Indigenous Peoples' Views on Climate Change and Their Experiences, Coping and Adaptation Strategies in South Asia: A Review

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Abstract Climate change is a global issue that affects everyone. According to Amnesty International, nearly 370 million indigenous peoples live in more than 90 countries and account for 5% of the world's population. Because of their close contact with the environment, they have an extensive understanding and knowledge of local climate conditions. Understanding how indigenous peoples perceive and interpret climate change and how they cope with the negative impacts of climate change is critical to formulating sustainable strategies for these local communities. Yet, there is a large gap in understanding climate change perceptions, especially among indigenous peoples around the world. Therefore, this chapter reviews some existing kinds of literature on indigenous peoples' views on climate change and explores their coping and adaptation strategies, especially for those living in South Asian countries. In addition, this chapter also discusses how indigenous peoples predict various climatic events in their own ways. Finally, in this chapter, we have outlined why it is important for the well-being of indigenous peoples and their resilience to climate change to integrate local or traditional knowledge and experiences into the mainstream scientific understanding of climate change. We found that while different indigenous groups perceive climate change differently, there is some agreement, particularly regarding changing patterns of temperature and precipitation. Local ways of understanding climate events ultimately make them aware of climate change adaptation strategies. We also found that indigenous experiences should be prioritized at the policy level to ensure sustainable development for local communities. The United Nations Sustainable Development Goal (SDG) highlights the need to take urgent

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action to address climate change and its impacts (SDG 13 or Goal 13) and suggests developing policies, plans, and strategies at the national level that include action on climate change (13.2) and prioritize local and marginalized communities, as well as women and youth (13.b). If we are to meet the requirements of the SDGs, the voices, experiences, and knowledge of indigenous peoples should be considered as part of a fair and effective participatory approach. This review study has the potential to encourage a wide range of stakeholders and policymakers to take sustainable actions that link indigenous peoples' knowledge and experiences with mainstream scientific policy to reduce the impacts of climate change on local communities and address appropriate mitigation and adaptation strategies.

Keywords Perception · Climate change · Indigenous population · Indigenous knowledge · Coping/adaptation to climate change · South Asia

1 Introduction

Climate change is a reality and pressing issue that has already been witnessed by natural and human systems (Braman et al., 2010). Although all countries are facing climate change, it is of particular concern in South Asian countries given their increased vulnerability to climate-related hazards (Hussain et al., 2018). It also brings a vulnerability to different populations, sectors, and geographic regions in many ways (Füssel & Klein, 2006; IPCC, 2007; Watson et al., 1998). A great deal of climate change estimations is regional or national in scale, making it difficult to translate to the local level (Bridges & McClatchey, 2009). Forty percent of the world's naturally protected areas are home to indigenous populations, who are the most vulnerable to the damaging effects of climate change because of their close ties to nature (Garnett et al., 2018; Green & Raygorodetsky, 2010; IPCC, 2014; Lam et al., 2019; Makondo & Thomas, 2018; Salick & Ross, 2009). Indigenous peoples have a deep understanding of the natural rhythms and processes of their environment and are among the very first to face the direct and indirect impacts of climate change and have been coping with local climate variability for thousands of years (Ahmed & Haq, 2019; Vogt et al., 2002). Although they have limited resources and few opportunities to cope with or adapt to the changing climate through their local knowledge, such knowledge plays a critical role in addressing climate change adaptation and mitigation strategies (Rahman & Alam, 2016). It is also argued that indigenous communities are better able to respond successfully to climate change, upholding their knowledge may be more useful in climate change assessments (Alexander et al., 2011; Nyong et al., 2007; Petheram et al., 2010; Sánchez-Cortés & Chavero, 2011; Turner & Clifton, 2009; Yeh et al., 2014). The Sustainable Development Goals (SDGs) adopted by the United Nations General Assembly include 17 specific goals and 169 targets, six of which include specific references to indigenous populations (Roy & Chakma, 2015). In recent times, the role of indigenous peoples and their knowledge systems in adapting to climate change has been increasingly recognized

in Intergovernmental Panel on Climate Change (IPCC) assessments and special reports (IPCC, 2014). In addition, the importance of indigenous peoples' observations of environmental changes, particularly those related to weather and climate, is also increasingly recognized in Western scientific pieces of literature (Green & Raygorodetsky, 2010).

In recent years, a great deal of research was conducted worldwide exploring local perceptions and knowledge in climate change (Macchi et al., 2014; McNamara & Prasad, 2014; McNamara & Westoby, 2011; Nehren et al., 2013). Some studies have also addressed indigenous peoples' views on climate change (Ahmed & Haq, 2019; Kent & Hannay, 2020). Local people's perceptions of climate change and indigenous coping mechanisms are key to shaping policy and decision-making. Therefore, understanding climate hazards from the perspective of local people and communities is necessary to increase their resilience to climate change (Kanwal et al., 2021). Understanding local views on climate change is key to assessing the feasibility of national and international adaptation programmes (Kim, 2011; Knight, 2016). Climate change adaptation measures will be no more than promises if they do not take into account the views of local people, who are the direct beneficiaries of the measures. This research understands the need of exploring perceptions of indigenous populations about climate change, coping, and adaptation strategies that can have implications for further research and disaster risk reduction policy.

The primary objective of this chapter is to understand how indigenous populations perceive climate change and its impacts and how they use their traditional knowledge to predict and adjust to different climate events. We choose selected countries of South Asia such as Bangladesh, India, Pakistan, Nepal and Sri Lanka to provide examples of traditional experiences and local strategies of indigenous populations. Before we conclude the chapter, we argue the importance of integrating indigenous knowledge into mainstream science of climate change adaptation and mitigation for sustainable development of indigenous communities. This chapter can be an effective reference tool for understanding indigenous peoples' perceptions of climate change and will make policy recommendations for adaptation and mitigation measures that incorporate indigenous peoples' experiences.

This chapter has been developed starting with the introduction. In the next section (Sect. 2), we briefly outline the methodology of the chapter. In Sect. 3, we present our results and discussions in different subsections. We reviewed how different indigenous communities perceive climate change (Sect. 3.1). The next section (Sect. 3.2) summarizes the different indigenous methods used to predict and understand climate risk. Section 3.3 summarizes the different problems identified by indigenous communities and their suggestions for overcoming these problems. The next subsection (3.4) shows how indigenous knowledge contributes to climate change coping and adaptation in our selected South Asian countries. In the final sub-section of the results and debates Sect. (3.5), we then attempt to argue why it is important to integrate indigenous knowledge into the scientific knowledge and understanding of climate change adaptation and mitigation policies. Finally, we conclude the chapter with some limitations and recommendations for further studies (Sect. 4).

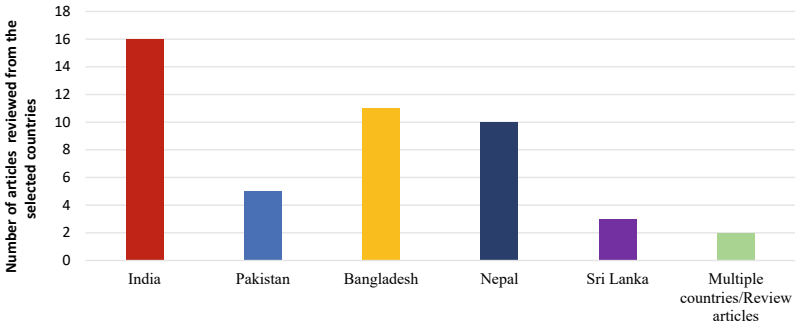

Fig. 1 Number of reviewed articles by countries

2 Methodology

We reviewed journal articles published in various databases (e.g., Web of Science, PubMed, Scopus and Google Scholar). The search technique aimed to find peer-reviewed literature that dealt with the perception of climate change and indigenous people's perception of climate change. Our literature search was limited to journal articles published only in English, between 1900 and 2021. Initially, we found 308 available literature pieces based on our inclusion criteria. We then searched again for available literature in the period between these years in some specific South Asian countries such as Bangladesh, India, Pakistan, Nepal and Sri Lanka. After specifying these requirements, we found 51 available articles. We initially reviewed all abstracts of original peer-reviewed articles and checked whether they met our targeted geographic areas (Bangladesh, India, Pakistan, Nepal and Sri Lanka), population (indigenous or local) and focus of this chapter (climate change perceptions, indigenous coping/adaptation strategies, indigenous ways of understanding climate change, etc.). We noted that four articles did not perfectly fit our inclusion criteria and we, therefore, removed them from the final review. In the end, 47 articles were reviewed for the purpose of writing this chapter. Figure 1 shows the number of articles and their study context that we reviewed for this chapter.

3 Results and Discussion

Based on our reviewed articles, in this section, we separately discussed our results in various parts keeping the objectives and aims of this study in our consideration.

3.1 Indigenous People's Perception of Climate Change: Understandings and Experiences

Kanwal et al. (2021) examined indigenous peoples' perceptions of weather-related risks and the various techniques they use to mitigate these risks in semi-arid regions of India. They selected two districts as study areas, one from a drought-prone region (Bikaner) and the other from a flood-prone region (Kota). Regarding the experience with climatic events, a large number of participants (43.4%) from drought-prone areas responded that they had experienced major droughts in the past 10 years. In contrast, most participants (76.7%) from flood-prone areas had not experienced drought. Most participants from both drought- and flood-prone regions indicated that they had experienced rainfall anomalies in the past 10 years. Another study, conducted in India by Pandey et al. (2018), noted that respondents cited changes in temperature and precipitation and decrease in water quantity and quality as the most difficult environmental challenges. In recent years, most respondents observed an increase in local average and extreme temperatures. In addition, in the past, they observed that winter lasted from October to March, while now it lasts from November to February. The combination of increasing winter temperatures and changing precipitation patterns has led to a reduction in water availability. Shukla et al. (2016) found a similar result, where most respondents (85%) in India were aware of and experienced an increase in temperature.

Paudel et al. (2020) surveyed three ecological regions of Nepal (mountains, hills, and Tarai) and found that farmers' socioeconomic and agricultural characteristics directly influenced their perceptions of climate change. Temperature changes were the most commonly observed indicator of climate change in Nepal (99.2%). In addition, other indicators observed included changes in rainfall (98.9%), climate-related diseases and pests (96.8%), changes in vegetation types and diversity (96.0%), and frequency of drought (80.2%). The temperature change was the most strongly felt indicator in the mountain region, while farmers in the mountain and Tarai regions felt changes in precipitation the most. People in the mountain and hill regions generally observed the occurrence of drought, while it was slightly less noticeable in the Tarai region. Dangi et al. (2018) found that snowfall decreased and precipitation was less predictable in two mountainous regions of Nepal (Myagdi and Mustang) that he studied. Average minimum winter temperatures have increased, and in mountainous regions, shorter winters and less snowfall threaten the livelihoods of people who depend on freshwater.

In Bangladesh, Rahman and Alam (2016) investigated the climate change perceptions of three forest-dependent indigenous communities (Khasia, Tripura and Garo) and found that indigenous people reported changes in temperature and precipitation, landslides, soil erosion and flash floods, extreme cold and fog, and natural disasters as the most common climate events. A similar study conducted by Ahmed and Haq (2019) in Bangladesh found that both the Khasia and Tripura populations largely believe that temperatures are rising. However, in terms of precipitation, Khasia is

more likely to believe that it is decreasing (61.1%), while the majority of Tripura believes that it is increasing (45%).

Ali et al (2020) surveyed farmers' perceptions of climate change in Pakistan and observed that the majority of respondents perceived hot days (93%), extreme temperatures (68.9%), higher rainfall intensity (83.4%) and more flooding (91.2%) in their areas.

Although perceptions of climate change vary between indigenous communities, depending on their understanding and experiences, we have discovered some commonalities between indigenous tribes when it comes to changes in temperature and rainfall. The vast majority of indigenous peoples found that temperatures were increasing and rainfall was decreasing. They also reported that some climate events such as floods, droughts and other hazards are occurring more frequently than in the past, affecting the livelihoods of many indigenous peoples. Local knowledge of climate is undoubtedly very important among indigenous peoples who live close to nature and rely on natural resources for livelihood. As a result of their reliance on natural resources, they are also able to preserve their immediate environment for future generations. Therefore, policymakers need to attach great importance to the perceptions of indigenous peoples to develop effective policies to make these communities resilient to climate change.

3.2 Indigenous Ways of Forecasting Climatic Risks

Indigenous peoples have their traditional and distinctive ways of understanding and interpreting climatic events that are part of their cultural or spiritual beliefs and are transferred to the next generations. McCall (1988) and UNESCO (2009) have therefore argued that it is pointless and dangerous to separate indigenous knowledge from its socio-cultural context, as this can lead to inaccurate interpretation and exploitation of information. This section discusses how indigenous peoples identify various climate risks based on their traditional knowledge and interpretations. However, these methods are not scientific in all cases.

Kanwal et al. (2021) found that participants from India used various indigenous methods to detect climate events. The appearance of a large number of luminous butterflies predicted the approach of heavy rains in the region. The presence of large numbers of ants and termites also indicated such events. Respondents noted that during heavy rains, certain tree species, such as ficus and acacia, bloom and green especially profusely. Factors such as the direction of the wind, the movement of the stars, and the clouds all play a role in determining whether a location will receive a lot or a little rain. Another study by Inaotombi and Mahanta (2019) in northeastern India found that participants used their indigenous knowledge to predict various weather and climate variations. When a large group of Reticulitermes insects, a group of termites, emerge from the ground during the monsoon season, it indicates that rains will be delayed by a few days. When frogs croak from bodies of water for an extended

period in the evening, participants believe rain is on the way. Unusual spinning, such as making shorter and thicker webs, also predicts rain.

In Bangladesh, Irfanullah and Motaleb (2011) found several traditional methods of prediction and preparation used by indigenous groups. For example, high temperatures and humid conditions indicate increased rainfall, good *jhum* production indicates increased wild boar attacks, and fruiting bamboo indicates increased rat attacks. Extremely high *jhum* production was also cited as an indicator of severe cold and flooding in the following months. Interestingly, participants explained that ants climb up houses during hailstorms, while they only cross highways during cyclones or *kalboishakhi*; however, they do both during heavy rains.

3.3 Local Level Problems and Policy Priorities for Climate Change Adaptation

Farmers in the villages of Maharashtra, India, face the most difficult challenges due to lack of implementation of government policies, lack of trust in scientific warnings, poor infrastructure, and lack of irrigation and mechanical equipment. Adapting agriculture to climate change involves changes in agricultural management practices that can reduce the likelihood of crop failure and improve the socio-economic situation of farmers (Swami & Parthasarathy, 2020). A survey of people in the Western Himalayas in India found that it is difficult to obtain climate information at the local level due to the lack of weather stations. Respondents cited increased forest protection, stronger building structures, and the use of alternative energy sources as possible policy priorities for adaptation. In addition, most respondents cited lack of funding, lack of access to information, and lack of awareness or understanding as to the top three barriers to planning and implementing adaptation measures (Pandey et al., 2018).

Rayamajhi and Manandhar (2020) noted that changes in biophysical indicators varied; the most commonly reported were a decrease in grazing area, followed by a decrease in crop yields and faster snowmelt on pastures in Nepal. They suggested that migrant herders' perceptions provide an important basis for state knowledge in data-poor areas, which in turn helps develop adaptation and intervention strategies to ensure the sustainability of the migrant herder system in the Himalayas. Another study in Nepal by Dangi et al. (2018) suggested that the development of weather stations to collect temperature and precipitation data at specific times and places and the continued involvement of local people, scientists, and governments could help address the global problems of these innocent mountain communities. In their study, Paudel et al. (2019) suggested that better farmer education, supportive policies, and adaptive strategies that encourage collaboration with local communities as part of sustainable policies are appropriate ways to manage farmland in Nepal.

In this section, we found that local people are constantly faced with a variety of barriers and that there are numerous ways to improve their circumstances. It is difficult

to implement effective climate change adaptation strategies at the local level due to the lack of infrastructure, particularly the lack of weather stations, lack of accurate information, and lack of trust in scientific knowledge. Therefore, it is the primary responsibility of the respective authorities and policymakers to properly disseminate scientific information at the local level, gain their trust, and increase awareness of climate change adaptation and mitigation policies to help these communities become more resilient to climate change.

3.4 Indigenous Knowledge and Climate Change Coping/Adaptation: Examples of Selected Countries

Purcell (1998, p. 260) defines 'indigenous knowledge' as the historically grounded body of knowledge associated with the long-term adaptation of human groups to biophysical environments. Indigenous peoples use their traditional knowledge and actions to cope with the adverse effects of climate change. In this section, we describe how indigenous peoples are coping with and adapting to climate change based on their traditional knowledge and lessons learned from their own experiences. In our literature review, we have identified several important coping/adaptation mechanisms, which are summarized and presented in Table 1.

In Nepal, Dangi and colleagues (2018) found that the expansion and diversification of agricultural production, adoption of good land management techniques, and an increase in tree planting all indicate improvements in community farming practices. People are concerned about drought and declining tourism on their former migration routes but are willing to shorten the harvesting season, extend the growing season, increase the size of the Sarvasi forest, establish markets and sanitation facilities, and expand tourism activities during the dry season. In another study conducted in Nepal by Panta et al. (2020), participants identified extreme rainfall followed by unfavourable geographical conditions, deforestation, drought and wind as the most important factors contributing to soil erosion in maize fields. Although the vast majority of people did not take any measures to reduce erosion, there were indigenous practices such as postponing harvesting dates, improving drainage systems and minimizing the frequency of weeds. While; Uprety et al. (2017) observed that the local people of Nepal have created some adaptive livelihoods to adapt to climate and environmental changes. For example, increasing pest infestation has affected traditional farming practices. As a result, respondents are now using pesticides and wearing mosquito nets to protect themselves from mosquitoes, which previously did not exist in the region.

Taking into account various factors (climatic, socio-economic, institutional, water and infrastructure), Swami and Parthasarathy (2020) found that in India, fear of crop failure has led farmers to use contaminated water in various forms for irrigation. Farmers' awareness of climate variability and experience of crop failure in the previous season led them to adopt adaptation measures. Farmers have mostly

Table 1 Indigenous coping/adaptation techniques for agriculture and livelihood in South Asian countries

Country	Participants (N)	Coping/adaptation techniques	References
Bangladesh	Indigenous populations (93)	• Rainwater harvesting through digging pond and deeper well • Mulching/covering soil with litter • Changing planting time • Crop diversification • Homestead gardening • Handicraft's business • Livestock rearing	Rahman and Alam (2016)
	Indigenous populations (78)	• Crop diversification • Changes in planting and harvesting periods • Cultivating short-season crops • Running a grocery shop • Working as a tour guide • Handicraft's production	Ahmed and Haq (2019)
	General populations (120)	• Crop diversification • Homestead gardening • Change in planting and harvesting time • Application of Pesticides • Plantation in heap • Mulching • Floating Garden • Duck rearing • Cage Aquaculture	Anik and Khan (2012)
Nepal	Farmers (654)	• Shifting harvest times • Upgrading drainage • Minimizing the frequency of weed	Panta et al. (2020)
	General populations (42)	• Employing pesticides • Wearing mosquito nets	Uprety et al. (2017)
	General populations (64)	• Shorten the harvesting season • Extend the growing season • Increase the size of the forest • Create markets and sanitation facilities • Expand tourism activities	Dangi et al. (2018)
Pakistan	Farmers (386)	• Changes in cropping patterns • Changed in cropping activities • Changes in input applications • Changes in soil conservation • Changes in water conservation • Diversification of income	Ali et al. (2020)

(continued)

Table 1 (continued)

Country	Participants (N)	Coping/adaptation techniques	References
India	Farmers (180)	• Adjustments made in sowing time • Crop rotation throughout the season • Land area diversification • Mixed farming	Kanwal et al. (2021)
	Farmers (400)	• Short duration crops • Drought resistant varieties • Crop diversification • Using irrigations • Rising animals	Swami and Parthasarathy (2020)
	Indigenous populations (120)	• Crop diversification • Mixed cropping • Farming • Crop rotation • Agro-forestry/agro-production • Improved varieties etc	Meena et al. (2019)
Afghanistan, China, Bhutan, Nepal, Pakistan, and India	General populations (221)	• Livestock and agricultural diversification • Grow fruit trees on private land	Wu et al. (2014)

adopted short duration crops, drought-tolerant varieties and crop diversification in implementing different adaptation strategies. The results also indicate that the vast majority of farmers do not want to change the timing of sowing and harvesting and do not want to take out crop insurance; however, a large majority of farmers use irrigation and livestock as adaptation strategies to combat climate change. In semi-arid regions of India, Kanwal and colleagues (2021) have shown that local participants use various strategies to minimize losses from climate events such as adjustment of sowing dates, in-season crop rotation, crop diversification, mixed cropping, etc. Participants are now also adopting crop diversification strategies to cope with climate disasters. Similarly, Meena et al. (2019) in their study argued that indigenous communities in the high altitude Pangi Valley in the Indian Himalayas are not overly engaged in modern agricultural practices and rely on traditional or indigenous techniques such as crop diversification, mixed cropping, field cultivation, crop rotation, agroforestry/agroforestry, improved varieties, etc.

Wu and colleagues (2014) conducted a study in six Hindu Himalayan countries, Afghanistan, Bhutan, China, India, Nepal and Pakistan. They found that herders in Pakistan and Afghanistan move their large animals seasonally between low-lying winter pastures and alpine summer pastures while practicing agriculture and raising goats near their permanent lowland residence. These communities have diversified both livestock and agriculture as a risk management technique. Some families in Afghanistan, Nepal and Pakistan also cultivate fruit trees on private land. The pastoralist peoples of the Hindu Kush-Himalayan region have always used livestock

diversification as a form of 'insurance' against major disease outbreaks, as different domestic livestock species are not usually susceptible to the same pathogen.

A study by Rahman and Alam (2016) has shown that climate change has multiple impacts on the livelihoods of indigenous communities (*Khasia, Tripura and Garo*) in northeastern Bangladesh. The indigenous communities have developed several adaptation strategies based on local knowledge and modern tools and techniques including rainwater harvesting by digging ponds and deeper wells, mulching/soil mulching, changing the timing of planting, crop diversification, home gardening, handicrafts, animal husbandry, etc. Ahmed and Haq (2019) also found that the indigenous people of Bangladesh (*Khasia and Tripura*) are now adopting different techniques to cope with the negative impacts of climate change: diversifying crops, changing planting and harvesting dates, and growing short-lived crops. In addition, both Khasia and Tripura residents are engaged in various activities to generate additional income, such as running food shops, working as tour guides or producing various handicraft products.

In Pakistan, Ali et al. (2020) found that few farmers were able to adapt to climate change due to various barriers, although they were aware of the problems. 77% and 94% of farmers had changed their cropping patterns and production activities, respectively. Other adaptation techniques used by farmers include: changing the use of inputs (89%), soil conservation (92%), water conservation (90%) and income diversification (64%).

3.5 Integrating Indigenous Knowledge into Scientific Knowledge of Climate Change Adaptation/Mitigation Policies

In the field of climate change, indigenous knowledge is recognized as critical to understanding scientific knowledge, and it is, therefore, important to link scientific data and indigenous knowledge to better inform mitigation and adaptation measures (Chaudhary & Bawa, 2011; Nicols et al. 2004; Speranza et al., 2009). Moreover, integrating local knowledge into climate change policy can lead to the development of effective, cost-efficient and sustainable adaptation strategies (Baul & McDonald, 2015). However, Berkes (2008) argues that it is a false assumption that all traditional/indigenous practices are ecologically appropriate and sustainable in their current form. Therefore, local observations and interpretations should be used as a complement to the scientific community and policymakers, but should not replace scientific knowledge on climate change, as it has many limitations (Byg & Salick, 2009).

Traditional knowledge is one of the most important sources of information that can be used to plan adaptation to climate change at the household level. Improving the flow of available scientific information can facilitate the implementation of adaptation measures in the region, but traditional knowledge will continue to play an

important role in mitigating the impacts of climate change and helping to restore various ecosystem services. Therefore, to effectively use sustainable development and adaptation information, robust adaptation strategies and plans need to be integrated into top-down and bottom-up planning approaches (Pandey et al., 2018). Ali et al. (2020) also emphasizes the integration of indigenous knowledge and locally relevant adaptation strategies for the development of local and national adaptation policies. They suggest that involving indigenous peoples in the decision-making process can be achieved and will help in understanding constraints and opportunities at the local level. Rahman and Alam (2016) noted that climate change has multiple impacts on the livelihoods of indigenous communities and that local knowledge can be a good starting point for developing climate change adaptation and mitigation strategies. The new Agenda 2030 calls for urgent collective action to empower indigenous peoples to protect their rights, participate in decision-making and become active agents of change (Magni, 2017).

A key promise of the Sustainable Development Goal is that *no one will be left behind*. Goal 13 of the SDGs calls for urgent action to combat climate change and its impacts, where it specifically mentions the need to integrate climate action into national-level plans and policies (13.2), taking into account local marginalized communities, women and youth (13.b). Indigenous peoples also live in close contact with nature and rely on natural resources for their survival, and are therefore well informed about their immediate environment and its sustainable management. Therefore, to promote the protection, restoration and sustainable use of ecosystems (SDG 15), indigenous peoples' experiences and lessons learned can be integrated into scientific knowledge and this can help to develop better policies to help local communities better adapt to climate change.

Indigenous populations' understanding of changing climate conditions in different regions of the world shows that traditional knowledge, local observations and experiences are an important source of data for climate science, and scientists argue for the importance of integrating local knowledge into scientific evidence (Becken et al., 2013; Bridges & McClatchey, 2009; Byg & Salick, 2009; Chaudhary & Bawa, 2011; Ford et al., 2016; Hiwasaki et al., 2014; Nicolas et al., 2004; Turner & Clifton, 2009).

4 Conclusions and Recommendations

This study focuses on indigenous populations' views and experiences of climate change and how they are adapting to different coping and adaptation strategies. We found that changes in temperature and precipitation are the two most commonly observed indicators of how respondents interpret climate change issues. In addition, extreme cold and fog, landslides, soil erosion, flash floods and natural disasters were also reported as common climate events at the local level. In terms of coping with the adverse impacts of climate change, we found that indigenous populations use different coping and adaptation strategies based on their traditional knowledge. This local or traditional knowledge and experiences are transferred from a generation to

another and help them to reduce their vulnerability to climate change impacts as much as possible and to survive in harsh environments. However, the perceptions, experiences and coping or adaptation strategies of indigenous or local people may not be perfectly suited to all the challenges that climate change will bring. There is therefore an urgent need to validate their traditional knowledge and embed it in a scientific context. Appropriate research needs to be carried out to demonstrate that it can be applied in the current context (Wisner, 2009). Experts argue that a participatory approach is essential to successfully balance different knowledge systems and it is essential to ensure that all relevant stakeholders see it as equally valid, relevant and relevant (Magni, 2017).

Scientific knowledge, ideas and information must be shared with these local communities to make them more resilient to adverse climate conditions. Reliable information provides new avenues and ideas for adaptation planning and coping and adaptation strategies tend to increase as the flow of information on different livelihood strategies of households improves (Pandey et al., 2018). However, in the literature we reviewed, we found gaps in the flow of scientific information at the local level. Meteorological stations are rarely visible at the local level, which therefore makes it difficult for locals to access credible climate information. A major limitation of the study is that it focused on only a few specific South Asian countries (Bangladesh, India, Pakistan, Nepal and Sri Lanka). It is highly recommended that this type of research be carried out in other locations, especially developing countries, as they are more exposed to climate change risks than developed countries. Moreover, a comparative study between developed and developing countries will certainly pave the way to a better understanding of how different country contexts, cultural contexts, levels of information dissemination, indigenous populations' level of awareness of climate change issues and other factors combine to influence local populations' coping and adaptation strategies to climate change.

A recommendation is that all stakeholders, including indigenous peoples and local populations, should be involved in policy dialogue for the development of sustainable climate change adaptation and mitigation policies. Local knowledge, experiences and perspectives should be seriously considered and validated in scientific evidence. Local people are the main beneficiaries of these policies and programs. Therefore, without their voices being heard, these actions are less likely to bring positive changes to their communities. We, therefore, emphasize that climate change adaptation and mitigation measures should be developed through a bottom-up strategy (involving local people and their experiences) rather than a top-down approach by the government or the state (which often excludes the voices and experiences of local people).

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