012) *An Explanatory Guide to the Nagoya Protocol on Access and Benefit-sharing*. IUCN, Gland, Switzerland.

ITC (International Trade Center) (2014) *Bhutan*. Http://www.intracen.org/country/Bhutan/Domestic-and-Foreign-Market-Access [accessed 11 october 2018].

Larson, A.M. & Soto, F. (2008) Decentralization of natural resource governance regimes. *Annual Review of Environment and Resources*, 33, 213–239.

Mfunda, I.M., Holmern, T. & Røskaft, E. (2012) Benefits and access to natural resources influence conservation perceptions and relationships between local people and other stakeholders: the case of the Serengeti ecosystem, Tanzania. *International Journal of Biodiversity and Conservation*, 4, 535–547.

MoA (Ministry of Agriculture) (2003) *Biodiversity Action Plan for Bhutan*. Keen Publishing, Bangkok, Thailand.

Nijar, G.S. (2011) *The Nagoya Protocol on Access and Benefit Sharing of Genetic Resources: Analysis and Implementation Options for Developing Countries*. Research Paper 36. The South Centre, Geneva, Switzerland. Https://www.southcentre.int/wp-content/uploads/2013/08/Ev_130201_GNjar1.pdf [accessed 6 August 2018].

Pant, K.P., Rasul, G., Chettri, N., Rai, K.R. & Sharma, E. (2012) *Value of Forest Ecosystem Services: A Quantitative Estimation from the Kangchenjunga Landscape in Eastern Nepal*. ICIMOD, Kathmandu, Nepal.

Ribot, J.C., Agrawal, A. & Larson, A.M. (2006) Recentralizing while decentralizing: how national governments reappropriate forest resources. *World Development*, 34, 1864–1886.

Rinzin, C. (2006) *On the Middle Path: The Social Basis for Sustainable Development in Bhutan*. Volume 352. Labor Grafimedia B.V., Utrecht, The Netherlands.

Rosendal, G.K. (2010) *Access to and Benefit Sharing of Genetic Resources in Cameroon*. Legal and Institutional Developments and Challenges. Fridtjof Nansen Institute, Lysaker, Norway. Https://www.fni.no/getfile.php/131915/Filer/Publikasjoner/FNI-R0810.pdf [accessed 12 November 2018].

Secretariat of the Convention on Biological Diversity (2002) *Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization*. United Nations Environmental Programme. Https://www.cbd.int/doc/publications/cbd-bonn-gdls-en.pdf [accessed 6 August 2018].

Secretariat of the Convention on Biological Diversity (2011) *The Nagoya Protocol on Access to Genetic Resources and Fair and Equitable Sharing of Benefits Arising from their Utilization*. United Nations Environmental Programme. Https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf [accessed 10 March 2016].

SAWTEE (South Asia Watch on Trade, Economics and Environment) (2006) *Access, Benefit Sharing and Prior Informed Consent: Legal Mechanisms in South Asia*. Modern Printing Press. Kathmandu, Nepal. Http://www.sawtee.org/publications/Book-6.pdf [accessed 6 August 2018].

United Nations (1992) *Convention on Biological Diversity*. Https://www.cbd.int/doc/legal/cbd-en.pdf [accessed 6 August 2018].

Uzunboylu, H., Cavus, N. & Ercag, E. (2009) Using mobile learning to increase environmental awareness. *Computers & Education*, 52, 381–389.

Vernooy, R. & Ruiz, M. (2013) Access to and benefit sharing of plant genetic resources: novel field experiences to inform policy. *Resources*, 2, 96–113.

Wang, S. (2016) *Assessment of Biodiversity and Socio-Economic Conditions across Conservation Landscapes in Bhutan*. United Nations Development Programme Bhutan, Thimphu, Bhutan.

West, S. (2012) Institutionalised exclusion: the political economy of benefit sharing and intellectual property. *Law Environment & Development Journal*, 8, 21–42.