Indigenous knowledge, climate change and transformations of Gwadar fishing community

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Received 12 June 2022
Revised 23 August 2022
Accepted 13 September 2022

Abstract

Purpose – This paper explores the indigenous climate knowledge (ICK) of the Gwadar fishing community in Pakistan. The main purpose of this paper is to explore the accuracy of ICK and how climatic change brings changes to it and the social lives of local fishers.

Design/methodology/approach – Qualitative research methods, including participant observation, in-depth interviews and oral histories, were used to collect the data.

Findings – Finding from this long fieldwork shows that this fishing community has a harmonious relationship with nature and local ecology. Their knowledge of local ecology enables them to have equal access to natural resources, sustainable resource management, disaster risk reduction and strong social organization on the coast of Gwadar. Recently their deep relationship with local ecology and sociocultural organization has been disturbed due to huge climate changes caused by human manipulation of the environment. Their ability to foresee climatic events has been reduced. They are finding it impossible to

Conflict of interest: The authors do not declare any conflict of interest.

Funding: There is no grant that supports this study.

Shakir Ullah collected field data, Abida Begum and Heesup Han collected the relevant literature and contributed to the first draft. Shakir Ullah and Usman Khan prepared and analyzed the data and produced the original final draft together. Abdullah Mohamed collected relevant literature for the revision and helped in preparing the revised version. All the authors reviewed and verified the submitted version of the manuscript.

International Journal of Climate Change Strategies and Management
Emerald Publishing Limited
1756-8692
DOI 10.1108/IJCCSM-06-2022-0069

estimate fish availability due to massive climate changes. Local communities are losing their traditional livelihoods and socioeconomic autonomy as a result of growing climate change. Climatic change adds to the existing poverty situation and increases political instability in the region.

Practical implications – The study suggests using the fishermen's valuable indigenous knowledge of local ecology, climate and its ties to local traditions, culture and resource management for a scientific understanding of climate change and marine resource management in Gwadar, Pakistan.

Originality/value – This is an ethnographic study based on a long term field work. Fishing community is passing through catastrophic climatic changes in the region. This community has been ignored by both government and researchers to record their problems and bring them to academia and media. Therefore, this study will help them raise their voices.

Keywords Indigenous climate knowledge, Fishers, Gwadar, Climate change, Livelihood

Paper type Research paper

Introduction

Khuda Bakhsh, a boat captain, enlightened me with his experience regarding fishing knowledge and timings during a casual conversation on the Eastern Beach (*Demi zar*) in *Gwadar*. For the past 45 years, he has been observing distinct star movements, local flora and fauna and wind movements. He argued:

> It is when we notice the specific movement of the stars and specific variations in wind directions, as well as changes in local flora and fauna, that we may discern distinct water conditions and decide whether or not to fish.

Gwadar's indigenous fishermen have established an intimate connection with the environment, making it culturally sensible or salient, encoding it linguistically and linking it to their sociocultural and economic lives. They have a keen understanding of their natural world using what some scholars refer to as traditional ecological knowledge (TEK) (Hernandez *et al.*, 2022). Furthermore, they have given names to plants, wind and stars to coordinate fishing activities and relate them to the natural habitat. It is not only to achieve successful local resource management but also to live a profitable and structured life on the Gwadar coast.

To deal with environmental challenges and climate catastrophes, the local community has always produced solutions based on their cognitive capacities, competence and locally informed skills. This locally informed knowledge is called indigenous technical knowledge (ITK), which generally refers to the indigenous knowledge that is evolved, generated and accumulated by the local community over the years of experience and knowledge (Grenier, 1998). ITK alludes to indigenous cultures' knowledge, skills, beliefs, value system, normative structures, behavioral patterns and practices at a certain time and location (Musimwa and Chapeyama, 1995; Grenier, 1998). This locally acquired cognitive knowledge is culturally appropriate, socially feasible and useful, allowing the natives to form close bonds and familiarity with their environment. The local population linguistically encodes numerous entities by naming plants and animals, including reptiles and mammals, for identification, preservation and use (Krech, 2005). If the indigenous people are compelled to stop developing, believing in and practicing ITK, the acquired treasure in the form of indigenous knowledge tends to vanish and the community's survival may be threatened in the years ahead. This illustrates how indigenous knowledge and survival tactics are beneficial to the natives' well-being and survival (Krech, 2005; Berkes, 1993; Carpenter *et al.*, 2001; Johannes, 1998).

Climate change's effects include increased temperatures, the extinction of animals, increasing sea levels, droughts, floods, diseases brought on by the heat and economic losses. The poorest and most disadvantaged populations in at-risk areas, including indigenous

peoples whose way of life depends on natural resources, are disproportionately impacted by climate change. Although they are not to blame for the changes and have no control over or means to mitigate them, increasing sea levels represent a threat to fishermen's livelihood and culture (Lazrus, 2009). However, indigenous peoples are also the world's frontline defenders against climate change (Chianese, 2016). It would be appropriate to highlight their environmental sensitivity, adaptive capacity and resilience, which are demonstrated by their capacity to change their behavior in response to changing climatic conditions, in addition to the fact that they are typically portrayed as poor and vulnerable to climate change victims (Hamanaka *et al.*, 2012). The knowledge of indigenous peoples can offer significant insights into the processes of observation, adaptation and mitigation of the effects of climate change (Chianese, 2016). The Kalasha people of Pakistan use a native knowledge called "Suri Jagek", which corresponds to "observing the sun", to forecast weather patterns, plan the crops to plant and rear cattle. Suri Jagek supports the neighborhood's capacity to adapt to changing weather patterns and maintain its communal lifestyle (UNHCR, 2020).

The resilience of the local population to climate variability and change can be increased as a result of community-based adaptation models. Effective adaptation techniques should attempt to secure subsistence farmers' well-being in the face of climatic changes, even though they have consistently used adaptive measures to some of these changes over the years (Somah, 2013). Adaptation is essential, especially for developing nations like Pakistan, where vulnerability is high since the climate is already changing to such a degree that it is of concern (Nhemachena and Hassan, 2007). Although mitigation strategies may be used, they will not be adequate to prevent changes in the global climate, which is why adaptation is so critical (Bizikova *et al.*, 2012). Additionally, the degree of climate change's negative effects depends on how many indigenous people can adapt; otherwise, the effects would be disastrous (Gbetibouo, 2008). From the postulations of Crate and Nuttall (2016), climate change is environmental colonialism since it primarily affects individuals who live close to nature – those who are most familiar with it and who, for example, experience droughts most severely. People who have historically been colonialism's victims are typically the ones who are most affected by climate change (El-Hinnawi, 1985). Leary *et al.* (2007) revealed that there was an overall adaptation deficit that is anticipated to grow as a result of climate change from region to region based on the findings of the Assessments of Impact and Adaptations to Climate Change. Every level, from the local to the global, will need to make adaptations and modifications to adapt to climate change (UNFCCC, 2007:29). Burton *et al.* (1998) assert that depending on the course of action adopted in response to the external threat, adaptation can take many various shapes. This means that the adaptation is gradual and short-term if it is done so before the threat and preventive if it is done so during the threat. In line with this, a reactive or corrective adaptation would be made if the action was conducted after the threat.

Perceptions of local climate fluctuations are closely related to their conviction of the significance and reality of climate change (Ali *et al.*, 2020; Al-Maliki *et al.*, 2022). One of the main reasons why people might not take measures to mitigate climate change or adapt accordingly has been noted as a lack of firsthand experience with potential consequences and adaptation of local measures toward combating climate change with most of the initiatives being borrowed from western cultures which in many instances may not be compatible with the local issues in developing countries (Ali *et al.*, 2020). Allison *et al.* (2005) inform that climate change can increase the likelihood that fishing days are lost to poor weather, the loss of nets, traps and long lines, damage to boats and shore infrastructure, the death rate among fishermen and the harm to coastal communities. However, people who directly experience climate change would be more concerned and motivated to continue with

sustainable lifestyles (González-Hernández *et al.*, 2022; Fierros-González and López-Feldman, 2021). However, it is crucial to understand that the observable effects of climate change give people a chance to increase their confidence in the reality of the phenomenon. Alternatively, prior beliefs may shape public perceptions through a process of motivated reasoning (Chimi *et al.*, 2022; Ali *et al.*, 2020). To properly organize the dissemination of contemporary scientific knowledge, it is also necessary to outline the indigenous knowledge and climatic concerns of the local population. Therefore, the goal of this study is to investigate fishers' perceptions of climate change using indigenous knowledge.

Indigenous peoples are more aware of changing climate dynamics, including changes in regional biodiversity, since their ontologies are strongly based on local ecosystems (Reyes-García *et al.*, 2022). Indigenous groups have, therefore, started building networks based on local epistemologies. These networks document events pertaining to wildlife, environmental health and climate change using indigenous knowledge. For instance, the Land Earth Observer network recognizes significant climate changes that affect local habitats, such as increasing local temperatures, fungal infection in smelt, declining fishing yields and infrastructure failure brought on by thawing permafrost. (Hernandez *et al.*, 2022; Johnson *et al.*, 2016; Mosites *et al.*, 2018). These networks operationalize TEK, making them more likely than western scientific methodologies to quickly identify tiny climatic changes (Moller *et al.*, 2004) and give indigenous peoples the warnings they need to take mitigation measures toward addressing issues raised by climate change.

Other attempts to mitigate climate change may also benefit from the information obtained through such networks (Hernandez *et al.*, 2022; Mosites *et al.*, 2018). If indigenous peoples are driven from their native homelands or alienated from ecological management, it might be more difficult to construct such networks. These networks support the use of indigenous epistemologies in natural resource management and the protection of indigenous land rights. The climate change narrative emphasizes the unavoidable relocations of many indigenous peoples, whereas networks support indigenous self-determination and cultural preservation. By using adaptation planning as a form of resistance that can aid indigenous peoples in preserving their native homelands and preventing them from being relocated to other lands away from their ancestral homes, indigenous forms of resistance work to refute these narratives (Goodyear-Ka 'ōpua, 2017). Globally, media attention to indigenous peoples' attempts to safeguard themselves and the environment was too fragmented to develop. Indigenous Peoples' Centre for Documentation, Research and Information (DOCIP) reaffirmed the connection between climate change and indigenous peoples' rights in its 2015 publication, noting that for many years, indigenous peoples have drawn this connection, taking the lead in its promotion [Indigenous Peoples' Centre for Documentation, Research and Information (DOCIP), 2015].

Scholars formerly believed that development experts equipped with contemporary scientific understanding could only protect the local population from the dreadful conditions of poverty, starvation and survival (Brokensha *et al.*, 1980; Chambers and Ghildyal, 1985; McCorkle, 1989; Sillitoe, 1998; Warren, 2003). However, development experts and policymakers' perspectives have recently altered, and they have begun to recognize the relevance of locally produced knowledge, particularly concerning community resilience, sustainability and climate change (Carpenter *et al.*, 2001; Johannes, 1998). According to different studies, interest in indigenous knowledge has risen dramatically in recent years. Researchers and scientists have begun to realize that the development goal cannot be met unless the knowledge, perceptions and cosmologies of the local people are properly considered. (Johannes, 1998; Berkes, 1993; Carpenter *et al.*, 2001; Couzin, 2007; Lauer and Aswani, 2009). It has been a test phenomenon that ITK in the context of fishing communities

includes fish habitats, fishing time, migration patterns of fishing, fishing methods, fish behavior, production and resource management (Musimwa and Chapeyama, 1995 Berkes,1993; Grenier, 1998; Dutta and Bhattacharjya, 2009; Vivekanandan, 2011; Aparna and Trivedi, 2011). Because of their over-dependence on fishing and fishing-related activities, this knowledge is considered a crucial part of their lives (Geetha *et al.*, 2015). These fishing communities make every effort to establish coping techniques to adapt to these ever-changing environmental conditions, keeping in mind the gravity of the issue. In this sense, they normally aim to track seasonal and spatial variation effectively in stocking fish while keeping climate fluctuation in mind. They frequently try to comprehend variations such as wind direction and speed, water waves, speed and velocity to create better predictions about fish distribution, spawning and abundance (Aparna and Trivedi, 2011; Salick and Ross, 2009).

Analyzing the Pakistani context, indigenous peoples are not acknowledged in the 1973 Pakistani Constitution, and the phrase "indigenous" is not used there. Therefore, there is no specific law to protect the rights and benefits of indigenous People. However, Article 1 of the Constitution and Articles 246 and 247 of the Constitution grant certain rights and privileges to the tribal people who reside in different portions of Pakistan. Under Articles 51 and 59, they are given political representation in Parliament. Despite Pakistan having ratified the ILO, national and provincial laws cannot be extended to the tribal areas without the President's approval. Indigenous and tribal populations are included in Convention 107. In the absence of any other legal framework protecting them, indigenous peoples can be categorized as Tribal Area Residents. The International Covenant on Economic, Social and Cultural Rights, the International Covenant on Civil and Political Rights, the International Covenant on Economic, Social and Cultural Rights, the Convention on the Rights of the Child and the International Convention on the Elimination of All Forms of Racial Discrimination are among the international human rights treaties and declarations that Pakistan has signed or ratified. In 2007, Pakistan cast a vote in favor of the UN Declaration on the Rights of Indigenous Peoples. ILO Convention 169 on Indigenous and Tribal Peoples, an update to ILO Convention 107, has not yet been ratified by Pakistan (Directorate of On-Farm Water Management, Government of Khyber Pakhtunkhwa, 2019).

The World Bank acknowledges that the lands on which indigenous peoples live and the natural resources they depend on are intrinsically linked to their identities and cultures. These unique circumstances expose indigenous peoples to various risks and levels of consequences from development initiatives, including exposure to disease, losing their identity, cultural distortion and denigration and traditional means of livelihood. Furthermore, there are complicated multigenerational and gender concerns affecting indigenous people. To ensure the reduction of poverty and sustainable development, indigenous peoples' human rights, economies and cultures must be respected, according to the World Bank's Operational Policy 4.10 on Indigenous Peoples (2013). Speaking at the 66th session of the UN meeting for the Economic and Social Council in March 2022, Pakistan's Minister for Human Rights, Shireen Mazari, stated that her country is committed to upholding its commitments to international obligations in the areas of disaster risk reduction, sustainable development and climate action and that it is also focusing on reforestation as part of its action plan to mitigate the effects of climate change (United Nations, 2022).

Due to a changing climate, Pakistan is significantly more vulnerable to extreme weather occurrences (Ajani and van der Geest, 2021; Elahi *et al.*, 2021; Malik *et al.*, 2012; ur-Rehman *et al.*, 2022). Pakistan was ranked eighth among nations affected by climate change, according to the global climate risk index (Abubakar, 2018; Siddiqui, 2022). Additionally,

forecasted climate change is likely to increase the frequency and severity of extreme occurrences (Arshad *et al.*, 2017; Babakholov *et al.*, 2022). As a result, there are clear repercussions for agriculture, and higher crop losses are anticipated, which would ultimately have an impact on Pakistan's economy (Chaudhry *et al.*, 2014; Shakoor *et al.*, 2011; Vozinaki *et al.*, 2015). Using indigenous knowledge is not a novel idea. Although it has been referenced and discussed in the literature, there is not much academic research on the topic of using indigenous knowledge to create more workable and sustainable climate policies (Turner and Clifton, 2009). Indigenous knowledge is the phrase used to describe the information that has been gathered through many generations and is mostly only available in oral form. It is derived from common rituals, experiences and stories that are strengthened by trial and error. Indigenous knowledge may not apply or be transferrable to other locations because it is comprehensive, integrative and located within the boundaries of cultural traditions that are predominantly local to a particular region (Ali *et al.*, 2020; Nawrotzki and Polina, 2010).

According to the Food Security Cluster (2016), extreme heat and drought have developed in Balochistan and some areas of Sindh, resulting in 37% of pregnant women and 26% of breastfeeding women being extremely malnourished. Similar to this, high malnutrition rates were discovered in the Thar Desert, which endured a severe drought from 2013 to 2015 (Kunbher *et al.*, 2017). In 2018, more than 500 children in Thar lost their lives due to conditions such as low birth weight, neonatal infection and birth asphyxia (Dawn, 2018). Thar's malnutrition, accompanying preterm births and low birth weight are blamed on crop failure brought on by climate change, which also reduced food security (Food Security Cluster, 2016). The Pakistan Government's climate change policy places a relatively greater emphasis on adaptation to actual and anticipated climate change impacts than on mitigation, recognizing that Pakistan contributes very little to global greenhouse gas (GHG) emissions and that climate change is already imposing significant economic and human expense (Government of Pakistan, 2013; Khan and Hussain, 2019). The size and urgency of the work call for efficient and effective techniques, but the government and other national stakeholders may run into some of the same difficulties that have been seen around the world while identifying and implementing these approaches. According to Martine and Schensul (2013), adaptation techniques have had significant drawbacks up to this point because they frequently lack a robust data foundation and tend to be reactive and post hoc.

In exploring farmers' adaptation to climate change in Pakistan, Abid *et al.* (2016) claimed that frequent insect assaults on conventional cotton types caused them to convert to genetically modified cotton cultivars. In response to an increase in the frequency of extreme maximum temperature events, they also showed an increased adoption of wheat species that can withstand heat. The adoption of crop varieties that were distinct from previously used varieties and efficient against the incidence of significant pest and insect attacks was another conventional strategy adopted by these farmers. Some farmers also switched from cotton to maize. Jamshid *et al.* (2019) qualitatively studied the forecasting and warning system developed by the locals to counter flooding in Khursheed village, Sargodha District in Pakistan, which has had a history of frequent floods for decades. The community is now more robust because it adopts traditional farming practices and building construction technologies. Their ability to withstand floods has improved due to their heightened spiritual level. According to Jamshid *et al.* (2019), the government should develop local disaster management policies that take into account both traditional and contemporary expertise.

To understand how important it is to impart contemporary scientific knowledge to the local community, Jamshid *et al.* (2019) merged local perceptions with indigenous knowledge.

According to their findings, climate change is the biggest environmental issue and scientists and the media are the two most reputable and effective channels for disseminating knowledge about it. Governments, corporations and business enterprises were thought to be very responsible for handling the issue of climate change, but farmers mistrust them. They noted some barriers to farmers' perceptions of climate change, such as financial constraints, high input costs and ignorance about potential adaptations. They advised that policymakers work more successfully with locals to address the climate change challenge, thus, creating the need to involve indigenous people in the decision-making process about local and national adaptation programs.

We propose, following Palsson's argument, that indigenous climate knowledge (ICK) is the result of a profound and centuries-old close link between the indigenous community and the environment (Pálsson, 1996). Palsson avers that the relationship between humans and the environment can be classified into three paradigms; orientalism (exploitation of nature and negative reciprocity); paternalism (protection of nature and balanced reciprocity); and finally, communalism (a concept that rejects the radical separation of nature and society and instead sees general reciprocity between human beings and the environment). In the context of the communalist paradigm, Pálsson (1996) clarifies that the interaction between humans and nature is figuratively conveyed through close personal relationships. Indigenous climatic knowledge reflects a communalist interaction between humans and the environment, and it might be claimed that the traditional Gwadar fishermen's relationship with their environment represents one of Palsson's communalist paradigms. This study found that Gwadar fishermen have a close link with the local ecosystem and environment, which has an impact on how they organize their life. We seek to argue that humans and their environment are inextricably linked and that ICK and community sociocultural organization and resource management/preservation are closely linked.

The sociocultural context in which ICK is practiced and promoted was explored. Because of the intimate and complicated interconnectedness between the environment and the cultural lives of fishermen, they cannot easily break the established relationships. Indigenous ecological knowledge, thus, serves not only to protect natural resources but also to organize social and cultural life in communities. We furthermore argue that indigenous ecological knowledge in Gwadar is systemic, relational and interdependent. Researchers have paid little attention to the coastal settlements of Balochistan, owing to the region's politically sensitive nature and a decade of political turmoil. We explore indigenous climatic knowledge, climate change and its effects on changing local cultural practices, resource management and scarcity in the Gwadar area using a case study. We conducted this research in the hopes of using the fishermen's valuable indigenous knowledge of local ecology, climate and its ties to local traditions, culture and resource management for a scientific understanding of climate change and marine resource management in Gwadar, Pakistan.

Gwadar and Balochistan are coastal areas that have relied heavily on the sea, sands and other coastal resources for ages (Ullah, 2020). Fishermen, the traditional occupiers of the coastal environment, have been almost completely excluded from the economic, social and political forces that have transformed the coastline, as Jamali (2013) points out, despite the major changes brought about by the ongoing development process on the Gwadar coast for decades (Jamali, 2013). As a result, it is fair to claim that the development process has harmed fishermen's natural environment, including the sea and the coast. When we consider the effects of massive urban development along the coast, the proliferation of recreational activities, the extraction of sand from the sea floor for regenerating beaches and the physical occupation of beaches that were previously the exclusive domain of fishermen with new hotels and other infrastructures, the invasion becomes complete. Climate and weather changes as a result of

human intervention have added to the slew of colonization agents that are already eroding the close bond between fishermen and the sea and eventually, the bond between humans and the environment. Another aspect that affects the relationship between fishermen and their environment cannot be overlooked. The importance of a fisherman's climate knowledge is increasingly being challenged by technological advancements in meteorology and satellite communication. Because everything now happens through radar, GPS and computers, the continuous conceptions of modernity, which are culturally meaningless, have killed everything from the perspective of physical contact that fishermen have with the world.

The same thing is happening in terms of traditional fishing techniques, with a new generation of electronic fish locating devices now available for use in even small fishing boats. According to our findings, local fishermen adopted such modernized techniques as a result of increased competition brought on by the influx of migrants to Gwadar, as well as other factors that compelled them to adopt harmful modernized techniques that resulted in environmental degradation and the invasion of infrastructure projects. All of this contributes to the erosion of the interaction between fishermen and their traditional habitat, or, as Valls (2007) puts it, fishermen's physical contact with the world. Working fishermen may still infer the approximate speed of the wind based on the appearance of the sea today (Valls, 2007). Traditional fishing methods are being phased out in favor of a greater reliance on modern fishing methods in the marine environment, which man has modified both via progress within the fishing process and by man-made environmental conditions. Fishermen now have more technology at their disposal, but they are also confronted with new environmental issues, particularly the shrinking amount of their catches. We saw that knowledge is being lost due to the deterioration of fishermen's cultural customs because such cultural traditions are inextricably linked to the region's ecological niches.

There are still some fishermen in the Gwadar group who are interested in preserving both the material and intangible cultural legacy, as well as traditional fishing. The data contained here was provided by these men. They are motivated to pass on the knowledge they received from their parents and grandparents, as well as through cultural rituals.

Indigenous knowledge is used by Gwadar fishermen to foresee changes in atmospheric conditions that affect not just their business but also their sociocultural existence. In the recent past, such knowledge was essential, but human manipulations on the Gwadar coast had a significant impact on it. Indigenous climatic knowledge is no longer passed down from generation to generation, not only because people have acquired alternative knowledge but also because they are part of a relationship with the environment that is being marginalized and lost. Many of today's young fishermen show no interest in learning this knowledge. However, in my fieldwork, I discovered some people are still interested in preserving this knowledge as part of their traditions and cultural heritage. Unlike those who are only interested in exploiting new technology, artisan fishermen are more cognizant of environmental issues, sustainable development and a less aggressive manner of fishing. They are also concerned about preserving their cultural heritage, which includes indigenous knowledge. The following examples were gathered from Gwadar fishermen through observation and interviews.

Methodology

This research is based on long-term fieldwork in Gwadar, Pakistan, a remote fishing town. The fieldwork was divided into three phases:

(1) a 35-day first visit in January 2020;

(2) a seven-month second visit in 2020; and

(3) a 105-day third visit in September 2020.

The study region was chosen for a variety of reasons. Traditional fishing groups have been living in the area for millennia, using traditional fishing techniques. Most traditional instruments, such as harpoons and arrows, traditional nets and a native wooden-made traditional boat known as the "Yakdar", are still used. They have their own culture, manner of life and sense of self. They give diverse sea and land areas names and safeguard them by believing that spiritual entities live there. Heavy rains, floods and sea storms have recently been reported in Balochistan's coastal areas. The Gwadar area has recently gained fame as a result of big projects, and the most significant of which is a Chinese-funded deep seaport project under the China–Pakistan Economic Corridor (a $62bn project) (Hussain, 2017; Rafiq, 2017). These and other elements are intricately intertwined in the production of climate change and its repercussions on livelihood. In preliminary studies, researchers discovered that unanticipated weather changes make it difficult for the fishing community to maintain their traditional livelihood.

We began by reviewing various published and unpublished materials relating to indigenous knowledge of weather and significant climate disruptions in Gwadar and Balochistan. About old stories, we consulted traditional religious literature and elder key informants. The elderly over the age of 80, who have traditional climatic expertise, were consulted. First and foremost, it was necessary to establish community trust with the researchers. Participant observation, interactive interviews, informal discussions, systematic observations and documentation from oral histories were all used to gather data. Oral histories were conducted with skilled fishermen and the community's most senior members, ranging in age from 40 to 50 for active fishermen and 60 to 70 for retired fishermen. Some of the interviews and oral histories were taped, and the data was analyzed and entered into a database. A voice recorder was used to ensure the fidelity of the interviews. Most of the interviews lasted 60–80 min. Oral informed consent was taken from all participants in the study. Participants were invited to be involved based on self-selection and personal interests to share information related to the topic. The research questions designed were not explicitly focused on ICK or change but on traditional fishers' deep connections with local ecology, cultural lives and how the climate change disturbances led to negative socioeconomic and cultural consequences.

We spent most of our time with local fishermen, taking part in cultural events like religious rituals, marriages and other community gatherings. The researcher also went on more than 30 fishing trips to the sea with local fishermen to see how fishing works according to the traditional weather calendar. The researchers traveled around the landscape with key informants to investigate diverse features of the environment and local customs' connections to the environment, such as singing, dancing and festivals. As an insider with a 10-year engagement with the community, the researcher had little trouble finding participants and involvement in community activities.

Indigenous knowledge of the climate of Gwadar fishermen

Following enormous development projects, this distant historical fishing town has altered dramatically. The fishing community's close ties to existing cultural geography and nature have had a significant impact on the established way of life and social organization, which has since dwindled. Ecological factors have a significant impact on the key cultural aspects of fishermen. Their social structure is inextricably linked to environmental factors and natural resources. Small-scale fishing has been a community-based profession on the Gwadar coast for generations; as a result, fishing activities and the influence of the coastal ecology are firmly embedded in the sociocultural milieu of the fishermen's community. It is common knowledge that the natural environment and resources have a significant impact

on social life and manner of life. The marine environment was close enough to small-scale fishermen on the Gwadar coast. This fishing community has evolved sophisticated rituals and traditions to keep them connected to nature while restricting access to essential natural resources. They maintain a link between a living organism and its inorganic environment through their deep understanding of the environment. There are two stages to the changes in climatic conditions over the course of the year. The first step is to identify the weather conditions using wind patterns and local flora and fauna. The second stage of the weather is determined by astrology and the identification of specific stars in the sky. Its appearance and disappearance dates in the sky are essential, as is how it influences fishermen's social and cultural lives, as well as the fishing profession itself.

Result and discussion

For decades, indigenous fishermen's knowledge of climate and weather has allowed them to live in harmony with their environment. Chianese (2016) recognized the contribution of indigenous people when they were described as the frontline defenders against climate change with the significant insights that they offer. The findings revealed that interviews with local fishermen on ICK go deeper into their profound ties to the local ecology, as well as their approaches to environmental conservation, disaster management and equal access to natural resources. The indigenous weather forecasting system predicts the weather with reasonable accuracy for the entire season, including both positive and negative consequences. The traditional seasonal calendar is used to provide information and directions about the timing and frequency of sea fishing. The entire weather information system is based on local ecology and has been incorporated into many parts of the cultural lives of fishermen. Nhemachena and Hassan (2007) viewed adaptation as crucial to surviving climate change vulnerabilities. This knowledge also gives them a distinct cultural identity, values and principles that govern and control not just their fishing profession and natural resources but also their entire social lives. Recognizing such stars allows fishermen to choose the best time to go fishing. When will the sea storm begin? How to look after their boats and keep them from getting too close to the shore? It also influences their social organization, such as when to engage in particular social activities and when to engage in other activities, because they understand the consequences of deviation.

Studies (González-Hernández *et al.*, 2022; Fierros-González and López-Feldman, 2021) emphasized this, stating that individuals that are directly affected by the effects of climate change would be more concerned and inspired to maintain sustainable lives. Gwadar fishermen feel that their interactions with ecology and activities can affect the entire environment as well as the weather when it comes to comprehending socio-ecological links. Indigenous ecological knowledge in Gwadar stresses banning certain activities at a given time while permitting other activities to take place simultaneously. Negative consequences might result from failing to follow the cultural protocols of each weather cycle, such as harmful weather, disasters, low fish catch and poor community health. The correct actions, such as visiting temple places in times of bad weather conditions and singing amba while dragging the boat for fishing, are believed to bring positive outcomes, including good weather conditions and the absence of natural disasters (Jamshid *et al.*, 2019). Both directly and indirectly, the organized way of social life and activities contributed to the production and protection of lives and livelihood. Their social organization, notably coordinated fishing activities, was a guaranteed system of natural resource conservation along the Gwadar coast. They developed climatic knowledge that was not just strongly linked to the natural environment but also to their cultural lives. It served as a type of shield for their social, cultural, theological and spiritual knowledge of the cosmological universe in which they

found themselves. However, it disappeared from the coast and will never be seen again. The community's fishing techniques and other associated knowledge had been forgotten. It is imperative to heed the call by Jamshid *et al.* (2019) that the government develops local disaster management policies incorporating both traditional and contemporary expertise.

In the face of increased interference in the environment and people's lives, this harmonic relationship with local nature has faded. Their social lives have been disrupted, as has their community organization. Manipulation of the environment by humans and increased disturbance has resulted in a slew of issues, some of which include a rise in sea level and eroding shoreline, a drop in fish harvest, impact on other life forms and damaging structures in the aftermath of heavy rains/flooding. Since many traditional fishing families have been displaced from their homes as a result of mega development projects such as deep sea port construction, the fishing profession has declined as a result of the influx of outsiders, the increasing role of technological advancement in fishing and state intervention in the sea. Normal weather conditions, fishing livelihood and sociocultural life are all inextricably linked. Local fishermen have expressed their dissatisfaction with the recent occurrence of strong winds and heavy rain, alleging that such conditions are unsuitable for sea fishing and have protested for government to take action. Ajani and van der Geest (2021) and ur-Rehman *et al.* (2022) predicted this in their discussion about how the changing climate has made Pakistan more vulnerable to the effects of climate change. These are graphically illustrated in Plates 1–4, Figure 1 and Plates 5–6.

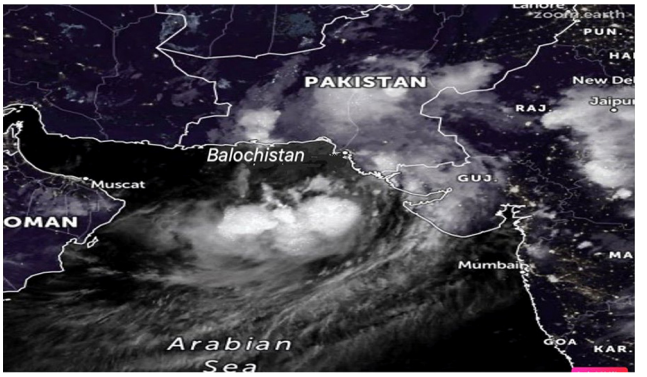
Climate and local environmental changes have an impact on not just their economic well-being but also their entire cultural organization. In this small-scale fishing community, imbalances in the complex interconnectedness not only contribute to ecological risks but also socioeconomic and cultural issues. These have been exemplified in the literature (Chaudhry *et al.*, 2014; Kunbher *et al.*, 2017; Shakoor *et al.*, 2011; Vozinaki *et al.*, 2015),

Plate 1.
Collapsed house in Gwadar from climate change effect

Plate 2.
Sea level rise and eroding shoreline effects of climate change

Plate 3.
Climate change consequences for fishermen in Gwadar

Plate 4.
Impact of climate change on animal life in Gwadar



Source: Zoom Earth (2021)

Figure 1.
Cyclone Shaheen hitting the Gwadar coast in 2021

Source: Baloch (2021)

Plate 5.
Fishermen rescuing a boat from the impact of Cyclone Shaheen

Plate 6.
Local fishermen protesting against lack of government support against climate change effects

depicting the impact of food shortages and other agricultural produce. The Gwadar fishing community's traditional wisdom exemplifies the close bond that exists between humans and the environment. However, several factors, including climate change, are eroding this link. Climate change, in combination with technologies and other factors, disrupts humans' close interaction with their environment, resulting in a loss of meteorological orientation. As Crate and Nuttall (2016) argue that climate change is environmental colonialism because it mainly affects people living close to nature-those who are most intimate with the natural world and who, for instance, suffer most severely from droughts.

Similarly, rising sea levels pose a major threat to fishermen's livelihood and culture, even though they are not responsible for the changes and are powerless to influence or alleviate them (Lazrus, 2009). Although it is a global issue, climate change, like colonialism, is a process that occurs from north to south, from urban to rural areas and from the center to the periphery. The people who are most affected by climate change are generally the same people who have been victims of colonialism in the past (El-Hinnawi, 1985). Climate change was caused by human intervention in the environment, not by natural causes. Fishing communities have been affected by forces well beyond their immediate surroundings throughout history. Allison *et al.* (2005) found that climate changes can lead to more frequent loss of fishing days due to bad weather, increasing loss of nets, traps and long lines, damage to boats and shore facilities, increased loss of life among fishermen and increased damage to coastal communities, through houses and farmland.

Due to unusual seasonal changes in the region, local fishermen have been unable to foresee climatic events in recent years. They get more heat waves and a longer summer season each year. They are finding it impossible to estimate fish availability due to massive

climate change. Changes in the time of date fruiting have been noticed by local fishermen in Gwadar. Dates are generally available in May and June when they are fully ripe, but this year the date tree fruited one and a half months earlier. The majority of local fishermen are concerned that their long-held climate calendar is no longer accurate. The majority of fishermen relied on climate-related announcements from the fishery department. However, they claim that such announcements are usually political and that the fishery department may provide false information to prevent fishermen from fishing due to high-profile official visits to Gwadar from Islamabad. Due to the growing conflict, Gwadar must be kept clean during high-level official visits. Fish productivity has decreased as a result of climate change, with subsequent socioeconomic effects. Local fishermen expressed their concerns that while fishing was previously profitable, it is now exceedingly fragile and uncertain, and working conditions are dangerous and exploitative. As a result of these circumstances, local fishermen have decided to change their traditional occupation. We conducted a survey and discovered that just 40% of local traditional fishermen fish four days a week on average. The majority of people are currently employed in the China–Pakistan Economic Corridor's construction projects (China mega project in Pakistan). They do not prefer to continue their traditional fishing activities due to low harvest.

Only state officials can now issue notices detailing when and how to travel to the water, what tools should be used, the limitations of sea visits and how the division of work should be structured. As a result, fishermen have no claim to autonomy over their social lives or their connection to the natural environment. Because of instability in their fishing livelihood and cultural identity, the fishing activities and cultural values that kept this small-scale fishing community organized do not work any longer. The government ignored the established way of life and the cultural heritage of the fishermen, resulting in a slew of socioeconomic and cultural issues for this small-scale traditional fishing community. The indigenous fishing community is fighting massive climatic change and the detrimental effects of ongoing development projects. They have banded together under the banner of Gwadar's "Mahigeer Ittehad", a political organization of fishermen who opine that the projects be safely executed without causing significant harm to the local flora and fauna, as well as marine species. Local fishermen said it is challenging to return to their traditional methods of fishing because they do not want to sacrifice the advantages of advancement but do not want it to come at the expense of their way of life and cultural identity. Hunger, poverty and unemployment are caused by escalating climate catastrophes, and insurgents take advantage of this condition to incite locals to rebel against the state. Locally unemployed young people are being hunted by rebel groups, adding to the region's growing political instability.

Conclusion

This research sheds insights into the Gwadar fishing community's indigenous climatic knowledge. ICK illustrates its profound ties to local ecology as well as its approaches to environmental conservation, disaster management and equitable access to natural resources. Ecological factors have a significant impact on the key cultural aspects of fishing. Their social structure is inextricably linked to environmental factors and natural resources. They maintain a link between a living organism and its inorganic environment through their deep understanding of the environment. With increased interference in the environment and their life, this harmonic relationship with local nature has faded. Their social lives have been disrupted, as has their community organization. Manipulation of the environment by humans and increased disturbance have resulted in a slew of issues, one of which is a drop in fish catch. Due to unusual seasonal changes in the region, local fishermen

have been unable to foresee climatic events in recent years. In a given year, they are subjected to more torrential rains, sea storms, heat waves and long summer months. They are finding it impossible to estimate fish availability due to massive climate change. Local communities are losing their traditional livelihoods and socioeconomic autonomy as a result of growing climate change.

The indigenous fishing community in the region is resisting massive climatic change as well as the detrimental effects of rising coastal urbanization. They are unified in their resistance to unequal growth and climate change. This study also discovered that negative climate changes have socioeconomic effects, leading community people to join insurgent groups and contributing to the region's growing political instability. Given that Pakistan contributes very little to global GHG emissions and that climate change is already imposing significant economic and human costs, the Pakistani government's climate change policy places a relatively greater emphasis on adaptation to actual and anticipated climate change impacts than on mitigation. The scope and urgency of the job necessitate efficient and effective methods, but the government and other national players can encounter some of the same challenges encountered globally when choosing and putting these methods into practice.

Our research is limited in terms of determining the precise climatic changes in the area. The severity of the fishing community's socioeconomic issues and cultural shifts as a result of climate change, on the other hand, indicated severe consequences for their lives. We did not attempt to generalize our findings; the situation in Gwadar may be very different from that in other parts of the world. Climate change, on the other hand, is a worldwide phenomenon that causes challenges for poor communities, even if it did not cause the ecological system to be disrupted in the first place. The study also pointed out that the necessity to include indigenous people in the decision-making process about local and national adaptation initiatives arises from the fact that residents and policymakers work together more successfully to handle the climate change challenge for the betterment of indigenous people.

References

Abid, M., Schilling, J., Scheffran, J. and Zulfiqar, F. (2016), "Climate change vulnerability, adaptation and risk perceptions at farm level in Punjab, Pakistan", *The Science of the Total Environment*, Vol. 547, pp. 447-460.

Abubakar, S.M. (2018), "Pakistan – the 8th most affected country from climate change", The Express Tribune, available at: https://tribune.com.pk/story/1861497/pakistan-8th-affected-country-climate-change

Ajani, A. and van der Geest, K. (2021), "Climate change in rural Pakistan: evidence and experiences from a people-centered perspective", *Sustainability Science*, Vol. 16 No. 6, pp. 1999-2011, doi: 10.1007/s11625-021-01036-4.

Ali, M.F., Ashfaq, M., Hassan, S. and Ullah, R. (2020), "Assessing indigenous knowledge through farmers' perception and adaptation to climate change in Pakistan", *Polish Journal of Environmental Studies*, Vol. 29 No. 1, pp. 525-532.

Allison, E.H., Adger, W.N., Badjeck, M.C., Brown, K., Conway, D., Dulvy, N.K., Halls, A., Perry, A. and Reynolds, J. (2005), "Effects of climate change on the sustainability of capture and enhancement fisheries important to the the poor: analysis of the vulnerability and adaptability of fisherfolk living in poverty", *DFID Fisheries Management Science Programme Project R4778J, Reino Unido*, available at: https://agris.fao.org/agris-search/search.do?recordID=GB2012105545

Al-Maliki, L.A., Al-Mamoori, S.K., Jasim, I.A., El-Tawel, K., Al-Ansari, N. and Comair, F.G. (2022), "Perception of climate change effects on water resources: Iraqi undergraduates as a case study", *Arab Journal of Geosciences*, Vol. 15, p. 503, doi: 10.1007/s12517-022-09695-y.

Aparna, P. and Trivedi, P. (2011), "Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan", *India. Indian Journal of Indigenous Knowledge*, Vol. 10 No. 1, pp. 183-189.

Arshad, M., Kachele, H., Krupnik, T.J., Amjath-Babu, T.S., Aravindakshan, S., Abbas, A., Mehmood, Y. and Müller, K. (2017), "Climate variability, farmland value, and farmers' perceptions of climate change: implications for adaptation in rural Pakistan", *International Journal of Sustainable Development and World Ecology*, Vol. 24 No. 6, pp. 532-544.

Babakholov, S., Bobojonov, I., Hasanov, S. and Glauben, T. (2022), "An empirical assessment of the interactive impacts of irrigation and climate on farm productivity in Samarkand region, Uzbekistan", *Environmental Challenges*, Vol. 7, p. 100502, doi: 10.1016/j.envc.2022.100502.

Baloch, B. (2021), "Under cyclone Shaheen, heavy rain batters Makran Coast", *Dawn*, available at: www.dawn.com/news/1649827

Berkes, F. (1993), "Traditional ecological knowledge in perspective", *Traditional Ecological Knowledge: Concepts and Cases*, Vol. 1, pp. 1-9.

Bizikova, L., Parry, J., Creech, H., Karami, J., Echeverria, D., Hammill, A., Gass, P., Akoh, B. and Creech, H. (2012), Africa transformation-ready: The strategic application of information and communication technologies to climate change adaptation in Africa, Final Report for the African Development Bank, the World Bank and the African Union, International Institute for Sustainable Development, Bristol.

Brokensha, D., Warren, D.M. and Werner, O. (1980), Indigenous Knowledge Systems and Development, University Press of America, Washington, DC.

Burton, I., Smith, J.B. and Lenhart, S. (1998), "Adaptation to climate change: theory and assessment", in Feenstra, J.F., Burton, I., Smith, J.B. and Tol, R.S.J. (Eds), *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*, UNEP, Nairobi, pp. 880-912.

Carpenter, S., Walker, B., Anderies, J.M. and Abel, N. (2001), "From metaphor to measurement: resilience of what to what?", *Ecosystems*, Vol. 4 No. 8, pp. 765-781.

Chambers, R. and Ghildyal, B. (1985), "Agricultural research for resource-poor farmers: the farmer-first-and-last model", *Agricultural Administration*, Vol. 20 No. 1, pp. 1-30.

Chaudhry, A.G., Ahmed, A. and Farooq, H. (2014), "Indigenous knowledge and sustainable agricultural development: a case history of the Indus valley, Pakistan", *European Academic Research*, Vol. 2 No. 6, pp. 7366-7391.

Chianese, F. (2016), "The traditional knowledge advantage: indigenous peoples' knowledge in climate change adaptation and mitigation strategies", *IFAD Advantage Series*, IFAD, Rome.

Chimi, P.M., Mala, W.A., Fobane, J.L., Essouma, F.M., Mbom, J.A., Funwi, F.P. and Bell, J.M. (2022), "Climate change perception and local adaptation of natural resource management in a farming community of Cameroon: a case study", *Environmental Challenges*, Vol. 8, p. 100539, doi: 10.1016/j.envc.2022.100539.

Couzin, J. (2007), "Opening doors to native knowledge", *Science*, Vol. 315 No. 5818, pp. 1518-1519, doi: 10.1126/science.315.5818.1518.

Crate, S.A. and Nuttall, M. (2016), *From Local to Global: Perceptions and Realities of Environmental Change among Kalahari San Anthropology and Climate Change*, Routledge, London, pp. 250-262.

Dawn (2018), "Over 500 children died in drought-hit Thar this year", Murad told, available at: www.dawn.com/news/1440059/over-500-children-died-in-drought-hit-thar-this-year-murad-told

Directorate of On-Farm Water Management, Government of Khyber Pakhtunkhwa (2019), "Indigenous people plan framework: Khyber Pakhtunkhwa irrigated agriculture improvement project (KPIAIP)", *World Bank*, available at: https://documents1.worldbank.org/curated/en/637091555578215632/text/Indigenous-Peoples-Plan-Framework.txt

Dutta, R. and Bhattacharjya, B.K. (2009), "A traditional fishing method of Assam for catfishes using duck meat as an attractant", *Indian Journal of Traditional Knowledge*, Vol. 8 No. 2, pp. 234-236.

Elahi, E., Khalid, Z., Tauni, M.Z., Zhang, H. and Lirong, X. (2021), "Extreme weather events risk to crop-production and the adaptation of innovative management strategies to mitigate the risk: a retrospective survey of rural Punjab, Pakistan", *Technovation*, Vol. 117, p. 102255, doi: 10.1016/j.technovation.2021.102255.

El-Hinnawi, E. (1985), *Environmental Refugees*, United Nations Environmental Programme, Nairobi.

Fierros-Gonzalez, I. and Lopez-Feldman, A. (2021), "Farmers' perception of climate change: a review of the literature for Latin America", *Frontiers in Environmental Science*, Vol. 9, p. 205, doi: 10.3389/fenvs.2021.672399.

Food Security Cluster (2016), "Sindh drought needs assessment: the state of agriculture, livelihood, food security, nutrition, water and sanitation in drought affected communities in Sindh", Food Security Cluster, Pakistan, Islamabad, available at: http://pdma.gos.pk/new/resources/downloads/sdnareport2016.pdf

Gbetibouo, G.A. (2008), "Understanding farmers' perceptions and adaptation to climate change and variability: the case of Limpopo basin, South Africa", *Policy Brief*, International Food Policy Research Institute, Pretoria, pp. 15-18.

Geetha, R., Vivekanandan, E., Kizhakudan, J.K., Kizhakudan, S.J., Chandrasekhar, S., Raja, S. and Gupta, K. (2015), "Indigenous technical knowledge (ITK) of coastal Fisherfolk on climate change-a case study in Chennai, South-east Coast of India", *Indian Journal of Fisheries*, Vol. 62 No. 1, pp. 144-148.

González-Hernández, D.L., Aguirre-Gamboa, R.A. and Meijles, E.W. (2022), "The role of climate change perceptions and sociodemographics on reported mitigation efforts and performance among households in Northeastern Mexico", *Environmental Development and Sustainability*, pp. 1-23, doi: 10.1007/s10668-021-02093-6.

Goodyear-Ka 'ōpua, N. (2017), "Protectors of the future, not protestors of the past: indigenous pacific activism and Mauna a wākea", *South Atlantic Quarterly*, Vol. 116 No. 1, pp. 184-194.

Government of Pakistan (2013), "Framework for implementation of climate change policy", Climate Change Division Islamabad, Government of Pakistan, Islamabad, available at: www.gcisc.org.pk/Framework%20for%20Implementation%20of%20CC%20Policy.pdf

Grenier, L. (1998), "Working with indigenous knowledge: a guide for researchers", International Development Research Centre (IDRC), Ottawa, available at: http://network.idrc.ca/ev.php?IN=28703_201&ID2=DO_TOPIC

Hamanaka, N., Kan, H., Yokoyama, Y., Okamoto, T., Nakashima, Y. and Kawana, T. (2012), "Disturbances with hiatuses in high-latitude coral reef growth during the Holocene: correlation with millennial-scale global climate change", *Global and Planetary Change*, Vols 80/81, pp. 21-35, doi: 10.1016/j.gloplacha.2011.10.004.

Hernandez, J., Meisner, J., Jacobs, L.A. and Rabinowitz, P.M. (2022), "Re-centering indigenous knowledge in climate change discourse", *PLOS Climate*, Vol. 1 No. 5, pp. 1-3, doi: 10.1371/journal.pclm.0000032.

Hussain, J. (2017), "China's CPEC investment in Pakistan reaches $62 billion", available at: Mint.www.livemint.com/Politics/dB5tQKISoKNrvl7EwDPFbP/Chinas-CPEC-investment-in-Pakistan-reaches-62-billion.html

Indigenous Peoples' Centre for Documentation, Research and Information (DOCIP) (2015), " Sustainable development goals and the post-2015 development agenda: indigenous peoples' fight not to be left behind", available at: http://cendoc.docip.org/collect/upd_en/index/assoc/HASHd175.dir/Upd109_eng.pdf

Jamali, H.A. (2013), *The Anxiety of Development: Megaprojects and the Politics of Place in Gwadar*, Pakistan.

Jamshid, A.T., Ahmad, M. and Ibrahim, K.H.M. (2019), "Role of indigenous knowledge in managing floods projects", *Journal of Process Management and New Technologies*, Vol. 7 No. 2, pp. 13-23, doi: 10.5937/jouproman7-21018.

Johannes, R.E. (1998), "The case for data-less marine resource management: examples from tropical nearshore finfisheries", *Trends in Ecology and Evolution*, Vol. 13 No. 6, pp. 243-246.

Johnson, N., Behe, C., Danielsen, F., Krümmel, E.M., Nickels, S. and Pulsifer, P.L. (2016), "Community-based monitoring and indigenous knowledge in a changing arctic: a review for the sustaining arctic observing networks", *Final Report to Sustaining Arctic Observing Networks*, Inuit Circumpolar Council, Ottawa, Canada, p. 65, doi: 10.25607/OBP-822.

Khan, K. and Hussain, S. (2019), "Introduction", in Sathar, Z. and Khan, K. (Eds) *Climate, Population, and Vulnerability in Pakistan: Exploring Evidence of Linkages for Adaptation*, Population Council, Islamabad, pp. 6-10.

Krech, S. III (2005), "Reflections on conservation, sustainability, and environmentalism in indigenous North America", *American Anthropologist*, Vol. 107 No. 1, pp. 78-86.

Kunbher, A.D., Ullah, S. and Alam, M. (2017), "Multi-sector nutrition-sensitive response to drought emergency in Pakistan", *Field Exchange*, Vol. 55, pp. 98-102, available at: www.ennonline.net/fex/55/msdroughtemergencypakistan

Lauer, M. and Aswani, S. (2009), "Indigenous ecological knowledge as situated practices: understanding fishers' knowledge in the Western Solomon Islands", *American Anthropologist*, Vol. 111 No. 3, pp. 317-329.

Lazrus, H. (2009), "The governance of vulnerability: climate change and agency in Tuvalu, South pacific", *Anthropology and Climate Change: From Encounters to Actions*, pp. 240-249.

Leary, N., Adejuwon, J., Barros, V., Batimaa, P., Biagini, B., Burton, I., Chinvanno, S., Cruz, R., Dabi, D., de Comarmond, A., Dougherty, B., Dube, P., Githeko, A., Hadid, A.A., Hellmuth, M., Kangalawe, R., Kulkarni, J., Kumar, M., Lasco, R., Mataki, M., Medany, M., Mohsen, M., Nagy, G., Njie, M., Nkomo, J., Nyong, A., Osman, B., Sanjak, E., Seiler, R., Taylor, M., Travasso, M., von Maltitz, G., Wandiga, S. and Wehbe, M. (2007), "A stitch in time: lessons for climate change adaptation from the AIACC project. AIACC working paper ", *The AIACC Project Office, International START Secretariat, Washington, DC*, Vol. 48.

McCorkle, C.M. (1989), "Toward a knowledge of local knowledge and its importance for agricultural RD&E", *Agriculture and Human Values*, Vol. 6 No. 3, pp. 4-12.

Malik, S.M., Awan, H. and Khan, N. (2012), "Mapping vulnerability to climate change and its repercussions on human health in Pakistan", *Globalization and Health*, Vol. 8 No. 1, p. 31, doi: 10.1186/1744-8603-8-31.

Martine, G. and Schensul, D. (2013), "Introduction", in Martine, G. and Schensul, D. (Eds), *The Demography of Adaptation to Climate Change*, UNFPA, IIED and El Colegio de México, New York, NY, London and Mexico City, pp. 15-21.

Moller, H., Berkes, F., Lyver, P.O. and Kislalioglu, M. (2004), "Combining science and traditional ecological knowledge: monitoring populations for co-management", *Ecology and Society*, Vol. 9 No. 3, p. 2, available at: www.ecologyandsociety.org/vol9/iss3/art2/

Mosites, E., Lujan, E., Brook, M., Brubaker, M., Roehl, D., Tcheripanoff, M. and Hennessy, T. (2018), "Environmental observation, social media, and one health action: a description of the local environmental observer (LEO) network", *One Health*, Vol. 6, pp. 29-33, doi: 10. 1016/j.onehlt.2018.10.002.

Musimwa, E. and Chapeyama, O. (1995), Indigenous Knowledge Systems and Natural Resource Management in Southern Africa: Report of the Southern African Regional Workshop, Harare, Zimbabwe, Iucn-World Conservation Union, 20-22 April 1994.

Nawrotzki, R. and Polina, K. (2010), "Addressing climate change with indigenous knowledge", *The International Journal of Climate Change: Impacts and Responses*, Vol. 2 No. 1, pp. 33-48, doi: 10.18848/1835-7156/CGP/v02i01/37290.

Nhemachena, C. and Hassan, R. (2007), "Micro-level analysis of farmers' adaptation to climate change in Southern africa", *IFPRI Discussion Paper No. 00714, IFPRI*, Washington, DC.

Pálsson, G. (1996), "Human-environmental relations: orientalism, paternalism and communalism", *Nature and Society: Anthropological Perspectives*, Routledge, London, pp. 63-81.

Rafiq, A. (2017), "China's $62 billion bet on Pakistan", Foreign Affairs, available at: www.foreignaffairs.com/articles/china/2017-10-24/chinas-62-billion-bet-pakistan

Reyes-García, V., Fernández-Llamazares, A., Aumeeruddy-Thomas, Y., Benyei, P., Bussmann, R.W., Diamond, S.K., García-del-Amo, D., Guadilla-Sáez, S., Hanazaki, N., Kosoy, N., Lavides, M., Luz, A.C., McElwee, P., Meretsky, V.J., Newberry, T., Molnár, Z., Ruiz-Mallén, I., Salpeteur, M., Wyndham, F.S., Zorondo-Rodriguez, F. and Brondizio, E.S. (2022), "Recognizing indigenous peoples' and local communities' rights and agency in the post-2020 biodiversity agenda", *Ambio*, Vol. 51 No. 1, pp. 84-92.

Salick, J. and Ross, N. (2009), "Traditional peoples and climate change", *Global Environmental Change*, Vol. 19 No. 2, pp. 137-190.

Shakoor, U., Saboor, A., Ali, I. and Mohsin, A.Q. (2011), "Impact of climate change on agriculture: empirical evidence from arid region", *Pakistan Journal of Agricultural Sciences*, Vol. 48 No. 4, pp. 327-333.

Siddiqui, U. (2022), "Perfect climate storm: Pakistan reels from extreme heat", Aljazeera.www.aljazeera.com/news/2022/5/21/hold-heatwave-in-pakistan-and-climate-change

Sillitoe, P. (1998), "The development of indigenous knowledge: a new applied ", *Anthropology. Current Anthropology*, Vol. 39 No. 2, pp. 223-252.

Somah, T.P. (2013), "Climatic change impacts on subsistence agriculture in the Sudano-Sahel zone of Cameroon – constraints and opportunities for adaptation", PhD thesis, Brandenburgische Technical University.

The World Bank Operations Manual OP 4.10 World Bank (2013), "Indigenous peoples", available at: http://go.worldbank.org/6L01FZTD20

Turner, N.J. and Clifton, H. (2009), "'It's so different today': climate change and indigenous lifeways in British Columbia", *Canada. Global Environmental Change*, Vol. 19 No. 2, pp. 180-190.

Ullah, S., Guoqiang, H., Khan, U. and Niazi, K. (2020), "State, religion and the marginalisation of traditional healing in Gwadar, Pakistan", *Medical Humanities*, Vol. 46 No. 4, pp. 444-453.

UNFCCC (2007), "Climate change: impacts, vulnerabilities and adaptation in developing countries", United Nations Framework Convention on Climate Change, Bonn, Germany, available at: https://unfccc.int/resource/docs/publications/impacts.pdf

UNHCR (2020), "Indigenous peoples' knowledge and climate adaptation", available at: https://reliefweb.int/report/world/indigenous-peoples-knowledge-and-climate-adaptation-9-august-2020

United Nations (2022), "Rural, coastal, indigenous women bear brunt of climate change, must be empowered to lead response efforts, speakers say as women's commission continues session", available at: https://press.un.org/en/2022/wom2215.doc.htm

Ur-Rehman, Z., Goldbaum, C. and Masood, S. (2022), "Pakistan's deadly flood season worsened by climate change and bad infrastructure", *The New York Times*, available at: www.nytimes.com/2022/07/24/world/asia/pakistan-monsoon-floods.html

Valls, J.-F. (2007), "Factores de éxito de las compañías aéreas de bajo precio", *Instituto de Estudios Turísticos*, Vols 175/176, pp. 59-79.

Vivekanandan, E. (2011), "Marine fisheries policy brief-3; climate change and Indian marine fisheries", *CMFRI Special Publication*, Vol. 105, pp. 1-97.

Vozinaki, A.E.K., Karatzas, G.P., Sibetheros, I.A. and Varouchakis, E.A. (2015), "An agricultural flash flood loss estimation methodology: the case study of the koiliaris basin (Greece), February 2003 flood", *Natural Hazards*, Vol. 79 No. 2, pp. 899-920, doi: 10.1007/s11069-015-1882-8.

Warren, D.M. (2003), "The role of indigenous knowledge systems in facilitating approaches to development", Sanga, G. and Ortalli, G. (Eds), *Nature Knowledge: Ethnoscience, Cognition, and Utility*, Berghahn, New York, NY, pp. 317-330.

Zoom Earth (2021), July 2021, available at: https://zoom.earth/

Further reading

Geo News (2010), "Relief efforts continue at Mekran, Sindh coasts", Geo News, available at: www.geo.tv/important_events/2010/cyclone_phet/pages/english_news.asp (accessed 29 August 2020).

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