What can communities teach us?

Indigenous and local knowledge for mountain conservation

Edited by Omer Aijazi and Sejuti Basu

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

ABOUT IUCN

IUCN is a membership Union uniquely composed of both government and civil society organisations. It provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together.

Created in 1948, IUCN is now the world's largest and most diverse environmental network, harnessing the knowledge, resources and reach of more than 1,500 Member organisations and some 18,000 experts. It is a leading provider of conservation data, assessments and analysis. Its broad membership enables IUCN to fill the role of incubator and trusted repository of best practices, tools and international standards.

IUCN provides a neutral space in which diverse stakeholders including governments, NGOs, scientists, businesses, Local communities, Indigenous peoples' organisations and others can work together to forge and implement solutions to environmental challenges and achieve sustainable development.

Working with many partners and supporters, IUCN implements a large and diverse portfolio of conservation projects worldwide. Combining the latest science with the traditional knowledge of Local communities, these projects work to reverse habitat loss, restore ecosystems and improve people's well-being.

www.iucn.org

https://twitter.com/IUCN/

ABOUT CEM

The IUCN Commission of Ecosystem Management is an international, multicultural and multilingual group of over 2,000 members worldwide. The main objectives of CEM are focused on developing and sharing expert guidance on ecosystem-based approaches to management of socio-ecological systems and use of natural and modified ecosystems to achieve biodiversity conservation, address climate change impacts, contribute to human wellbeing and promote sustainable development. Additionally, CEM aims to provide guidance for ecosystem-based approaches to the management of landscapes and seascapes and enhance the resilience of transformed ecosystems necessary to address global changes.

CEM's network of volunteer conservation scientists, experts and managers contributes to the IUCN's work through an array of Thematic Groups, Specialist Groups and Task Forces. Collectively, this volunteer specialist network provides scientific and authoritative advice to IUCN's Programme as it relates to the management, restoration and sustainable use of the world's ecosystems.

https://www.iucn.org/our-union/commissions/commission-ecosystem-management

What can communities teach us?

Indigenous and local knowledge for mountain conservation

Edited by Omer Aijazi and Sejuti Basu

The designation of geographical entities in this book, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN or other participating organisations concerning the legal status of any country, territory or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of IUCN or other participating organisations.

IUCN is pleased to acknowledge the support of its Framework Partners who provide core funding: Ministry of Foreign Affairs, Denmark; Ministry for Foreign Affairs, Finland; Government of France and the French Development Agency (AFD); Ministry of Environment, Republic of Korea; Ministry of the Environment, Climate and Sustainable Development, Grand Duchy of Luxembourg; the Norwegian Agency for Development Cooperation (Norad); the Swedish International Development Cooperation Agency (Sida); the Swiss Agency for Development and Cooperation (SDC) and the United States Department of State.

This publication has been made possible in part by funding from the Commission on Ecosystem Management and the Social Sciences and Humanities Research Council of Canada.

Published by: IUCN, Gland, Switzerland

Produced by: IUCN CEM Mountain Ecosystems Specialist Group

Copyright: © 2023 IUCN, International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorised without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Recommended citation: Aijazi, O. & Basu, S. (Eds.) (2023). *What can communities teach us? Indigenous and local knowledge for mountain conservation.* Gland, Switzerland: IUCN.

ISBN: 978-2-8317-2242-9 (PDF)
DOI: https://doi.org/10.2305/YHPH7204

Cover design and illustrations: Estudio Relativo | www.estudiorelativo.com

Layout by: Estudio Relativo

Table of contents

Preface	IV
Executive summary	V
Acknowledgements	VIII

CH. 1

Local ecological knowledge in high-altitude Ladakh: A cost-effective survey method of the distribution and abundance of mammals

1

CH. 2

Alternative management of mountain ecosystems in the Sierra de Santa Marta: Ecology of knowledge for integral sustainability, notes from Veracruz, Mexico

26

CH. 3

Promoting community-based environmental management around a Himalayan high-altitude wetland

54

CH. 4

Indigenous knowledge for hazard prediction and risk reduction strategies: A case study of the Garo tribe, Meghalaya, India

77

CH. 5

Tracing local understandings of hazards and disaster: Learning from Himalayan villages in Uttarakhand, India

99

E.S.
CH.1
CH.2
CH.3
CH.4
CH.5
← TC

Preface

Decolonisation has entered the environmental movement's lexicon. For nature conservation, this means several things: 1) the recognition that, in some instances, poorly conceived, undemocratic conservation practices have led to the erasure of Indigenous and local lifeworlds, 2) Indigenous peoples and Local communities are at the forefront of conservation and are keepers of valuable ecological knowledge that conservation science can learn from and scale-up, 3) scientific, Indigenous and local knowledge are not in opposition but are complementary knowledge forms arrived at through separate adjudication processes, 4) a stance of humility, respect and openness is needed when working with locally situated environmental knowledge; technocratic arrogance must be put aside.

Organised as a series of research articles, the publication puts the above ideas into perspective by demonstrating how integrating Indigenous and local knowledge enhances conservation outcomes. This CEM-led initiative is a welcome addition to IUCN guidance on mountain ecosystems and the organisation's commitment to Indigenous peoples and Local communities. The volume presents lessons learned and insights gained from the regional experiences of its diverse members. The compendium will contribute to IUCN knowledge resources to influence critical global, regional and local decisions and actions on ecosystem conservation and governance. The knowledge produced in this volume bridges gaps in policy and practice by placing Indigenous peoples and Local communities at the heart of nature conservation.

Angela Andrade

Chair, IUCN Commission on Ecosystem Management

Executive summary

Indigenous and Local communities are keepers of valuable environmental knowledge accumulated over generations. This knowledge is held individually and collectively, often orally transmitted and embodied. At least 25% of the world's land area is owned, managed, used or inhabited by these groups, and such areas are degrading less quickly than others. Yet, despite abundant empirical evidence, Indigenous and Local communities struggle to have their voices meaningfully included in environmental governance. Much more work remains to be done on the integration of Indigenous and local knowledge within nature conservation, which has the potential to reframe resource management systems, practices and relations altogether. *What can communities teach us?* responds to this gap and the growing calls for decolonising the conservation movement. The compendium, put together by members of the Mountain Ecosystem Specialist Group of the IUCN Commission on Ecosystem Management (CEM), presents five peer-reviewed articles that explore the centrality of Indigenous and local knowledge and practices for environmental stewardship in mountain regions.

The opening chapter by Hofhuis et al. develops a cost-effective and community-engaged protocol for collecting Local Ecological Knowledge (LEK). Set in the remote Trans-Himalayan high-altitude cold desert of Ladakh within India, the piece is a collaboration between researchers from Wageningen University and the Snow Leopard Conservancy India Trust. Committed to the conservation of mammalian herbivorous species such as the urial (*Ovis orientalis vignei*), ibex (*Capra ibex*) and blue sheep (*Pseudois nayaur*), the authors interviewed local knowledge holders such as livestock herders and farmers on the distribution and relative abundance of the mammalian species and their predators. The authors found that these results were consistent with the data collated from existing surveys. The paper offers insights for developing a standardised protocol for LEK collection that can be adjusted and replicated in other difficult-to-access regions.

Jesús Moreno Arriba takes us to the south-eastern Mexican state of Veracruz, a region rich in biodiversity and home to the Indigenous Nahua and Popoluca peoples. Using a decolonial lens, the author analyses the processes and practices of natural resource management in the Sierra de Santa Marta massif. Moreno Arriba notes how decades of interventions have led to sustained underdevelopment or maldevelopment with grave consequences for both nature and Local communities. Informed by

cutting-edge literature on *alternatives to development*, Moreno Arriba studies five non-governmental mountain ecosystem management projects that employ intercultural and sustainable methods, such as alternative socio-ecological practices of reforestation and the direct participation of Local communities in governance. The author argues that alternatives to contemporary notions of development lie within these exemplary projects. Moreno Arriba makes a convincing case for integrating Indigenous epistemologies within nature conservation, a step essential for local empowerment while enhancing development and conservation outcomes.

Alexander R. O'Neill examines the management of high-altitude wetlands of Tsomgo Lake in the eastern Himalayas of Sikkim, India. The Tsomgo Lake guides human-nature relationships in the region, and Indigenous and Local communities value traditional relationships with the lake and other sacred wetlands. The author argues that a historical analysis is key to understanding the current role of Local communities in environmental management and the shape of present-day wetland management practices. The study highlights the success of Tsomgo Pokhri Sanrakshan Samiti (TPSS), a community organisation with direct authority over wetland management. TPSS partners with government and non-governmental organisations for local adaptive programming and utilises tourism revenues for conservation purposes. O'Neil recommends several decentralised, multi-stakeholder high-altitude wetland management measures. He also notes the importance of transparency and trust among stakeholders and the value of local knowledge when planning, executing and monitoring management interventions.

Raka Matchisal A. Sangma focuses on hazard prediction and risk reduction practices of the Garo people in Meghalaya, also in India's eastern Himalayas. Using qualitative methods, the author argues that the Garo people have a unique and intimate understanding of natural systems, including rich meteorological knowledge, which helps them predict climatic patterns. Such knowledge is integrated into their way of life through cultural beliefs and practices that support the Garo people in adapting to sudden shocks and stressors. This includes local observations of cloud appearances, wind direction, flowering plants and the behaviour of animals, birds and insects concerning different hazards. Sangma also explores vernacular earthquake-resistant architecture and local practices contributing to food security.

In the concluding chapter, Aditi Sharma continues with the theme of disasters. She also explores traditional knowledge in relation to disaster risk reduction. Sharma takes us to Uttarakhand, in India's central Himalayas, and uses perception studies to document the

responses of individuals during situations of risk. The study presents risk perceptions rooted in the subjective experiences of the respondents and uses participatory risk mapping to understand critical social setups and hazard risk zones. The author captures community observations on the atmosphere, the movement of insects and birds, and various socio-cultural, religious and ecological norms and rituals that Local communities associate with disasters. The multi-disciplinary study lays the foundation for further exploration of community risk perceptions for strengthening local disaster risk reduction capacities.

Indigenous peoples and Local communities must be meaningfully included within national and global processes that set conservation policies and programme design. *What can communities teach us?* presents efforts to embrace Indigenous and local knowledge within nature conservation, providing insights and recommendations for cultivating a sustainable and just relationship with nature, with Indigenous peoples and Local communities at the forefront.

About the editors

Omer Aijazi

works at the intersections of environmental justice, critical theory and decoloniality. He is a lecturer (assistant professor) in disasters and climate crisis at the Humanitarian and Conflict Response Institute, University of Manchester.

Sejuti Basu

works on community-led conservation and ecosystem-based adaptation. She is a researcher and a fellow of the Royal Geographical Society.

Acknowledgements

The publication was supported by the Anthropology Department at the University of Victoria and the Social Sciences and Humanities Research Council of Canada (SSHRC).

Editing support was provided by Autumn Knowlton (ReVisions) and Maahin Ahmed. Sara-Maya Kaba assisted with the peer-review process, and Mariana Rivera offered administrative help. Sarina van der Ploeg provided publication assistance. A special thanks to Angela Andrade and Bernal Herrera for supporting this initiative.

The chapters were peer-reviewed by Khursheed Ahmad (Sher-e-Kashmir University of Agricultural Sciences & Technology), Anaisa Garcia (Universidad del Valle de Guatemala), Peter R.W. Gerritsen (Universidad de Guadalajara), Matías Guerrero-Gatica (Universidad de Chile), Janita Gurung (ICIMOD), Maarten Hofman (UNEP), Dushyanti Mohil (Wetlands International South Asia), Eleonora Musco (Eurac Research/UNEP Vienna Office), Alexander O'Neill (Duke University), Herbert H.T. Prins (Wageningen University), Ali Rahi (Independent Consultant), Muhammad Rais (PMAS Arid Agriculture University Rawalpindi), Andrea Rinaldi (University of Cagliari), Raka Matchisal A. Sangma (Tata Institute of Social Sciences), Aditi Sharma (Tata Institute of Social Sciences), Anil Shrestha (University of British Columbia) and Chandni Singh (Indian Institute for Human Settlements).

Contributors

Jesús Moreno Arriba, Stijn P. Hofhuis, J. F.de Jong, Tsewang Namgail, Alexander R. O' Neil, Herbert H. T. Prins, Raka Matchisal A. Sangma and Aditi Sharma.

CHAPTER

1

Local ecological knowledge in high-altitude Ladakh

A cost-effective survey method of the distribution and abundance of mammals

By

Stijn P. Hofhuis
Wildlife Ecology & Conservation Group
Wageningen University, the Netherlands

Tsewang Namgail
Snow Leopard Conservancy India Trust
Union Territory of Ladakh, India

J. F. de Jong
Animal Sciences Group
Wageningen University, the Netherlands

Herbert H.T. Prins
Animal Sciences Group
Wageningen University, the Netherlands

About the authors

Herbert H.T. Prins

is professor emeritus of resource ecology in the Animal Sciences Group of Wageningen University. He holds an MSc in mathematics and natural sciences (1979) and a PhD in behavioural ecology (1987). He has been an adjunct professor in computational ecology at the University of KwaZulu-Natal (South Africa) and visiting professor at the University of Pietermaritzburg (South Africa), the Royal Melbourne Institute of Technology (Australia), the Commonwealth Scientific and Industrial Research Organization in Townsville (Australia) and Princeton University (USA). He has been working on the ecology and conservation of African savannas since 1982 and the Trans-Himalaya region since 1995.

Joost F. de Jong

holds a PhD in conservation genetics (2018). Currently, he is a lecturer at the Wildlife Ecology & Conservation Group, Wageningen University. He teaches courses in fundamental and applied animal ecology and supervises BSc, MSc and PhD students' research projects on mammal ecology in Europe, Africa and Asia.

Tsewang Namgail

heads the Snow Leopard Conservancy India Trust. He obtained his PhD in wildlife ecology from Wageningen University. He has a special interest in large mammals and high-altitude ecology. He has carried out pioneering ecological works in the Indian Trans-Himalaya region, focusing on the birds and mammals of Ladakh. Apart from conducting research, he helps Local communities conserve the snow leopard and its prey species.

Stijn P. Hofhuis

completed his MSc in forest and nature conservation at Wageningen University (2018). His work in Ladakh was part of an internship at the Snow Leopard Conservancy India Trust. He is currently pursuing a PhD in ecology at the Northern Populations and Ecosystems Group of the University of Tromsø, working with red foxes in the Arctic tundra.

Email: stijn_hofhuis@hotmail.com

Abstract

The Trans-Himalayan high-altitude desert of Ladakh, presently part of northern India, is characterised by a high diversity of mammalian species. Yet because of low precipitation and a history of hunting or competition with livestock, the density of these mammals is generally very low. In addition to the remote and rugged mountainous terrain, the dispersed nature of these mammals in the landscape poses major challenges for standard survey techniques.

We develop a standardised protocol for collecting Local Ecological Knowledge (LEK) on mammal-species distributions and relative abundances in Ladakh. The protocol is based on existing research that was refined in cooperation with the Local community through interviews conducted in villages throughout the mountainous landscape. We then compared the outcomes of the LEK protocol to those of detailed published surveys previously carried out by two of the authors (Namgail and Prins) in the same areas. We also checked the consistency of the outcomes within villages and between nearby villages.

The described protocol is a cost-effective way of collecting LEK on mammal distributions and relative abundances. The collected LEK appears to be accurate and consistent on both larger and smaller spatial scales.

We conclude that Local communities in Ladakh can contribute significantly to conservation efforts in these remote and vulnerable mountain landscapes. Developing new methods and insights into the use of LEK can benefit similar remote areas facing conservation challenges.

Keywords:

LEK | interview protocol | mountain desert | Himalayas | herbivores

Introduction

Conservation efforts worldwide rely on accurate ecological knowledge of the species that are under threat. Knowledge of species' spatial distributions and abundances is fundamental, as it helps identify conservation priorities, assess threats and determine conservation status (Ceballos et al., 2005; Hoffmann et al., 2010; Boitani et al., 2011). This fundamental knowledge is not always available, especially in remote and inaccessible regions where conventional survey methods are impractical and labour-intensive (Gilchrist et al., 2005). In contexts where conservation efforts are hindered by a lack of data, alternative survey methods should be sought.

In recent years, the ecological knowledge of local people is increasingly recognised as a valuable source of knowledge to be used in scientific methods and conservation strategies (Brook & McLachlan, 2008). Local Ecological Knowledge (LEK) is based on generations of life experience and the observations of people living in natural environments (Gilchrist et al., 2005; Brook & McLachlan, 2008). This knowledge is typically local in scale and rich in observations over long (lifetime) periods (Nakashima, 1993; McGregor, 2000). In contrast, conventional scientific methods are often based on observations at a specific point in time (Gadgil et al., 1993) and are more effective at discerning underlying ecological mechanisms that can be applied elsewhere (Bart, 2006; Peloquin & Berkes, 2009). These differences do not necessarily mean that LEK and conventional scientific methods lead to different conclusions (e.g. Polfus et al., 2014). Instead, each knowledge system can complement the other (Bart, 2006; Polfus et al., 2014).

Particularly, in regions that are inaccessible and impractical to survey using conventional methods, LEK can be an effective way to fill gaps in knowledge (Gilchrist et al., 2005). Previous studies have used LEK to estimate species abundances, distributions and long-term population trends (e.g. Ferguson et al., 1998; Mallory et al., 2003; Vaughan et al., 2003; Moller et al., 2004; Ehrich et al., 2016). The use of LEK has shown promising results in terms of accuracy and cost-effectiveness (van der Hoeven et al., 2004; Anadón et al., 2009). Therefore, LEK should be considered in areas where essential ecological knowledge is still limited, such as in the remote Ladakh region.

Ladakh is a high-altitude desert that stretches between the plains of the Tibetan Plateau and the rugged peaks of the Indian Trans-Himalaya. The region is unique in that it straddles four different zoogeographic regions: the Sino-Japanese, Oriental, Saharo-Arabian and Palearctic (Holt et al., 2013). Ladakh's location has led to a high diversity of

mammalian species (Namgail, 2009a). Yet because of low precipitation and a history of hunting or competition with livestock, the density of these mammals is generally very low (Namgail, 2009b). In addition to the rugged mountainous terrain, the dispersed nature of these mammals in the landscape poses major challenges for standard surveying techniques.

Sports hunters provided the first anecdotal information on Ladakh's mammals in the early 20th century (e.g. Stockley, 1936). Later, Fox et al. (1991), Mallon (1991), Namgail (2009b) and Shawl et al. (2011) conducted more systematic surveys that have given estimates of abundances, indicating that some species are relatively common whereas others have very small and patchy populations. Further research on the distribution of mammalian herbivores in Ladakh has indicated two main geographical groups: species on the high plains in the east and those in more rugged mountainous areas in the west (Namgail et al., 2013).

Many of Ladakh's mammals are currently listed as vulnerable or near threatened (IUCN, 2020; Namgail, 2009a). More accurate knowledge about their distributions and abundances is needed to conserve these species. This study explores the potential of LEK to acquire this knowledge. The purpose of this study is twofold. First, we designed and tested a protocol for collecting LEK in Ladakh. Second, we analysed the potential of the collected data in terms of accuracy and consistency.

Methods

Designing a protocol to collect LEK

LEK can be collected using varying methods (Huntington, 2000). The first challenge is selecting and finding a target group of local experts with the knowledge of interest. The target group of experts must be clearly defined so that the information received is of high quality and is comparable between different interviews (Davis & Wagner, 2003; Anadón et al., 2009). The next challenge is to ask the right questions to obtain information that is useful to the research objectives (Huntington, 2000).

In this study, an initial questionnaire was constructed and tested during 86 interviews conducted in June and July 2018 within 16 villages located in three sampling areas in Ladakh (Figure 1). A range of potential local experts was interviewed, the majority of whom were livestock herders (n=18), farmers (n=15), retired military personnel (n=9) and individuals working with both livestock herding and farming (n=35). In addition to demographic questions and questions about the interviewees' daily

activities, the researchers asked about the presence and relative abundance of the following mammalian herbivore species: urial (*Ovis orientalis vignei*), Asiatic ibex (*Capra ibex sibirica*), blue sheep (*Pseudois nayaur*), Tibetan argali (*Ovis ammon hodgsoni*), Tibetan wild ass or kiang (*Equus kiang*), marmot (*Marmota spp.*), hare (*Lepus spp.*) and pika (*Ochotona spp.*). The researchers also asked about the presence (but not abundance) of the following predators: snow leopard (*Uncia uncia*), Eurasian lynx (*Lynx lynx isabellinus*), the Pallas's cat (*Otocolobus manul*), Tibetan wolf (*Canis lupus chanku*), wild dog (*Cuon alpinus*), red fox (*Vulpes vulpes*), brown bear (*Ursus arctos*), mountain weasel and stoat (*Mustela erminea* and *Mustela altaica*) and stone marten (*Martes foina*).

Figure 1. The location of Ladakh within India and the 16 sampled villages within three sampling areas

Source: ESRI (2018)

Interviews were conducted in English and Ladakhi with the help of an interpreter. The team wrote a final protocol for collecting LEK based on the 86 attempted interviews, discussions with the interpreter and recommendations from the literature. This protocol describes the preferred method for collecting LEK about mammal distributions and abundances in Ladakh.

Analysing the accuracy and consistency of collected LEK

The LEK on mammal distributions and abundances was mapped in ArcGIS (ESRI, 2017). The team checked the large-scale accuracy of LEK by comparing the data to previous presence-absence surveys of mammalian herbivores within 120 grid cells, each 20x20 km, throughout Ladakh (Namgail et al., 2013). The team compared the data visually and statistically by computing the kappa coefficient between LEK in the village and the nearest grid cell location in R statistical software (R Studio Team, 2019).

No reference data were available to test the accuracy of the LEK on a smaller scale. The small-scale consistency of the data was analysed using the incremental spatial autocorrelation test in ArcGIS (ESRI, 2017) over distances of 1 to 35 km. In addition, the collected data were compared to the average altitude and terrain ruggedness within 2 km of the relevant village (ESRI, 2018) to compare the LEK on mammal abundances to the known habitat use of the mammals.

Results

Protocol to collect LEK

The following protocol describes the preferred method for collecting LEK about mammal distributions and abundances in Ladakh. The team developed the protocol based on the premise that interviews are the most effective way of gathering LEK. These interviews were conducted with local experts in villages throughout Ladakh. The following steps describe the suggested selection criteria of the local experts, the questions to ask in the interviews and how to conduct analyses of data collected. Researchers need to decide beforehand which animal species are of interest and adjust the protocol accordingly.

STEP 1: Selecting and finding local experts

The target group of local experts is defined as people who have lived in the respective village for at least 10 years in both the summer and winter seasons and who are not physically challenged (e.g. due to bad eyesight) to observe wildlife. We recommend a minimum sample size of seven local experts per village. Our data show that this sample size substantially reduces the margin of error while still being a realistic sampling goal. Villages more than 3 km apart should be sampled because mammal abundances sometimes change abruptly on a small spatial scale.

Chain referrals, where one interviewee is asked to suggest the next one (Huntington, 2000), have proved most effective at finding local experts. The very elderly were often recommended in chain referrals as they were considered knowledgeable. However, mental and physical limitations often excluded them from our target group.

STEP 2: Introduction to interview

Upon finding a potential local expert to interview, confirm they match the target group criteria and then introduce the aim of the interview. Then ask for permission to conduct a short 20-minute interview.

STEP 3: Demographic questions

Demographic questions are part of the protocol to check the chain referral and allow researchers to refine the target group after analysing the accuracy and consistency of collected LEK. The demographic information will also be helpful if researchers return and engage in community participation and knowledge sharing in the future. Names of interviewees must be treated confidentially and not be made public. Data can be stored in a secured research group directory, with the names of interviewees stored in a separate file. Demographic information collected should include:

1. Name,
2. Age,
3. Highest level of education (grade reached),
4. Previous experience with giving interviews.
   If so, who conducted the interview?
5. Occupation,
6. Gender,
7. Date,
8. Village name, and
9. Name of researchers and interpreter conducting the interview.

STEP 4: Sampling exposure of local expert

In Step 4, the interviewer determines the sampling exposure (activity) of the interviewee in the mountains surrounding the village by asking the following question:

1. Is the interviewee active in the mountains surrounding the village through herding livestock, collecting plants or doing other outdoor activities?

- If yes:
  1. In summer, approximately how many times per month do they travel in the mountains?
  2. Approximately how many km do they travel each time?
  3. In winter, approximately how many times per month do they travel in the mountains?
  4. Approximately how many km do they travel each time?
     - If only active during one season per year, ask if the interviewee stays in the village during the other season. If the interviewee does not reside in the village during all seasons, they do not match the target group description.
- If no:
  1. Do they stay in the village in both the summer and winter seasons?
     - If no, the interviewee does not match the target group description.
  2. How many years ago did they travel in the mountains surrounding the village?

STEP 5: Recognition of animals

Before proceeding to the next step, the interviewer should ensure that the interviewee is alone and is not receiving any external help while responding to questions. Interviews potentially influenced by bystanders or interviewees listening to previous interviews should not be included in the study.

In this step, the interviewer shows images of different animal species to the interviewee. Start with a species of animal that is known to occur in the area and is easily recognizable (e.g. the hare or marmot). In this way, the interview starts on a positive note, and the interviewee understands what is expected of them.

1. Show a previously prepared card with images of the animal in question. Make sure that only one species is shown at a time. Let the interviewee examine the image of the animal for a few seconds.
2. Ask what animal is shown on the card.
   - If the interviewee gives the correct name in the Ladakhi language, the animal is recognised.
   - If the animal is sexually dimorphic, record if only one of the sexes is recognised (both sexes have different names in Ladakhi).
   - If the interviewee gives a wrong answer, wait a few seconds for the interviewee to reconsider the answer.
   - If the interviewee answers *ridaks* (a generic name for mountain ungulates in Ladakh), explain that you want to know which kind

of *ridaks* is represented in the image. If the interviewee still does not understand, show several animal species simultaneously and indicate that these are all *ridaks* but that you are interested in knowing what kind of *ridaks* is shown on the card in question. If they still answer with *ridaks*, they do not recognise the animal in question.

- If the interviewee indicates that they know the animal but has only temporarily forgotten the name, give them some time. After a while, you can help the interviewee by mentioning the correct name in a questioning way. The interviewee's reaction will indicate whether they are familiar with the animal or not.
- If the interviewee is confused about the size of the animal represented (e.g. the interviewee answers house cat when showing the lynx), indicate the approximate size of the animal to help the interviewee.
- Do not correct the interviewee when a wrong answer is given unless they explicitly ask for the correct answer.
- If the interviewee recognises the animal, continue with steps 6 through 9. Return to step 5 for each new animal species (i.e. run through all of the questions for each species separately).
- If the interviewee does not recognise the animal, assume that the animal is unknown and ask no further questions.

STEP 6: Presence/absence of animal

1. Ask whether the recognised animal occurs in the village or the nearby mountains surrounding it.
   - The Ladakhi language has separate names for males and females of some sexually dimorphic species. To prevent confusion when asking about sexually dimorphic species, do the following:
     - If the animal is sexually dimorphic and the interviewee recognises both sexes, ask whether both sexes occur (e.g. do *skin* [male ibex] AND *dadmo* [female ibex] occur in the village or the nearby mountains surrounding it?).
     - If the animal is sexually dimorphic and the interviewee recognises only one of the sexes, ask whether this sex occurs (e.g. does *skin* (male ibex) occur in the village or the nearby mountains surrounding it?).
   - The considered area (the village and the nearby mountains) includes the village high pasture (*phu*) but no further.
   - If the animal occurs, continue to step 7.
   - If the animal does not occur, ask no further questions.

STEP 7: Relative abundance of animal

1. Ask when the interviewee last saw the animal in the considered area.
   - For sexually dimorphic species, ask when either of the sexes was last seen.
2. For ungulate species usually seen in groups, ask the maximum group size seen in the considered area.

STEP 8: Temporal changes in abundance

1. Ask the interviewee if the abundance of the animal in the considered area has increased, decreased or stayed the same over the last 10 years.
   - If increased: Ask if the animal has become twice as abundant or more.
   - If decreased: Ask if the animal has become half as abundant or less.
   - Ask for possible reasons explaining the increase or decrease.
2. Tell the interviewee it is okay if they do not know the answer. If they do not know the answer, record it as “unknown.”

STEP 9: Next animal

1. Return to step 5 to ask about the next species of interest.
   - If the interviewee seems tired, give the interviewee a mental break by showing an animal that is more common and easier to recognise. If you are not interested in asking about each animal in detail, save these for the end so that the interviewee is still energised when answering the more difficult questions. It is also nice to end the interview with an easier animal to conclude on a positive note.
2. When all animals of interest have been questioned about, continue to step 10.

STEP 10: End of interview

1. Thank the interviewee for their participation.
2. Ask the interviewee to suggest other knowledgeable people from the same village that match the target group description.

STEP 11: Data analysis

We suggest analysing the collected data in the following ways:

1. Presence/absence: A species can be considered present within a village when indicated by the majority of the interviewees. Mapping village locations with the associated presence or absence of the animal in question can result in large-scale distribution maps. Furthermore, presence-absence data may be combined with environmental data to inform species distribution models and predict distributions in areas not directly sampled (Evangelista et al., 2018).
2. Relative abundance: To compare interviewees' answers with different sampling exposures, calculate the average daily km travelled by each interviewee (based on the answers collected in step 4 of the protocol). Because some interviewees are not active in the surrounding mountains, assume that all interviewees travel at least 1 km per day within the village (add 1 km to each interviewee's daily distance). Multiply the average daily km by the number of days since an animal was last observed. This measure describes the approximate distance in km travelled since an animal was last observed. Divide the results over the following scale: 0–3 km; >3–10 km; >10–30 km; >30–100 km; >100–500 km; > 500 km; and "never observed." Use a colour palette to assign a different colour to each category of relative abundance. The relative abundances reported by the interviewees within one village can be plotted as a cluster of coloured dots on the mapped village location. This will result in a smaller-scale relative abundance map of the animal in question. The relative abundance may be calibrated in the future by conducting count surveys of the species of interest near some of the sampled villages. The maximum group size of a species seen at one time gives an approximate indication of the minimum number of individuals of that species in the area.
3. Temporal changes in abundance: Results regarding temporal changes in animal abundances may primarily be used to gain insight into possible population dynamics, which may help formulate hypotheses on potential threats and aid further research efforts.

Accuracy and consistency of collected LEK

A visual comparison between the collected LEK about the presence/absence of mammalian herbivores and data collected in a previous survey by Namgail et al. (2013) is shown in Figures 2 and 3. The kappa coefficient of agreement between both sources of data was 0.69.

COLLECTED LEK

- Animal present in village and surrounding mountains
- Animal absent in village and surrounding mountains

REFERENCE DATA

- Animal present in 20 x 20 km grid cell (Namgail et al. 2013)
- Animal absent in 20 x 20 km grid cell (Namgail et al. 2013)

Figure 2. The presence/absence of urial, ibex, blue sheep and argali within the 16 sampled villages in Ladakh

Animals were considered to be present within the village and surrounding mountains when answered so by the majority of interviewees in the village. To assess the accuracy of the LEK, the presence/absence data are mapped alongside data reported by Namgail et al. (2013)

Source: ERSI (2018)

COLLECTED LEK

- Animal present in village and surrounding mountains
- Animal absent in village and surrounding mountains

REFERENCE DATA

- Animal present in 20 x 20 km grid cell (Namgail et al. 2013)
- Animal absent in 20 x 20 km grid cell (Namgail et al. 2013)

Figure 3. The presence/absence of kiang, marmots, hares and pikas within the 16 sampled villages in Ladakh

Animals were considered to be present within the village and surrounding mountains when answered so by the majority of interviewees in the village. To assess the accuracy of the LEK, the presence/absence data are mapped alongside data reported by Namgail et al. (2013)

Source: ESRI (2018)

The LEK about the relative abundances of mammalian herbivores is illustrated in Figures 4 and 5. This LEK showed significant spatial autocorrelation over distances of 1 to 25 km (Figure 6).

Figure 4. The relative abundances of urial, ibex, blue sheep and argali, as indicated by the approximate distance travelled since the last observation

The three grey boxes for each species illustrate the three sampled areas in Ladakh, and a cluster of dots illustrates each sampled village. A single dot within this cluster illustrates each separate interview

Source: Data compiled by the chapter authors

Figure 5. The relative abundances of kiang, marmots, hares and pikas, as indicated by the approximate distance travelled since the last observation

The three grey boxes for each species illustrate the three sampled areas in Ladakh, and a cluster of dots illustrates each sampled village

Source: Data compiled by the chapter authors

Figure 6. The spatial autocorrelation in the approximate distance travelled since interviewees last observed the animal

This autocorrelation is indicated by the Moran's I statistic and is plotted for a range of considered distances. Values higher than the threshold indicated by the 95% confidence interval indicate significant clustering. Spatial autocorrelation values for kiang and argali are not plotted because these animals were not consistently sampled

Source: Data compiled by the chapter authors

The abundances of some (but not all) herbivore species reported in this study showed trends with terrain ruggedness and altitude that were consistent with the known habitat use of these species as found in the existing literature. As seen in Figure 7, urials were most frequently observed in the terrain of lower altitude and lower terrain ruggedness. This is in accordance with Pfister (2004), who describes the distribution of urials as restricted to lower valley slopes between 3,000 and 4,000 m altitude. Compared to urials, blue sheep were more frequently observed in areas of higher altitude and higher terrain ruggedness (Figure 7), which is in accordance with Namgail et al. (2010). The relative abundance of ibex showed no clear trends with either altitude or terrain ruggedness (Figure 7). This is in contrast to Fox et al. (1992), who describe ibex in Ladakh as occurring mainly between 4,000 and 4,800 m altitude and in rugged terrain. The relative abundances of marmots and hares showed no clear trends with either altitude or terrain ruggedness (Figure 7). The two species of marmot and hare that occur in Ladakh share common names in Ladakhi but have different

habitat preferences, according to Pfister (2004). The relative abundance of pikas increased distinctly with both altitude and terrain ruggedness (Figure 7), but Pfister (2004) reports that the different species of pika that occur in Ladakh have widely varying habitat preferences.

Figure 7. The relative abundances (as indicated by the approximate distance travelled since the last observation) of six sampled herbivores against the average altitude and terrain ruggedness within 2 km of the sampled village

Values for kiang and argali are not plotted because these animals were not consistently sampled

Source: Data compiled by the chapter authors

LEK on the presence of predators indicated that some occur throughout the sampled area (snow leopard, wolf, red fox, weasel and stoat). In contrast, some occur rarely (lynx, wild dog and the Pallas's cat), or only within one of the sampled areas (brown bear) (Figure 8). In agreement with these results, Pfister (2004) writes that red fox, wolf and mountain weasel are indeed occasional to common residents, that lynx, the Pallas's cat and wild dog are rare residents, and that the brown bear is more likely encountered in western Ladakh. In contrast to the collected LEK, Pfister (2004) describes the snow leopard as a rare resident.

Figure 8. The presence/absence of nine predators within villages and their surrounding mountains indicated by interviewees

The three grey boxes illustrate the three sampled areas, and a cluster of dots illustrates each sampled village. A single dot within this cluster illustrates each separate interview

Source: Data compiled by the chapter authors

Discussion

Protocol to collect LEK

The described protocol is a potentially effective way of collecting LEK on mammal distributions and abundances in Ladakh. The main advantage of this method is its cost-efficiency. This relatively simple method can be followed independently by volunteers or graduate students with the help of an interpreter. Each interview takes approximately 20 to 30 minutes. Accounting for travel time, this means that one village can be sampled per day. Resourceful ways to travel between villages include bus service, shared taxi, hitch-hiking or walking. This makes the method simple, cheap and fast.

The described protocol should not be considered absolute, as the method may be adjusted as new insights are acquired. There are several areas of the protocol that show potential for improvement. First of all, the target group of local experts is still quite broad. Davis and Wagner (2003) argue that the target group should be defined as clearly and precisely as possible to get accurate and comparable data. Further efforts can be put into defining a target group of local experts that is specific and knowledgeable but also present in a sufficient sample size within each village. Furthermore, inquiring about the relative abundance of a species is one of the most challenging but informative questions to ask during the interview. There is a trade-off between asking comprehensible and straightforward questions to the interviewee and asking complex questions that may draw more meaningful and unbiased information. The method currently used in step 7 of the protocol is relatively simple but fails to consider possible variations in a species' abundance throughout the year. Furthermore, some interviewees have difficulties expressing the distance they travel in kilometres, making their sampling exposure challenging to determine. Alternative questions should be considered.

Accuracy and consistency of collected LEK

The collected LEK on the presence/absence of mammalian herbivores matched well with data collected by Namgail et al. (2013) (Figures 2 and 3). The kappa coefficient of 0.69 is considered to indicate "fair to good agreement beyond chance" (Fleiss et al., 2003). The LEK, therefore, seems accurate on a large spatial scale. On a smaller spatial scale, LEK on the relative abundances of mammalian herbivores showed significant spatial autocorrelation (Figure 6). The fact that the answers given by the interviewees are correlated spatially indicates that the answers are consistent. In other words, interviewees within the same village and between nearby villages gave similar answers regarding their

observations of mammalian herbivores, implying that the answers are not random and may reflect the actual distribution patterns of the species in question. The collected LEK on the presence/absence and relative abundance of mammalian herbivores, therefore, shows potential in terms of accuracy and consistency on larger and smaller spatial scales.

The LEK on the relative abundances of urials and blue sheep matched well with the known habitat use of both species described in the literature (Figure 7; Pfister, 2004; Namgail et al., 2010). However, LEK on the relative abundance of ibex did not match with the known habitat use (Figure 7; Fox et al., 1992). Some interviewees travelled greater distances from the village than others, and ungulates may sometimes be observed from afar. The habitat features measured at a radius of 2 km from the village may therefore not accurately reflect the habitat in which some animals were observed. Therefore, future studies aiming to incorporate LEK to research small-scale habitat use should aim to determine where the animals are observed more accurately. In addition, the Ladakhi language does not differentiate between different species of marmots, hares and pikas that have different habitat preferences (Pfister, 2004). This makes it challenging to use LEK to research the habitat use of these species.

The LEK on the presence/absence of predators indicated that some occur throughout the sampled area, whereas others occur rarely or only within one of the sampled areas (Figure 8). Except for the widespread reported occurrence of snow leopards, these findings roughly correspond to what is described by Pfister (2004). The fact that LEK found snow leopards to be widespread may be related to the fact that they predate on livestock, which is a significant economic loss for affected households (Jackson & Wangchuk 2004). Because encounters with snow leopards are likely to be very memorable experiences, the occurrence of snow leopards may be comparatively overestimated in LEK. Regardless, we cannot draw conclusions on the abundance of these predators based on presence-absence data only. Asking questions from which relative abundances can be inferred is therefore advisable. Because the specifics of every animal cannot be questioned in detail during each interview, researchers must carefully choose beforehand as to which species are of interest to them.

By conducting strategic count surveys in areas where LEK has been collected, the accuracy of LEK and the best means to collect LEK can be further analysed. Furthermore, data from count surveys can calibrate relative abundance estimates from LEK and thus help estimate population sizes on a larger scale. This will enable the detection of threats and priority areas for conserving Ladakh's vulnerable and unique diversity of mammals.

Conclusion

The described protocol is a cost-effective way of collecting LEK on mammal distributions and relative abundances in Ladakh. The LEK collected using this protocol appears to be accurate and consistent on both large and smaller spatial scales. Based on these findings, LEK can potentially help us learn more about the distribution and relative abundances of Ladakh's mammals. This valuable information can lead to more detailed population estimates and identification of priority areas to allocate conservation resources. Thus, LEK may provide a valuable contribution to conservation efforts in Ladakh.

This method should not be considered absolute and can be improved as new insights and ideas are acquired. Recognising the value of LEK and reflecting upon its strengths and weaknesses may benefit conservation efforts in Ladakh and other remote regions of conservation concern.

Acknowledgements

This study was facilitated by the employees and volunteers of the Snow Leopard Conservancy India Trust. Special gratitude goes to Lobzang Angchuk for his skills in interpreting between English and Ladakhi, and Mohammad Raza and Serena Carpentari for their help and company in the field. Finally, great appreciation is expressed to all interviewees and the people of Ladakh for their generous and welcoming nature.

References

- Anadón, J.D., Giménez, A., Ballestar, R. and Pérez, I. (2009). 'Evaluation of Local Ecological Knowledge as a Method for Collecting Extensive Data on Animal Abundance'. *Conservation Biology* 23:617–625. https://doi.org/10.1111/j.1523-1739.2008.01145.x
- Bart, D. (2006). 'Integrating Local Ecological Knowledge and Manipulative Experiments to Find the Causes of Environmental Change'. *Frontiers in Ecology and the Environment* 4:541–546. https://doi.org/10.1890/1540-9295(2006)4[541:ilekam]2.0.co;2
- Boitani, L., Maiorano, L., Baisero, D., Falcucci, A., Visconti, P. and Rondinini, C. (2011). 'What Spatial Data Do We Need to Develop Global Mammal Conservation Strategies?'. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 366:2623–2632. https://doi.org/10.1098/rstb.2011.0117
- Brook, R.K. and McLachlan, S.M. (2008). 'Trends and Prospects for Local Knowledge in Ecological and Conservation Research and Monitoring'. *Biodiversity and Conservation* 17:3501–3512. https://doi.org/10.1007/s10531-008-9445-x
- Ceballos, G., Ehrlich, P.R., Soberón, J., Salazar, I. and Fay, J.P. (2005). 'Global Mammal Conservation: What Must We Manage?'. *Science* 309:603–607. https://doi.org/10.1126/science.1114015
- Davis, A. and Wagner, J.R. (2003). 'Who Knows? On the Importance of Identifying "Experts" when Researching Local Ecological Knowledge'. *Human Ecology* 31:463–489. https://doi.org/10.1023/A:1025075923297
- Ehrich, D., Strømeng, M.A. and Killengreen, S.T. (2016). 'Interference in the Tundra Predator Guild Studied Using Local Ecological Knowledge'. *Oecologia* 180:1195–1203. https://doi.org/10.1007/s00442-015-3521-1
- Environmental Systems Research Institute (ESRI) (2017). ArcGIS Desktop: Release 10.5.1. Redlands, CA: Environmental Systems Research Institute.
- ESRI. (2018). 'World Elevation Terrain' and 'World Hillshade' Image Services. *Elevation Layers.* https://www.arcgis.com/home/group.html?id=bbc5f50839094e9d8dc5255b6a7783dd
- Evangelista, P.H., Mohamed, A.M., Hussein, I.A., Saied, A.H., Mohammed, A.H. and Young, N.E. (2018). 'Integrating Indigenous Local Knowledge and Species Distribution Modeling to Detect Wildlife in Somaliland'. *Ecosphere* 9: e02134. https://doi.org/10.1002/ecs2.2134
- Ferguson, M.A., Williamson, R.G. and Messier, F. (1998). 'Inuit Knowledge of Long-Term Changes in a Population of Arctic Tundra Caribou'. *Arctic* 11:201–219. https://doi.org/10.14430/arctic1062
- Fleiss, J.L., Levin, B. and Paik, M.C. (2003). *Statistical Methods for Rates and Proportions* (3rd ed.). Hoboken, NJ: John Wiley Sons. https://doi.org/10.1002/0471445428
- Fox, J.L., Nurbu, C. and Chundawat, R.S. (1991). 'The Mountain Ungulates of Ladakh, India'. *Biological Conservation* 58:167–190. https://doi.org/10.1016/0006-3207(91)90118-s
- Fox, J.L., Sinha, S.P. and Chundawat, R.S. (1992). 'Activity Patterns and Habitat Use of Ibex in the Himalaya Mountains of India'. *Journal of Mammalogy* 73:527–534. https://doi.org/10.2307/1382018

- Gadgil, M., Berkes, F. and Folke, C. (1993). 'Indigenous Knowledge for Biodiversity Conservation'. *Ambio* 22: 151–156.
- Gilchrist, G., Mallory, M. and Merkel, F. (2005). 'Can Local Ecological Knowledge Contribute to Wildlife Management? Case Studies of Migratory Birds'. *Ecology and Society* 10:106–136. https://doi.org/10.5751/es-01275-100120
- van der Hoeven, C.A., de Boer, W.F. and Prins, H.H. (2004). 'Pooling Local Expert Opinions for Estimating Mammal Densities in Tropical Rainforests'. *Journal for Nature Conservation* 12:193–204. https://doi.org/10.1016/j.jnc.2004.06.003
- Hoffmann, M., Hilton-Taylor, C., Angulo, A., Böhm, M., Brooks, T.M., Butchart, S.H., ... and Darwall, W. R. (2010). 'The Impact of Conservation on the Status of the World's Vertebrates'. *Science* 330: 1503–1509. https://doi.org/10.1126/science.1194442
- Holt, B.G., Lessard, J.P., Borregaard, M.K., Fritz, S.A., Araújo, M.B., Dimitrov, D., ... and Nogués-Bravo, D. (2013). 'An Update of Wallace's Zoogeographic Regions of the World'. *Science* 339:74–78. https://doi.org/10.1126/science.1228282
- Huntington, H.P. (2000). 'Using Traditional Ecological Knowledge in Science: Methods and Applications'. *Ecological Applications* 10: 1270–1274. https://doi.org/10.1890/1051-0761(2000)010[1270:utekis]2.0.co;2
- International Union for Conservation of Nature (IUCN) (2020). *The IUCN Red List of Threatened Species*. Version 2020-2. http://www.iucnredlist.org
- Jackson, R.M. and Wangchuk, R. (2004). 'A Community-Based Approach to Mitigating Livestock Depredation by Snow Leopards'. *Human Dimensions of Wildlife* 9:1–16. https://doi.org/10.1080/10871200490505756
- Mallon, D.P. (1991). 'Status and Conservation of Large Mammals in Ladakh'. *Biological Conservation* 56:101–119. https://doi.org/10.1016/0006-3207(91)90092-n
- Mallory, M.L., Gilchrist, H.G., Fontaine, A.J. and Akearok, J.A. (2003). 'Local Ecological Knowledge of Ivory Gull Declines in Arctic Canada'. *Arctic* 21:293–298. https://doi.org/10.14430/arctic625
- McGregor, D. (2000). 'The State of Traditional Ecological Knowledge Research in Canada: A Critique of Current Theory and Practice'. *Expressions in Canadian Native Studies* 10:436–458.
- Moller, H., Berkes, F., Lyver, P.O.B. and Kislalioglu, M. (2004). 'Combining Science and Traditional Ecological Knowledge: Monitoring Populations for Co-Management'. *Ecology and Society* 9:13–43. https://doi.org/10.5751/es-00675-090302
- Nakashima, D.J. (1993). 'Astute Observers on the Sea Ice Edge: Inuit knowledge as a Basis for Arctic Co-Management'. *Traditional Ecological Knowledge Concepts and Cases* 1:89–97.
- Namgail, T. (2009a). 'Geography of Mammalian Herbivores in the Indian Trans-Himalaya: Patterns and Processes'. PhD thesis. Wageningen: Wageningen University.
- Namgail, T. (2009b). 'Mountain Ungulates of the Trans-Himalayan Region of Ladakh, India'. *International Journal of Wilderness* 15:35–40.
- Namgail, T., van Wieren, S.E., Mishra, C. and Prins, H.H.T. (2010). 'Multi-Spatial Co-Distribution of the Endangered Ladakh Urial and Blue Sheep in the Arid Trans-Himalayan Mountains'. *Journal of Arid Environments* 74:1162–1169. https://doi.org/10.1016/j.jaridenv.2010.04.013

- Namgail, T., van Wieren, S.E.V. and Prins, H.H. (2013). 'Distributional Congruence of Mammalian Herbivores in the Trans-Himalayan Mountains'. *Current Zoology* 59:116–124. https://doi.org/10.1093/czoolo/59.1.116
- Peloquin, C. and Berkes, F. (2009). 'Local Knowledge, Subsistence Harvests, and Social–ecological complexity in James Bay'. *Human Ecology* 37:533–545. https://doi.org/10.1007/s10745-009-9255-0
- Pfister, O. (2004). *Birds and Mammals of Ladakh*. Oxford: Oxford University Press.
- Polfus, J.L., Heinemeyer, K. and Hebblewhite, M. (2014). 'Comparing Traditional Ecological Knowledge and Western Science Woodland Caribou Habitat Models'. *The Journal of Wildlife Management* 78:112–121. https://doi.org/10.1002/jwmg.643
- R Studio Team. (2019). RStudio: Integrated Development Environment for R, version 125033. Boston: R Studio Inc.
- Shawl, T., Takpa, J. and Namgail, T. (2011). 'Distribution and Encounter Rates of Large Herbivores in Chang Chenmo and Daulat Beg Oldi, Ladakh, Jammu and Kashmir, India'. *Our Nature* 9:55–60. https://doi.org/10.3126/on.v9i1.5734
- Stockley, C.H. (1936). *Stalking in the Himalayas and Northern India*. London: Roche Press.
- Vaughan, N., Lucas, E.A., Harris, S. and White, P.C. (2003). 'Habitat Associations of European Hares Lepus Europaeus in England and Wales: Implications for Farmland Management'. *Journal of Applied Ecology* 40:163–175. https://doi.org/10.1046/j.1365-2664.2003.00784.x

CHAPTER

2

Alternative management of mountain ecosystems in the Sierra de Santa Marta

Ecology of knowledge for integral sustainability, notes from Veracruz, Mexico[1]

By

Dr. Jesús Moreno Arriba

Department of Geography, Faculty of Geography and History

University of Salamanca (USAL), Spain

1 The paper draws from the author's doctoral dissertation: *The management of natural resources in the Sierra de Santa Marta in Veracruz (Mexico): An example of a strategic alliance of local knowledges and technical-scientific knowledges for sustainability*, carried out at the National University of Distance Education (hereinafter UNED, Spain, 2016). Document available for free access and/or download at: http://e-spacio.uned.es/fez/view/tesisuned:Filosofia-Jmoreno

About the author

Jesús Moreno Arriba

is a Spanish geographer and anthropologist. He has bachelor's degrees in geography from the University of Salamanca (USAL, 2001) and in anthropology from the National University of Distance Education (UNED, 2011). Moreno Arriba also holds an MSc in teacher training (higher education in teaching and research competencies) (UNED, 2013), as well as two PhDs: one in geography (2010) and one in anthropology (2016), both from UNED. For more than 15 years, Moreno Arriba has been working on research and development activities in Spain and Latin America. His research includes rural geography and anthropology, bio-cultural heritage, political ecology, agroecology, interculturality, dialogue/ecology of knowledge and integral sustainability.

Email: jmorenoarriba@usal.es

Abstract

The Sierra de Santa Marta in south-eastern Veracruz (Mexico), which is integrated into the Biosphere Reserve of Los Tuxtlas, has been affected by decades of state and federal led developmentalist, extractivist and assistantialist public policies. The Sierra de Santa Marta is highly dependent on external inputs for the management of natural resources. The area has been overexploited by humans and cattle, which has led to the loss of forest cover as well as a reduction in corn cultivation resulting in a loss of food self-sufficiency. These factors have contributed to sustained underdevelopment and maldevelopment. In turn, demographic densification, combined with a rural exodus, is causing serious overpopulation problems in a fragile environment.

In the face of the failure of hegemonic developmental models, it is urgent to find alternatives that can improve the precarious ecological, demographic and socio-economic reality of this mountain territory, predominantly inhabited by Nahua and Popoluca peasant Indigenous populations. This qualitative study examines a heterogeneous set of five non-governmental socio-ecological projects focused on the management of natural resources, including agrosilvopastoral, fishing and ecotourism projects. These projects promote socio-ecological practices based on emerging and alternative models of development focused on integral sustainability (environmental, economic, social and eco-cultural).

Keywords:

Sierra de Santa Marta (Veracruz, Mexico) | mountain ecosystems management | peasant Indigenous communities | dialogue/ecology of knowledge | integral sustainability

Introduction

The Sierra de Santa Marta (hereafter, the Sierra) is a biologically and culturally important mountain region located in the south-east of the Mexican state of Veracruz. The Sierra is one of two mountain ranges that border Los Tuxtlas, an ancient settlement of the Olmec, Zoque-Popoluca and Nahua peoples. The region constitutes the Biosphere Reserve of Los Tuxtlas (hereafter RBLT, by its Spanish acronym). Archaeological evidence from this region shows that the area's original settlers certainly "knew how to adapt to the conditions of the rainforest to practice agriculture and take advantage of the resources they were offered by the jungles and forests of the mountain" (Blom & La Farge, 1926: 33).

Decades of interventions by federal and state governmental institutions, as well as a wide variety of non-governmental actors and agents from within and outside the region, have formed a fundamentally clientelist socio-political network to manage regional natural, agrosilvopastoral and fisheries resources. Government development policies have largely consisted of programmes of forest clearing and opening of new lands for human settlement alongside the creation of large extensions of pasture to expand cattle ranching that is highly dependent on external inputs. In this context, sustained underdevelopment or more precisely: maldevelopment, has prevailed due to public policy interventions based on harmful developmental and/or extractivist modalities.

These eco-social processes have left a legacy of major transformations in the region with grave consequences for the natural and anthropic environment. The increased colonisation of land for cattle grazing and the intensification of agricultural activities to the detriment of the forest cover (Figure 2) have led to the severe deterioration of natural resources and biodiversity of the Los Tuxtlas. Another side effect has been the loss of food self-sufficiency among the local population, especially in relation to corn cultivation. This has led to the expulsion and displacement of vulnerable Nahua and Popoluca Indigenous peasant communities from their traditional territories. Paternalistic government interventions have led the local population to become dependent on these programmes. Thus, the region faces extreme poverty, low rankings on the Human Development Index (HDI) and pressure on natural and eco-cultural resources. Consequently, *alternatives to development* must be found urgently in order to improve the precarious ecological, demographic and socio-economic reality of this mountain territory predominantly inhabited by peasant Indigenous populations.

Research objectives

The current study analyses the processes and practices of natural resource management—including agrosilvopastoral, fishing and ecotourism—in the Sierra. The main objectives of this research study are the following:

- To identify a significant sample of non-governmental eco-social projects developed since the 1990s in the six municipalities that make up the Sierra. These projects focus on the management of natural resources in the peasant Indigenous communities of the Nahuas and Popolucas, with reference to their most immediate geographic, historical and socio-cultural environment, the RBLT.
- To determine to what extent these non-governmental projects constitute examples of better socio-environmental and eco-cultural practices than those previously implemented in the region by various governmental bodies.
- To examine the extent to which these projects contribute to improving the current precarious reality (ecological, demographic, socio-economic and socio-cultural) facing the peasant Indigenous communities in the area under study.

The secondary objectives of the research are:

- To analyse the ecological, demographic, socio-economic and/or socio-cultural benefits derived from these diverse natural, agrosilvopastoral, fishing and ecotourism resources in the Sierra and Los Tuxtlas.
- To relate these incipient experiences with the ideas behind the emerging development models outlined in the previous section.

Therefore, this study has both empirical and theoretical aims. Empirically, this study contrasts five alternative socio-ecological projects to show their capacity to improve the integral sustainability (socio-ecological, socio-economic and socio-cultural) of the territory and populations under study. On a theoretical level, this study aims to rethink development using *alternatives to development* that posit the idea that another world is possible in terms of environmental relations. I address the theoretical framework below.

Alternatives to development based on integral sustainability

In recent decades, critical positions have questioned the ability of unbridled economic growth to overcome 'underdevelopment' and the catastrophic consequences produced by the process of 'maldevelopment' (Amin, 1990; Slim, 1998; Tortosa, 2001) generated

by Eurocentric, neocolonialist, asymmetric and hegemonic notions of development[2]. New alternative models share an endogenous approach that is opposed to the externality of the dominant model. In short, these new models share the idea that development is possible without giving up local cultural categories. This is also one of the main objectives of the emergent and alternative socio-ecological experiences of the Sierra, which I outline below.

Alternatives to development versus alternative development

Given the intimate relationship between extractivism and development, alternatives to current developmentalism must be generated. I agree with Gudynas (2012) that "it is necessary to identify the orientation of these alternatives" (270-271) to development. Another idea comes from Escobar (2005), who explained that *alternative development* is necessary to reduce and minimise social and environmental costs and to improve the economic contribution of 'development' initiatives. In this model, these are mostly instrumental modifications that persist largely within the conventional paradigm of development. *Alternatives to development*, on the other hand, requires discussing the entire conceptual basis of development, its ways of understanding *nature* and *society*, its institutions, and its discursive defences. These alternatives aim to move towards radically different strategies, not only in their instrumentation, but also in their ideological bases. Weighing these ideas against each other, I propose that the exit route requires *alternatives to development*.

In order to imagine these alternatives, it is necessary to examine the conceptual horizons that support "the exit alternatives of '*predatory extractivism*,' to move on to '*sensible practices*' and from there to

2 Emerging and alternative models to conventional development include ethnodevelopment (Bonfil, 1982, 1987), participatory models (Chambers, 1983; Cernea, l995; Kottak, 1995; Rahnema & Bawtree, 1996), empowerment (Sen & Grown, 1988; Friedman, 1992; Rowlands, 1997; León, 1997; James, 1999), interculturality (Dietz, 2008, 2009, 2011 & 2012; Mateos & Dietz, 2010; Walsh, 2003), dialogue and ecology of knowledge (Argueta, 2011; Bastidas et al., 2009; Canclini, 2004; Castilleja, 2011; Castillo, 2011; De la Cadena, 2006; Díaz-Tepepa et al., 2011; Dietz et al., 2011; Escobar, 2007; Galvani, 2008; Gutiérrez & Gómez, 2011; Hersch, 2011; Lazos, 2011; Leff, 2003; Mignolo, 2005; Moreno-Arriba, 2016; Santos, 2005, 2006, 2007b, 2009; Toledo, 2011; Walsh et al., 2003; Zolla, 2011), political ecology (Carpintero, 1999; Descola & Pálsson, 2001; Dobson; 1997; Georgescu-Roegen, 1996; Gorz, 1982; Illich, 2006; Leff, 2003; Lipietz, 2002; Marcellesi, 2012; Martínez Alier, 1991; Porto-Gonçalves, 2001; Riechmann & Naredo, 1995: Roustang, 2003), agroecology (Altieri, 1987; Ellen, 1982; Hecht, 1999; Krantz et al., 1974), and *alternativas al desarrollo* (Escobar, 1996, 1998, 2000, 2010, 2012; Gudynas, 2011, 2012; Narotzky, 2010). All of these models are oriented towards integral sustainability (environmental, economic and social).

the '*indispensable ones*'" (Gudynas, 2011: 391-392). In recent discourses on development, various authors have introduced the notion of dialogue/ecology of knowledge (Leff, 2003; Argueta, 2011; Toledo, 2011) and/or intercultural dialogue.[3] Santos (2006) and other authors claim that "the need to expand the so-called 'intercultural dialogues', is often essentially limited to epistemic exchanges between 'representatives' of certain 'cultures', 'religions' or 'civilisations', towards an 'ecology of knowledge'" (Santos, 2006; Galvani, 2008). A more *integrated* and *ecological* approach would include a whole "set of practices that promote a new active coexistence of knowledge with the assumption that all of them, including scientific knowledge, can be enriched in this dialogue" (Santos, 2005). In the context of Latin America, these dialogues on knowledge should include studying, systematising and intertwining Indigenous peoples' and other peasant groups' ecological and environmental knowledge (Leff, 2003; Santos, 2006).

For García-Canclini (2004: 181), the "intercultural construction of knowledge" is based on a long-standing Latin American tradition of close collaboration between social movements and grassroots groups, on the one hand, and activist intellectuals and academics, on the other hand. Ultimately, this dialogic approach among academics, social actors and government sectors can "interrelate and thereby decolonise various knowledges layperson, popular, traditional, urban, peasant, provincial, of non-western cultures, that circulate in society" (Santos, 2007a: 67).

Converging with the reflections of authors such as Bretón (2010) and Escobar (2010), it can be affirmed that transcending development will only be possible by paying attention to local cultures, knowledge and imaginaries in the construction of a future notion of development. Therefore, the concepts, theories and models included in this theoretical framework constitute a small but real alternative to the hegemonic model of development.

A final component of this study's framework is Mexican social environmentalism[4], which exists at the confluence of academic, activist

3 See Argueta, 2011; Bastidas et al., 2009; García-Canclini, 2004; Castilleja, 2011; Castillo, 2011; de la Cadena, 2006; Díaz-Tepepa et al., 2011; Dietz et al., 2011; Escobar, 2007; Galvani, 2008; Gutiérrez y Gómez, 2011; Hersch, 2011; Lazos, 2011; Leff, 2003, 2011; Moreno-Arriba, 2016; Mignolo, 2005; Santos, 2005, 2006, 2007b, 2009; Toledo, 2011; Walsh et al., 2003; Zolla, 2011; among others.

4 One of the key figures in the intellectual tradition of Mexican social environmentalism is Efraín Hernández Xolocotzi, pioneer of ethnobotany and agroecology in Mexico. Hernández Xolocotzi contributed to the revaluation of traditional peasant and Indigenous practices and the emergence of an important school of agroecology.

and Local community initiatives. It has decisively contributed to rural development programmes carried out in a participatory, collaborative, intercultural and sustainable way. According to this model, "sustainability can be a viable proposal if it leads us to a new, more just and equitable international policy scheme and does not allow itself to be hijacked by the rigid models and interests that hegemonize the economic, social and environmental development space" (Gutiérrez-Garza & González-Gaudiano, 2010: 193). In addition to this, this research assumes as its foundation the following definition of integral sustainability (ecological, economic and social) offered by Jiménez-Herrero (2000: 109):

> **"An effective commitment to contribute to the conformation of a new civilising stage, based on knowledge, in order to harmonise the lives of human beings with themselves and with each other, that promotes socio-economic development with equity and practices an environmentally friendly attitude to preserve in the long term the vitality and diversity of our planet [...] as a set of relationships between systems (natural and social), process dynamics (energy, matter and information) and scales of values (ideas, ethics, etc.)."**

Arguably the construction of spaces of action around these emerging theoretical models among new non-governmental projects in the Sierra and Los Tuxtlas facilitates "diverse intervention projects from ones self-styled as 'alternative' initiatives" (Narotzky, 2010, p. 127). The paper focuses on the margins of the system, on local practices and projects, and on substantive local cultures that are generally made invisible in prevailing development discourses. Paying attention to these ideas, I now turn to the study's methodology.

Research methodology

This study adopts a qualitative ethnographic approach. Data are principally collected through a mix of semi-structured and open-ended interviews with local interlocutors in the study area. I combine the principles of activist anthropology developed by Hale (2008) and Speed (2006) with a "decolonising and decolonised anthropology" (Harrison, 1991), which considers that research should "start from the explicit recognition of asymmetric and dialectical relationships that exist at different levels" (Dietz, 2009). Thus, the reciprocal negotiation of academic and political interests has generated a "novel mixture of theory and practice" (Escobar, 1993: 386). I have attempted an exchange

between the local knowledge possessed by Indigenous as well as peasant groups and the knowledge generated by academic experts.[5]

The sample includes a set of five heterogeneous natural resource management, agrosilvopastoral, fishing and ecotourism projects launched in the 1990s by different civil and non-governmental organisations. All five projects have direct, participatory[6] and intercultural collaboration with the local peasant population, including Indigenous, *mestizo* (of mixed Indigenous and European descent) and non-Indigenous people. This ethnographic study drew on three principal methods: fieldwork, participant observation and in-depth interviews. I will explain each one in turn.

Fieldwork was conducted in the state of Veracruz in Mexico between 5 October 2011 and 30 September 2013 in rural communities in the six municipalities that make up the Sierra: Catemaco, Hueyapan de Ocampo, Mecayapan, Pajapan, Soteapan and Tatahuicapan de Juárez. I also conducted fieldwork in other locations in the state of Veracruz, such as the Universidad Veracruzana Intercultural (Intercultural University of Veracruz, UVI) headquarters in Grandes Montañas (municipality of Tequila, Sierra de Zongolica) and in the capital of the state of Veracruz, Xalapa.

I conducted my participant observation during the 2012 seminar "Climate Change, Vulnerability and Water" in the community of Huazuntlán, the headquarters of UVI-Selvas. I participated in field visits in mountainous communities to learn about local experiences in the domains of natural resource management, agrosilvopastoral activities and ecotourism. I also learned about the experiences of community-related research as part of my bachelor's degree in Intercultural Management for Development (hereinafter LGID) of the UVI-Selvas. With the help of contacts established during these meetings with multiple local actors, I was later invited to observe various community assemblies in the Sierra (communal land, agroforestry cooperatives, etc.).

---

5 As for my own positionality, I bring a double perspective as a geo-anthropologist and a person closely linked to the rural agrarian world, due to my family ancestry as humble peasants and shepherds of the Sierras de Gredos and Béjar-Candelario-El Calvitero (Ávila and Salamanca, Spain).

6 *Participatory processes* aid development projects in avoiding the pitfalls and failures of the past, namely: a) *close knowledge* of the realities on the ground that foreign technicians and state bureaucrats do not have; b) *networks of relationships* that are essential both for the success of ongoing projects and for long-term investments in rural areas; and c) *cooperation* at the local level of organisations capable of carrying out development activities (Rahnema & Bawtree, 1996).

These visits were supplanted by 82 semi-structured interviews and 20 informal open-ended interviews of varying lengths. Both men and women of different ages and social statuses were included. I also participated in informal *pláticas* (chats) with participants. The polyphony of views generated through these methods has allowed me to better interpret the position of different people and groups involved in the management of local endogenous natural resources.

In the following section, I offer a succinct contextual perspective on the main geographical, ecological, demographic, socio-economic and anthropological conditions that characterise the site of this research, the Sierra.

Research context

The Sierra is one of two volcanoes that configure the Los Tuxtlas region in Veracruz. The Sierra or Soteapan is the south-east volcanic area, configured by the Yahualtajapan-Bastonal mountain range and the volcanoes of Santa Marta (1550 masl) and San Martín de Pajapan (1270 masl), located on the Veracruz coast of the Gulf of Mexico (Figure 1).

Figure 1. Geographic location of the Sierra de Santa Marta and boundaries of the Los Tuxtlas Biosphere Reserve (Veracruz, Mexico)

Source: Chapter author's composition based on Guevara et al., 2004

Currently, the Sierra has the most concentrated Indigenous population in the south-east of Veracruz. Among its six municipalities, the majority of the population identifies as Indigenous, specifically Nahua and Popoluca. According to the United Nations Development Program (UNDP), it is estimated that the Mexican Indigenous population represents 9.5% of the country's total, and its levels of development are below those of the non-Indigenous population.

In the Sierra, there is a great diversity of ecosystems and vegetation types, as well as an altitudinal range that goes from sea level to 1550 meters above sea level, which provides the region with substantial biodiversity. However, decades of developmentalist and extractivist public policies have promoted livestock and forestry plans that have led to a massive deforestation of this biodiverse territory.[7] The area thus became dependent on external inputs, which led to a process of "sustained underdevelopment" (Chevalier & Buckles, 1995: 126) and a fragile eco-cultural balance.

Although these controversial interventions expanded the agricultural belt and responded to the strong pressure from displaced Indigenous groups for land, the move towards monoculture and extensive cattle ranching has been devastating for the ecosystem and biodiversity. Especially since the early 1990s, the federal government has restructured rural policies in accordance with the basic precepts of neoliberalism.
In this way, the vast majority of protectionist barriers have been removed and small producers have been exposed to international competition. Given these circumstances, most Mexican farmers simply have not been able adapt and many small peasant producers have found it more profitable to rent or sell their plots and migrate to cities, or even the United States, in search of work. These conditions have transformed Veracruz from a land of immigration and promise to a land of emigration.

Thus, while this area is rich in resources, the current primary production model is characterised by the overexploitation of natural resources

7 A turning point in the deforestation of these lands occurred in the 1940s, when the Veracruz coast of the Gulf of Mexico and the jungles of Veracruz became the site of massive colonial interventions to promote cattle ranching and commercial agricultural production through public plans such as the National Clearing Program (PRONADE) or the *Idle Lands Law*. These plans led to the expropriation of peasants-*ejidatarios*' (communal land holders') 'unproductive' plots (that is to say, forest or jungle lands). According to Agüero and León (2010), this period marked the modernisation of the countryside through the imposition of a capitalist commercial agricultural form of production, highly dependent on industrial agricultural inputs such as mechanisation and irrigation, fertilisers and pesticides.

without any regeneration plan. As a result, there are two production models in Veracruz: a traditional subsistence-based economy and an agro-business model that competes in commercial and export production. The most dramatic impacts of the intense rate of anthropic and livestock colonisation have been:

1. Rapid deforestation between the 1950s and 1990s. According to the Sierra de Santa Marta Project (hereafter PSSM, by its Spanish acronym) between 1958 and 1991 the equivalent of 63% of forest areas and jungles were lost (Figure 2).

DEFORESTACIÓN DE LA SIERRA MARTA 1958-1991

El mapa de 1958 se elaboró a partir de las cartas Roca Partida y San Andrés Tuxtla elaborados con fotografías aéreas de 1958 por el Departamento de Cartografía Militar de la Sría. de la Defensa Nacional (1958). Los mapas de 1967 y 1978 fueron elaborados por Ramírez, a partir de fotointerpretación de aerofotos y, para el segundo caso se cotejó con la carta topográfica San Juan Volador 1:50.000 (INEGI 1984), la imagen de 1991 se obtuvo de la fotointerpretación de Rafael Gutiérrez (1994) reclasificada por Ramírez (1994).

Figure 2. Evolution of the deforestation process in Los Tuxtlas and the Sierra de Santa Marta (1958–1991)

Source: Chapter author's composition based on Blanco, 2006

2. The loss of food self-sufficiency due to land grabbing has converted subsistence ancestral *milpas* (corn fields) into cattle pastures. For example, between 1950 and 2011 in the municipality of Pajapan there was a 66% decrease in the total area cultivated for corn.

In spite of these impacts on the ecology of the region, the Sierra has the largest continuous extension of forests in Los Tuxtlas and remains a "depositary of a great biological diversity" (Paré et al., 1997: 9) in Mexico.

After decades of struggles to conserve the remnants of forests and other mega-diverse regional natural resources, in 1998 the RBLT was declared by recategorising two pre-existing Natural Protected Areas into one administrative unit. However, despite the limitations established within the RBLT, currently most of the territory "has a serious deterioration due to clandestine logging, overgrazing, erosion, collection and poaching, in addition to the few alternatives that the population has for its development" (Boege et al., 1995: 70).

In view of this critical reality, it is urgent to find alternatives to official development that improve the situation of Indigenous peasant communities, ecologically, demographically and socio-economically. But, as Velázquez (2000) questions: "How could these alternatives be created in a context of minimising public investment for the countryside and of disadvantageous insertion in the international markets?" (123). In the next section, I consider the five alternative socio-ecological projects at the heart of this study and return to emerging socio-environmental and eco-cultural models that offer alternatives to the hegemonic model of development.

Alternative management of mountain ecosystems in the Sierra: case selection

I identified a heterogeneous set of five alternative non-governmental mountain ecosystem management projects emerging since the 1990s in the Los Tuxtlas region. These environmentalists have obtained financial support from various agencies, embassies and international non-governmental and/or civil groups to support innovative and alternative approaches to agrosilvopastoral, fishing and ecotourism activities. The five initiatives at the centre of this study are: PSSM AC, Community Development of Los Tuxtlas Civil Association (hereafter DECOTUX, by its Spanish acronym), the Committee of Agroforestry Cooperatives of the Texizapan-Huazuntlán Stream Basin (hereafter CICATH, by its Spanish acronym), Natural Spaces and Sustainable Development Civil Association (hereafter ENDESU, by its Spanish acronym) and UVI-Selvas. These projects were selected based on the language and practices employed by them in their focus on integral sustainability (environmental, economic and social). The projects relate well with the *alternatives to development* theoretical approach taken in this research (Table 1).

Table 1. Selected projects from Sierra de Santa Marta and Los Tuxtlas (Veracruz, Mexico) that put forward ideas relevant to author's discussions on emerging and/or *alternatives to development* models

SELECTED NON-GOVERNMENTAL PROJECTS	EMERGING MODELS AND/OR *ALTERNATIVES TO DEVELOPMENT*
SIERRA DE SANTA MARTA PROJECT (PSSM)	Political ecology
	Agroecology
	Ethnodevelopment
	Dialogue/Ecology of knowledge and intercultural collaboration
LOS TUXTLAS COMMUNITY DEVELOPMENT (DECOTUX)	Political ecology
	Ethnodevelopment
	Dialogue/Ecology of knowledge and intercultural collaboration
INTERCOMMUNITY COMMITTEE OF AGROFORESTRY COOPERATIVES OF THE ARROYO TEXIZAPA-HUAZUNTLÁN (CICATH)	Political ecology
	Ethnodevelopment
	Dialogue/Ecology of knowledge and intercultural collaboration
NATURAL SPACES AND SUSTAINABLE DEVELOPMENT (ENDESU)	Agroecology
	Ethnodevelopment
	Dialogue/Ecology of knowledge and intercultural collaboration
UNIVERSIDAD VERACRUZANA INTERCULTURAL, REGIONAL HEADQUARTERS SELVAS (UVI-SELVAS)	Dialogue/Ecology of knowledge and intercultural collaboration
	Agroecology

Source: Chapter author

This research attempts to confront whether these five projects allow for identifying useful practices relevant for advancing a different imagination to the developmentalism that has prevailed for decades in the Sierra, in Mexico, and, by extension, in the rest of Latin America.

Alternative socio-ecological practices for integral sustainability

These projects reflect the search for cooperative and innovative forms of production, aimed at the conservation of natural resources by taking into account a three-fold socio-territorial impact: environmental, economic and social. Environmental impacts refer to ecosystems that are conserved or recovered based on an approach of reciprocity with nature that aims to combat poverty and rural vulnerability of the local peasant Indigenous communities. Economic impacts refer to the work of restoration and/or socio-environmental conservation and peasants being fairly compensated for their efforts. The management of endogenous natural resources contributes to the strengthening of the local social fabric through cooperative management, which refers to social impacts. The following quote refers to how these three impacts shape integral sustainability:

> **Three years ago, I wanted to sell my plot because I needed *lana* [money]. I was offered 400,000 pesos for the 15 ha that I own. I consulted with my wife to see if it was viable to sell, and she told me: 'hold on a little, let's see if some other projects come along that can offer us more, ensuring our ability to eat over the long term.' We endured a year, when more reforestation and environmental restoration projects came. Now I tell the engineer that a lady from Mina [Minatitlán] offers me 2 million pesos for my plot. Now, what happens is that many people ask me how the project is. And I tell them that it is very advantageous for me. My children, my wife and I have been working here for three years, and we earn a part of the resources to buy food and corn for the whole year.**
>
> (B.R.H., *interview*, 18 October 2012)

A good example of the results of these projects is the reforestation that has been carried out by the beneficiaries of the programmes. The following interview quote illustrates this further:

> **Before joining the PSSM, DECOTUX, CICATH and ENDESU projects, there were practically no trees in my property. That water level came down drastically, and people were looking for crabs and little fish because the water was very low. Now, with the reforestation, this year the water level never lowered, there will be more water when there are more trees.**
>
> (W.G.D., *interview*, 28 August 2012)

Another study participant explained:

> **I plan to introduce deer in my plots because they like mountainous terrain, badgers and *changos* [simiiform primates] too. My land is already a jungle again; it can support so much wild life. We also released iguanas. So, we are *chambeando* [working] hard. I thank all those who have supported us: the engineers, the promoters, the technicians, the teachers, the *chavos* [guys] from the UVI and all the co-workers of the project, because they were the ones who gave us the first idea of how to do this.**
>
> (W.G.D., *interview*, 29 August 2012)

I now turn to the specific natural resource management projects mentioned earlier.

The PSSM: the Mexican social environmentalism platform in the Sierra

First, I present the case of the PSSM, The Mexican Social Environmentalism Platform in the Sierra, an organisation that has been pioneering the participatory, comprehensive and sustainable management of natural and agrosilvopastoral resources in the region since its birth in 1993. The PSSM is marked by:

1. Broad and multidisciplinary representation within the academic world.
2. Influence on other NGOs and civil society actors, whose main purposes are to intervene directly and systematically to promote integral sustainability.
3. A shared objective of seeking, together with Local communities, ways to manage natural resources to improve the living conditions of local populations in the short term, and promote socio-ecological and/or eco-cultural conservation in the medium- and long-term.
4. Strategies that include socio-environmental self-diagnosis, participatory and intercultural community activity and socio-territorial zoning activities, based on alternative agroecological[8] activities.

---

8 For Altieri (1987), integral sustainability is not possible without preserving the socio-cultural diversity that nurtures local agriculture. Thus, stable production can only be carried out within the context of a social organisation that protects the integrity of natural and/or agrosilvopastoral resources, while ensuring the harmonious interaction of human beings, the agroecosystem and the environment. Ultimately, from this perspective, the requirements to develop sustainable agriculture are not only biological or technical, but also social, economic and political.

5. A shared technical staff that frequently circulates between the different initiatives.

The PSSM not only set out to develop productive options, but also to build commercial alternatives aimed at achieving access to potential markets through establishing high-quality agricultural niches. A participant remarked:

> **I sold half a ton of fat pepper [*Pimenta dioica*] right here. Now there are many buyers who come here to buy from Puebla, from Orizaba; they also come from Xalapa. They compete with one another for our pepper. I can sell 10, 20 or 30 kg and with that I already have enough money to buy corn and food for my family for the whole season.**
>
> (S.R.G., *interview*, 14 October 2012)

A participatory logic characterises the initiatives developed by the PSSM achieved through techniques such as self-diagnosis workshops. The PSSM aimed to benefit the local population. This included maintaining local control over natural resources and ensuring alternative production processes that allowed entry into the market without compromising integral sustainability.

The PSSM participates in planning at different levels (local, municipal, inter-municipal, regional) in an attempt to generate consensus among communities, scientists and authorities on the need to conserve natural, agrosilvopastoral and fishing resources. The PSSM also takes a multidisciplinary approach in the academic world in order to influence public policies. The PSSM has developed collaborative processes and cooperative networks (training activities, demonstrations, shared technical staff, etc.) with other non-governmental organisations that share the same approach as the PSSM, namely Mexican social environmentalism and integral sustainability.

Theoretical-practical vocation that characterises the PSSM's work and politics has allowed this project, with the participation of local Indigenous actors, to take root in a relatively short time in the local social fabric of the region. This has awarded the PSSM the opportunity to present itself as a source of productive alternatives compatible with the objective to conserve nature in eco-culturally appropriate ways.

DECOTUX and CICATH: Indigenous resistance and the governance of natural resources

DECOTUX emerged in 1994 from several founding members of the PSSM (academics, intellectuals, activists, researchers, technicians/peasant promoters, etc.). DECOTUX had the objective of strengthening the technical capacities of Local communities managing the territorial water associated with the reforestation of the Texizapa–Huazuntlán basin within the RBLT. They conduct this work with a participatory approach to the conservation and restoration of mountain ecosystems using a minimum of external inputs.

At present, the DECOTUX technical team acts as a scientific and legal advisor to CICATH, an organisation formed by Indigenous and *mestizo* peasant communities carrying out a regional project of restoration, conservation and local socio-environmental governance in the Texizapa–Huazuntlán stream basin. This stream basin supplies water to the large urban petrochemical agglomerations in southern Veracruz. CICATH was organised as a form of resistance and resilience to win improvements in local living conditions and safeguard natural resources through the direct participation of communities in regional socio-environmental governance. The following quotes support this:

> **It seems very important to me how people here try to think only about the common good of the entire Sierra de Santa Marta. When we enter the work, people no longer have a political party or a religion. We just think about the restoration of the environment. Everything else is left behind. Nobody thinks or says, 'I am red, you green, you blue,' because that does not exist. If all of us had started with that mechanic that *you are red, you are green* and so on, the organisation would have long disbanded.**
>
> (F.T.Q., *interview*, 29 August 2012)

> **We have faced many obstacles, but in the end the organisation has only grown and survived. We have built more than 150 units of social housing. There will be other initiatives next year; we continue with the work. We are seeing positive changes in the ecological, the social and in other domains; they are small changes, but they are important.**
>
> (F.G.L., *interview*, 29 August 2012)

The initial results of the CICATH work plan, with the advice of DECOTUX, translated into 750 ha reforested; 600 restored natural springs; 300 landslide areas restored; 250 km of reforested riparian areas; 250 ha of coffee with maintenance; production of native seeds; and a community forest nursery. In addition, from the perspective that there can be no environmental restoration without social restoration, CICATH and DECOTUX have managed to promote different strategic alliances to include integral development projects, the construction of health and educational centres, social housing and other projects.

ENDESU: agroecological models for the empowerment of the Indigenous peasantry[9]

ENDESU is a non-governmental organisation founded in 1995 through synergies between private companies, such as Petróleos Mexicanos (PEMEX), and civil society organisations, a combination that differentiates it from the rest of the sample. ENDESU has the objective of conserving and promoting the sustainable use of natural resources with the participation of the whole society. ENDESU also aims to professionalise conservation work through innovative agroecological approaches and models. ENDESU began its activity in the Sierra in 2009 through the implementation of integral agrosilvopastoral models based on the integral management of natural resources through incorporating crops, trees and livestock on the same land with the full participation of local peasants (Figure 3).

Beyond simple economic growth, thus far ENDESU has achieved the following aims: reducing peasant poverty, reforesting the territory, reducing vulnerability based on agriculture and livestock and ensuring a measure of empowerment of the Indigenous peasantry, with an emphasis on gender. ENDESU has contributed to generating remarkable advances in the conditions of life and the integral well-being of the people participating in their programmes. An example

9 The empowerment approach, with special emphasis on gender, is related to access to and control of three types of powers: a) *social*, understood as access to the productive wealth base; b) *political*, or access of individuals to the decision-making process, especially those that affect their own future; and c) *psychological*, understood in the sense of individual potentiality and capacity (Friedman, 1992: 33). Similarly, Rowlands (1997) indicates further three dimensions: a) *personal*, as development of the sense of self, of confidence and individual capacity; b) *close relationships*, as the ability to negotiate and influence the nature of relationships and decisions, and c) *collective*, as participation in political structures and collective action based on cooperation. Empowerment is a strategy that encourages women, and other marginalised groups, to increase their power; that is, that they gain access to the use and control of material and symbolic resources, gain influence and participate in social change.

of this is provided in the emotional testimony of a Popoluca peasant woman:

> **Last year all my cattle, 11 animals, died because of the drought and lack of grass. I was left with nothing. Then the engineer invited me to enter the programme... First, I reforested. I also have a natural spring. I planted many plants, and now I plant coffee and other very productive plants that the engineer gave me. Right now, on my plot there is water, wood, firewood, everything. My cattle are my assets; they are my 'savings account.' Yes, I have everything I need for my daily life. I am grateful to the engineer and the project; my life has improved a lot. Too much!**
>
> (S.L.E., *interview*, 19 October 2012) (Figure 3)

Figure 3. Land plots belonging to beneficiaries of ENDESU with integrated agrosilvopastoral management

Photo credit: Jesús Moreno Arriba

These comprehensive agroecological models keep some members of the peasantry from needing to emigrate, which helps to prevent problems for migrants and their families, both in the places of departure and arrival. Due to improved conditions, people are even returning home:

> **In the community of Venustiano Carranza, we have been working with agrosilvopastoral models for two years; additional employment is being generated. For example, a *cuate* [buddy] who had emigrated to the plastic fields of Sinaloa, on the border with the US, has now returned to the Sierra to work in milk production. If before he milked 30 l, now with the new agrosilvopastoral handling on his farms, he milks 80 l daily. He earns enough to take care of his entire family.**
> (L.H.R., *interview*, 28 August 2012)

ENDESU illustrates how agroecological agrosilvopastoral systems are a sustainable option for other rural indigenous areas of the Global South. In order to replicate these findings, the support of all the multiple actors involved is required, including the attention of the NGOs and local populations. It is necessary to combine the will, effort and resources, especially financial, of the public, the government and even private entities.

UVI–Selvas: intercultural community research in tropical mountain areas

The UVI–Selvas is an academic programme of the Veracruz University taught in the four indigenous regions of the state of Veracruz, including the Sierra. The university's main objective is to implement a collective process of linked and collaborative community research with an intercultural approach to respond to the problems of local peasant Indigenous communities.

Regional processes to strengthen endogenous capacities to develop integral and sustainable peasant production are leading to the improvement of the well-being of local Indigenous communities, as explained by a student below:

> **Within their forest plots, the community actors, the Indigenous peasants with whom I am linked, acquire food for their subsistence because they have many different plants of chilies [*capsicum annuum*], coffee and many other medium-term plants. But, from our vision as graduates of the UVI, they can also take advantage of their land to develop**

> **other crop diversification projects such as mushroom orchards or other local products for regional trade.**
>
> (P.T.T., *interview*, 8 September 2012)

These production initiatives are made possible through the intercultural generation of knowledge, skills and attitudes. This knowledge sharing can also be seen in the interview fragment below, which shows a dialogue or ecology of knowledge approach that favours the construction of more integral, equal, humane, intercultural and sustainable societies:

> **Through my linkage with the community, we have exchanged a lot of knowledge. I have taught the *señor* (boss) how to use the Internet, how to use GPS, how to take photographs, etc., a bit of all the knowledge and technical tools taught at the UVI. We have exchanged our knowledge, e.g., the way farmers use organic fertilisers, etc. Also, he has taught me about medicinal plants and the polyculture he manages inside their coffee plantations, and that is totally different from the scientist's view. The concept that I had about polyculture was that one species helped another species to develop faster. I learned from him that polyculture is also important so that the plot is always occupied and used all year because each species bears fruit in different seasons. And we have exchanged a lot of other knowledge.**
>
> (S.H.M., *interview,* 9 September 2012)

Many of the students and graduates of the UVI–Selvas are also linked, academically or professionally, to the other four initiatives presented previously.

Conclusion

Alternative socio-spatial practices, such as those that have been developing in the Sierra since the 1990s, articulate a potentiality of how the world *could* be. In these local spaces, "not only are they incubated, but new imaginaries and ideas about how to reassemble the socio-natural are experienced and analysed" (Escobar, 2010: 46-47). Non-governmental organisations and other civilian associations, intellectuals, sectors of the academic world (see UVI-Selvas) and local Indigenous peasant actors are all stakeholders active in the research presented here (Table I). While implementing these programmes, they openly question the capacity of traditional economic paradigms to generate

development, understood as an increase in the integral well-being of the people. The socio-ecological processes promoted by the five non-governmental initiatives in this study provide feasible examples of alternative eco-cultural practices that improve the lives of communities while circumventing the logic of capitalist hegemony, in Mexico and the rest of the Global South.

The five cases highlight the urgent need to implement research from different areas of knowledge, as well as alternative epistemological, theoretical-conceptual and empirical-methodological perspectives. In this way, on global and local scales, researchers can analyse and, when applicable, advocate for the invaluable opportunity to strategically articulate both local Indigenous peasant knowledge and scientific-technical knowledge. These collaborations can increase Indigenous people's human development indices, their levels of well-being, their quality of life and their integral sustainability (ecological, demographic, economic, social, socio-cultural and socio-political). In conclusion, converging with Bretón (2010), researchers, activists and communities should search for intercultural mechanisms to further global, regional and local dialogue and collaboration. In this way, we can contribute to solving the epistemological and methodological problems we face in real life, including the challenges of economic development. To this end, this research contributes to ending the current deadlock in development, even if only in a small way.

REFERENCES

- Agüero, J.C. and León, N.J. (2010). 'Agrarian Distribution and Institutionalization of the Peasant Organization'. In: E. Florescano and J. Ortiz (eds.) *Atlas of the Natural, Historical and Cultural Heritage of Veracruz: II Historical Heritage*, pp. 191–198. Xalapa: Editorial of the Universidad Veracruzana – Government of the State of Veracruz.
- Altieri, M.A. (1987). *Agroecology: The Scientific Basis of Alternative Agriculture*. Boulder, CO: Westview Press.
- Amin, S. (1990). *Maldevelopment: Anatomy of a Global Failure*. London: Zed Books.
- Aparicio, J.R. and Blaser, M. (2008). 'The 'Lettered' City and the Insurrection of Subjugated Knowledges in Latin America'. *Anthropological Quarterly* 81 (1):59–94. https://doi.org/10.1353/anq.2008.0000
- Argueta, A. (2011). 'The Dialogue of Knowledge, a Realistic Utopia'. In: A. Argueta, E. Corona and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 495–510. Mexico City: UNAM.
- Bastidas, M., Pérez, F.N., Torres, J.N., Escobar, G., Arango, A. and Peñaranda, F. (2009). 'The Dialogue of Knowledge as a Human Position in Front of the Other Ontological and Pedagogical Referent in Health Education'. *Nursing Research and Education* 27 (1):104–111.
- Blanco, J.L. (2006). 'Erosion of Agrobiodiversity in the Cornfield of the Zoque Popolucas of Soteapan Xutuchincon and Aktevet'. PhD thesis. Mexico City: Iberoamerican University.
- Blom, F. and La Farge, O. (1926). *Tribes and Temples*. Mexico City: INI.
- Boege, E., García, H. and Gerez, P. (1995). *Alternatives to Hillside Management in Veracruz*. Xalapa: SEMARNAP – Friedrich Ebert Stiftung Foundation.
- Bonfil, G. (1982). *Latin America: Ethnodevelopment and Ethnocide*. San José, Costa Rica: FLACSO.
- Bonfil, G. (1987). *The Deep Mexico, a Denied Civilization*. Mexico City: CONACULTA.
- Bretón, V. (2010). 'Introduction: Does Saturn Devour His Children?'. In: V. Breton (ed.) *Saturn Devours His Children. Critical Views on Development and Its Promises*, pp. 7–32. Barcelona: Icaria.
- Carpintero, Ó. (1999). *Between the Economy and Nature. The Controversy over the Monetary Valuation of the Environment and the Sustainability of the Economic System*. Madrid: The Books of the Waterfall.
- Castells, M. (2002). *The Age of Information*. Mexico City: Siglo XXI Editores.
- Castilleja, A. (2011). 'Knowledge Systems in Competition'. In: A. Argueta, E. Corona-M. and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 393–416. Mexico City: UNAM.
- Castillo, A. (2011). 'Communication and Interactions between Environmental Sciences (Socio-ecological) and Different Sectors of Society'. In: E. Argueta, M. Corona and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 83–100. Mexico City: UNAM.
- Cernea, M. (1995). *People First. Sociological Variables in Rural Development*. Mexico City: FCE.
- Chambers, R. (1983): *Rural Development. Putting the Last First*. London: Longman.

- Chevalier, J. and Buckles, D. (1995). *Land without Gods: Process Theory. Maldevelopment, and the Mexican Nahuas.* London: Zed Books. https://doi.org/10.1016/s0261-3050(97)83640-6
- De la Cadena, M. (2006). 'Are the Mestizos Hybrids? The Conceptual Politics of Andean Identities'. *Universitas Humanística* 61:51–85.
- Descola, P. y Pálsson, G. (2001). 'Introduction'. In: P. Descola y G. Pálsson (eds.) *Nature and Society. Anthropological Perspectives*, pp. 11–36. Mexico City: Siglo XXI Editores.
- Dietz, G. (2008). 'The Experience of the Intercultural Veracruzana University'. In: D. Mato (ed.) *Cultural Diversity and Interculturality in Higher Education. Experiences in Latin America*, pp. 359–370. Caracas: Colombian Association of Universities (SCUN).
- Dietz, G. (2009). *Multiculturalism, Interculturality and Diversity in Education: An Anthropological Approach.* Muenster, Germany and New York: Waxmann.
- Dietz, G. and Mateos L.S. (2010). ´Reflective ethnography in the accompaniment of educational interculturality processes. An example from Veracruz´. *Cuicuilco* 17 (48):107–131.
- Dietz, G. and Mateos, L.S. (2011). *Dialogue of Knowledge, Actions and Powers between Educational and Community Actors: A Reflective Ethnography of Intercultural Higher Education in Veracruz (InterSaberes).* Xalapa, Mexico: IIE – UV – UVI.
- Dietz, G. (2012). *Multiculturalism, Interculturality and Diversity in Education: An Anthropological Approach.* Mexico City: FCE.
- Ellen, R. (1982). *Environment, Subsistence and System.* Cambridge, UK: Cambridge University.
- Escobar, A. (1993). 'The Limits of Reflexivity: Politics in Anthropology's Post–writing Culture Era'. *Journal of Anthropological Research* 49:377–391. https://doi.org/10.1086/jar.49.4.3630155
- Escobar, A. (1996). *The Invention of Development.* Bogota: Norma Editorial Group.
- Escobar, A. (1998). *The Invention of the Third World. Construction and Deconstruction of Development.* Bogota: Norma Editorial Group.
- Escobar, A. (2000). 'The Place of Nature and the Nature of the Place: Globalization or Post-Development'. In: A. Viola (ed.) *Anthropology of Development: Ethnographic Theories and Studies in Latin America*. pp. 169–218. Barcelona, Buenos Aires and Mexico City: Paidós.
- Escobar, A. (2004). 'Worlds and Knowledges Otherwise: The Latin American Modernity/ Coloniality Research Program'. *Cuadernos del CEDLA* 16:31–67. https://doi.org/10.1080/09502380601162506
- Escobar, A. (2005). 'Postdevelopment as a Concept and Social Practice'. In: D. Mato (ed.) *Economy, Environment and Society Policies in Times of Globalization*, pp. 17–31. Caracas: Central University of Venezuela.
- Escobar, A. (2007). 'Worlds and Knowledges Otherwise: The Latin American Modernity/ Coloniality. Research Program'. *Cultural Studies* 21:179–210. https://doi.org/10.1080/09502380601162506]
- Escobar, A. (2010). 'Latin America at a Crossroads: Alternative Modernizations, Post-liberalism or Post-development?'. In: V. Breton (ed.) *Saturn Devours His Children. Critical Views on Development and Its Promises*, pp. 33–86. Barcelona: Icaria. https://doi.org/10.1080/09502380903424208

- Escobar, A. (2012). 'The Development and Anthropology of Modernity'. In: B. Pérez Galán (ed.) *Anthropology and Development: Discourse, Practices and Actors*, pp. 39–71. Madrid: The Books of the Waterfall.
- Friedman, J. (1992). *Empowerment. The Politics of Alternative Development*. Cambridge, MA: Blackwell.
- Galvani, P. (2008). 'Transdisciplinarity and Greening of Knowledge: Operational Steps in the CEUArkos'. *Teaching Vision Con-Science* 40-41:4–13.
- García-Canclini, N. (2004). 'Knowledge Societies: The Intercultural Construction of Knowledge'. In: N. García-Canclini (ed.) *Different, Unequal and Disconnected: Maps of Interculturality*, pp. 181–194. Barcelona: Gedisa.
- Georgescu-Roegen, N. (1996). *The Law of Entropy and the Economic Process*. Madrid: Argentaria Foundation.
- Gorz, A. (1982). *Ecology and politics*. Barcelona: The Old Topo.
- Gudynas, E. (2011). 'Beyond the New Extractivism: Sustainable Transitions and Alternatives to Development'. In: F. Wanderley (eds.) *The Development in Question. Reflections from Latin America*, pp. 379–410. La Paz: Oxfam – CIDES UMSA.
- Gudynas, E. (2012). 'Senses, Options and Areas of Transitions to Post-extractivism'. In: M. Lang and D. Mokrani (comps.) *Beyond Development*, pp. 265–298. Quito: Abya–Yala.
- Guevara, S., Laborde, J. and Sánchez-Ríos, G. (2004). *Los Tuxtlas. The Landscape of the Sierra*. Xalapa: INECOL.
- Gutiérrez, N.G. and Gómez, J.A. (2011). 'Stories of Productive Life around Corn. Corn, Milpa, Local Knowledge and Knowledge in Agricultural Communities'. In: A. Argueta, E. Corona-M. and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 329–344. Mexico City: UNAM.
- Gutiérrez-Garza, E. and González-Gaudiano, E. (2010). *From Development Theories to Sustainable Development: Construction of a Multidisciplinary Approach*. Mexico City: UANL – Siglo XXI Editores.
- Hale, C. (2008). 'Introduction'. In: C. Hale (ed.) *Engaging Contradictions: Theory, Politics and Methods of Activist Scholarship*, pp. 1–30. Berkeley, CA: University of California Press. https://doi.org/10.1525/9780520916173-004
- Harrison, F.V. (1991). 'Anthropology as an Agent of Transformation: Introductory Comments and Queries'. In: F.V. Harrison (ed.) *Decolonizing Anthropology: Moving Further toward an Anthropology for Liberation*, pp. 1–14. Washington, DC: Association of Black Anthropologists (ABA). https://doi.org/10.1111/an.1992.33.3.24
- Hecht, S.B. (1999). 'The Evolution of Agroecological Thinking'. In: M. Altieri (eds.) *Agroecology. Scientific Basis for Sustainable Agriculture*, pp. 15–30. Montevideo: Nordan–Comunidad.
- Hersch, P. (2011). 'Knowledge Dialogue: What For? For Whom? Some Experiences from the Research Program Social Actors of Medicinal Flora in Mexico, of the INAH'. In: A. Argueta, E. Corona and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 173–200. Mexico City: UNAM.
- Illich, I. (2006). *Collected Works*. Mexico City: FCE.
- James, W. (1999). 'Empowering Ambiguities'. In: A. Cheater (ed.) *The Anthropology of Power*, pp. 13–27. London: Routledge.

- Jiménez-Herrero, L.M. (2000). *Sustainable Development. Transition towards Global Coevolution*. Madrid: Pyramid.
- Kottak, C.P. (1995). 'When People Are Not Given Priority: Some Sociological Lessons from Finished Projects'. In: M.M. Cernea (eds.) *People first: sociological variables in rural development,* pp. 493–530. Mexico City: FCE.
- Krantz, B.A. and Associates (1974). 'Cropping patterns for increasing and stabilizing agricultural production in the semi-arid tropics'. In: ICRISAT, *International Workshop on Farming Systems*, 18-21 November 1974, pp. 217-248. Hyderabad, Andhra Pradesh, India: International Centre for Research in Semi-Arid Tropics (ICRISAT).
- Lazos, E. (2011). 'Knowledge Dialogues: Challenges Facing the Transnationalization of Agriculture in Mexico'. In: A. Argueta, E. Corona-M. and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 255–176. Mexico City: UNAM.
- Leff, E. (2003). 'Environmental Rationality and Dialogue of Knowledge: Meanings and Paths of a Sustainable Future'. *Development and Environment* 7:13–40.
- León, M. (1997). *Power and Empowerment of Women*. Bogota: TM Editors.
- Lipietz, A. (2002). *What Is Political Ecology? The Great Transformation of the 21st Century.* Santiago de Chile: Institute of Political Ecology.
- Marcellesi, F. (2012). 'What Is Political Ecology? A Path to Hope in the 21st Century'. CUIDES 9:3–40.
- Martínez-Alier, J. (1991). *From Ecological Economics to Popular Environmentalism*. Montevideo: Nordan – Icaria.
- Martínez-Alier, J. (2005). *The Evironmentalism of the Poor. Environmental Conflicts and Valuation Languages.* Barcelona: Icaria.
- Mignolo, W. (2000). *Local Histories/Global Designs: Coloniality, Subaltern Knowledges and Border Thinking.* Princeton, NJ: Princeton University Press. https://doi.org/10.1515/9781400845064
- Mignolo, W. (2005). 'Coloniality Far and Wide: The Horizontal Hemisphere on the Colonial Horizon of Modernity'. In: E. Lander (ed.) *The Coloniality of Knowledge: Eurocentrism and Social Sciences: Latin American perspectives*, pp. 55–85. Buenos Aires: CLACSO. https://doi.org/10.1057/9780230114432_4
- Moreno-Arriba, J. (2013). 'Community Management of Natural, Agrosilvopastoral and Fishing Resources in the Sierra de Santa Marta in Veracruz (Mexico): A Possible Alternative to the Developmental Discourse and Capitalist Globalization?'. *Universitas Humanística* 75/75:189–217.
- Moreno-Arriba, J. (2016). 'La gestión de recursos naturales en la Sierra de Santa Marta en Veracruz (México): un ejemplo de alianza estratégica de saberes locales y conocimientos técnicos-científicos para la sustentabilidad'. PhD thesis. Madrid: UNED.
- Naredo, J.M., Riechmann, J., Taibo, C., Bermejo, R., Estevan, A. and Rodríguez, J.C. (1995). *From Economics to Ecology*. Madrid: Trotta.
- Narotzky, S. (2010). 'Reciprocity and Social Capital: Theoretical Models, Development Policies, Alternative Economies. An Anthropological Perspective'. In: V. Breton (ed.) *Saturn Devours His Children. Critical Views on Development and Its Promises*, pp. 127–174. Barcelona: Icaria.

- Paré, L. (2019). *Challenges of Action-research in the Face of Sustainable Development Paradigms and Public Policies*. Mexico City, Mexico: Collection Research Line Luisa Paré of the Repository of the Social Research Institute of the UNAM.
- Paré, L., Velázquez, E., Gutiérrez, R., Ramírez, F., Lozada, M.P., Blanco, J.L., Perales, H. and Hernández, Á. (1997). *The Special Reserve of the Biosphere, Sierra de Santa Marta, Veracruz: Diagnosis and Perspective*. Mexico City: SEMARNAP – UNAM-IIS – PSSM
- Porto-Gonçalves, C.W. (2001). *Geo-graphics. Social Movements, New Territorialities and Sustainability.* Mexico City: Siglo XXI Editors.
- Rahnema, M. and Bawtree, V. (1996). *The Post-development Reader*. London: Zed Books.
- Roustang, G. (2003). 'Breaking the Production-employment-consumption Triangle'. In: P. Merlant and J. Robin (eds.) *Getting out of Economism* (s. p.). Ivry-sur-Seine, France: Workshop Editions.
- Rowlands, J. (1997). *Questioning Empowerment*. Oxford, UK: Oxfam.
- Sánchez, J. (1989). 'Mountain Areas: An Approach to Their Current Problems'. *Space, Time and Form* 2:169–190. https://doi.org/10.5944/etfvi.2.1989
- Santos, B. (2005). *The University in the XXI Century: For a Democratic and Emancipatory Reform of the University.* Mexico City: UNAM – CIICH.
- Santos, B. (2006). 'The Sociology of Absences and the Sociology of Emergencies: For an Ecology of Knowledge'. In: B. Santos *Renew Critical Theory and Reinvent Social Emancipation (meetings in Buenos Aires)*, pp. 13–41. Buenos Aires: CLACSO.
- Santos, B. (2007a). *The University in the XXI Century. For a Democratic and Emancipatory* Reform of the University. La Paz: CIDES-UMSA – ASDI and Plural Editors.
- Santos, B. (2007b). *The Rise of the Global Left.* London: Zed Books.
- Santos, B. (2009). *An epistemology of the South: The Reinvention of Knowledge and Social Emancipation.* Mexico City: CLACSO – Siglo XXI Editores.
- Sen, G. and Grown, C. (1988). *Development, Crisis and Alternative Approaches: Perspectives for Women in the Third World.* Mexico City: COLMEX – PIEM.
- Slim, H. (1998). 'What Is Development?'. In: M.B. Anderson (present.) *Development and Social Diversity*, pp. 65–70. Barcelona: Icaria.
- Speed, S. (2006). 'Between Anthropology and Human Rights: Towards an Activist and Critically Committed Investigation'. *Alteridades* 31:73–85. https://doi.org/10.24275/alte.v0i31
- Tetreault, D.V. (2009). *Poverty and Environmental Degradation. The Struggles from Below in Two Communities in Western Jalisco: Ayotitlán and La Ciénega.* Guadalajara: University of Guadalajara (UDG).
- Toledo, V.M. (2011). 'From 'ghosts dialogue' to the 'dialogue of knowledge': knowledge and community sustainability'. In: A. Argueta, E. Corona-M. and P. Hersch (eds.) *Collective knowledge and dialogue of knowledge in Mexico*, pp. 469–484. Mexico City: UNAM.
- Tortosa, J.M. (2001). *The Global Game: Maldevelopment and Poverty in the World System.* Barcelona: Icaria.
- United Nations Development Program (UNDP) (2013). *Mexico Human Development Report*. Mexico City: Mundi-Press.
- Velázquez, E. (2000). 'Livestock and Political Power in the Sierra de Santa Marta'. In: E. Léonard and E. Velázquez (eds.) *The Sotavento Veracruzano. Social Processes and Dynamic Territories*, pp. 111–127. Mexico City: CIESAS – IRD.

- Walsh, C., Mignolo, W.D. and García Linera, Á. (2003). *Interculturality, Decolonization of the State and Knowledge*. Buenos Aires: Ediciones del Signo.
- Zolla, C. (2011). 'From IMSS-COPLAMAR to the Experience of the Hospital Mixto de Cuetzalan, Dialogues, asymmetries and medical interculturality'. In: A. Argueta, E. Corona and P. Hersch (eds.) *Collective Knowledge and Dialogue of Knowledge in Mexico*, pp. 201–234. Mexico City: UNAM.

CHAPTER

3

Promoting community-based environmental management around a Himalayan high-altitude wetland

By

Alexander R. O' Neill

Duke University Wetland Center, Nicholas School of the Environment

Duke University, United States

About the author

Alexander R. O'Neill

is an ecologist affiliated with the Nicholas School of the Environment at Duke University, located in Durham, North Carolina (USA).

Email: onward@bodhi.eco

Abstract

Community knowledge provides valuable insight into ecological processes and can guide management activities in local contexts. However, its application remains contentious in the Indian Himalayas, where states have historically favoured protectionist policies over community-based environmental management. This case study describes a distinct pivot from 'people-free' approaches toward more inclusive conservation programmes in northeast India. In March 2007, communities in the state of Sikkim spearheaded an ambitious campaign to conserve Himalayan high-altitude wetlands. Emphasising resilient infrastructure, their efforts transformed existing tourism practices around Tsomgo Lake and integrated local knowledge into their wetland policy solutions. Central to their success was the creation of a community organisation known as the Tsomgo Pokhri Sanrakshan Samiti (TPSS), or the Tsomgo Lake Management Committee. Notified by the government of Sikkim, the TPSS maintains direct authority over wetland management and partners with government and environmental organisations to develop management plans. This chapter highlights these developments, as well as lessons learned during TPSS's first decade. These lessons emphasise the importance of trust and transparency among interest groups, as well as the value of local knowledge when planning, executing and monitoring management interventions.

Keywords:

Tsomgo Lake Management Committee | biodiversity | conservation | local knowledge

Introduction

Indigenous and Local communities play an important role in Himalayan wetland management (Bhatta et al., 2018). They provide management capacity in otherwise remote areas and guide environmental programmes aimed at the sustainable and wise use of mountain wetlands (Chatterjee et al., 2010; Gujja, 2007). Over the past two decades, these contributions have been marked in northeast India, where environmental organisations have worked with traditional institutions to conserve biodiversity (Lachungpa, 2009; Bourdet-Sabatier, 2004). Despite their documented successes, such collaborations remain contentious with many Indian states, who favour protectionist policies over community-based environmental management (Phuntsho et al., 2012). Case studies on indigenous and local contributions to environmental programmes are needed to expand the dialogue on wetland policy (Armstrong et al., 2017; Balée, 2006).

The Indian Himalayas contain vast tracts of high-altitude wetlands (HAWs) that are vital to the ecologies and economies of the region (Gujja et al., 2003). Generally defined, HAWs are areas of temporary or permanent saturation located 3,000 m above sea level and between the tree line and permanent snowline (Khan & Baig, 2017). In northeast India, they are typically located within mountain valleys and along plateaus where topographic conditions favour wetland formation (Chatterjee et al., 2010). These systems provide critical habitat for threatened and endangered species (O'Neill, 2019; Kandel et al., 2010, 2016). In the future, environmental managers must establish ecological baselines around these sites to guide wetland planning (Kandel et al., 2019; Manish & Pandit, 2019). Integrating community knowledge into biological conservation can effectively address gaps in current data (O'Neill et al., 2017; Rick & Lockwood, 2012; Chaudhary & Bawa, 2011; Szabó & Hédl, 2011).

This case study describes community contributions to HAW management in the northeast Indian state of Sikkim. Sikkim, India's 22nd state and a former Buddhist kingdom, is located between Bhutan, Nepal and the Tibetan Autonomous Region of China (Xinjiang Autonomous Region). Its geopolitical boundaries are contiguous with an ecoregion known as the Sikkim Eastern Himalayas, a subset of the Himalayan Biodiversity Hotspot, and contain an estimated 69,000 ha of HAWs (Gurung et al., 2019). In March 2007, Local communities in Sikkim spearheaded an ambitious campaign to conserve one such wetland complex known as Tsomgo. Working with government and environmental organisations, they transformed existing tourism practices around the lake and integrated local knowledge into their wetland policy solutions

(Figure 1). This chapter highlights these developments, as well as the environmental history of Himalayan HAWs. In doing so, it emphasises the value of acknowledging historical relationships with place and empowering Local communities to conserve their wetland resources.[1]

Figure 1. Logo of the Tsomgo Pokhri Sanrakshan Samiti, a community-based environmental organisation overseeing management and development activities at Tsomgo HAW

Logo image provided by Alexander R. O' Neill

Regional setting and climate

Sikkim has been inhabited by humans for at least 10,000 years, facilitated by climate change during the Holocene. Geologic records indicate that the Eastern Himalayas formed approximately 40 million years ago (MYA) following the collision of Indian and Eurasian landmasses (Jagoutz et al., 2015; Rubatto et al., 2013). Around this time, high-grade metamorphic slabs were pushed upward with extreme force, generating the iconic massifs visible today. From the Last Glacial Maximum (27 MYA) through the Pleistocene, glacial activity continued to shape and isolate regional basins, which facilitated many of the biogeographical patterns visible today (Dahal et al., 2017; Kluge et al., 2017; Nie et al., 2017; Owen & Dortch, 2014). Between 5,000 and

1 My research is based on archival research and ethnographic fieldwork conducted as a Fulbright-Nehru Research Scholar from August 2015 to July 2016.

3,000 BCE, these glacial dynamics were abruptly altered by shifts in monsoon patterns and warmer temperatures on the Tibetan Plateau. Existing glaciers decayed, revealing morphologically stable terrain suitable for human migration (Meyer et al., 2009).

As the glaciers retreated, trans-Himalayan passes increasingly facilitated human movement from the Tibetan Plateau to the southern Himalayan slopes. In Sikkim, the earliest known human artifacts are dated between 10000 BCE and 5000 BCE (Mullard, 2011). Discovered less than 40 km from Tsomgo, these discoveries suggest that two waves of early settlers populated the region. The first group likely migrated from modern Yunnan and Sichuan Provinces, in the present-day People's Republic of China (PRC), through the Brahmaputra Basin before entering Sikkim (van Driem, 2006). Drought on the Tibetan Plateau likely sparked a second wave of migrants from the Gansu and Qinghai regions of the PRC c. 5000 to 3000 BCE (Mullard, 2011; Meyer et al., 2009). Nomadic trans-Himalayan groups from the Chumbi Valley also settled in Sikkimese valleys during this time (Namgay et al., 2013). Charcoal horizons dated between 4900 and 4500 BCE, and as early as 6800 BCE, reflect patterns associated with slash-and-burn agriculture linked to these migrations near the Chumbi Valley (Meyer et al., 2009). When coupled with palynological samples from high-altitude lakes, these data suggest a period of agricultural expansion, wherein large tracts of *Juniperus* and *Rhododendron* scrubland were replaced by agro-ecosystems dominated by barley and intensified grazing (Meyer et al., 2009). Although unconfirmed, these records suggest that glacial retreat and monsoon shifts during the Holocene placed yak- and barley-based pastoral communities in contact with high-altitude lakes.

Tsomgo is a high-altitude lake located along a well-travelled Himalayan pass known as Natu-la. It is a tributary of the Rangpo-Rongli Khola watershed and greater Bhramaputra River basin; its hydrology is dictated by the seasonal interplay of snowmelt and monsoon precipitation upon a high-grade metamorphic basin of gneiss and granulite (Searle et al., 2005). Approximately 25 ha, the central lake has a maximum depth of 15 m (average depth = 4.58 m) and connects to two smaller systems known as Manju I (area: 2 ha) and Manju II (area: 3 ha). Given its topography and substrate, groundwater stores are typically located within disjunct joints, fractured zones and weathered aquifers of phyllite, schist, gneiss and quartzite. Recharge into these shallow aquifers occurs primarily by direct infiltration, although most precipitation is lost as runoff due to high-grade slope within the sub-watershed (Integrated Watershed Management Programme Sub-watershed 3A1C8e2b). Based on short-term data, discharge varies between 0.25 and 1.8 l s^{-1} in springtime (WSNES, 2015). It is lowest between December and May and highest

during the post-monsoon period from September through November (Tambe et al., 2012). The lake is frozen for about five months of the year.[2]

Since the late 1800s, over 550 species have been reported around the Tsomgo, including several that are considered threatened or endangered by the International Union for Conservation of Nature (Table 1; O'Neill, 2019). The basin's ecosystems are dominated by alpine assemblages of *Caltha* (Ranunculaceae), *Meconopsis* (Papaveraceae), *Primula* (Primulaceae), *Pedicularis* (Orobanchaceae), *Saussurea* (Asteraceae) and several Rosaceous species. Tree growth is nearly absent from Tsomgo, except for stunted forms of *Abies* (Pinaceae), *Juniperus* (Cupressaceae), *Prunus* (Rosaceae) and *Rhododendron* (Ericaceae). Together, these plants provide important habitat and food for migratory birds and mammals (O'Neill, 2019; Shrestha et al., 2012; Gopal et al., 2010).

Table 1. Species reported from Tsomgo, a high-altitude wetland of the Sikkim Eastern Himalayas

	REPRESENTATIVE NUMBER OF		
KINGDOM	FAMILIES	GENERA	SPECIES
Animalia	36	58	69
Chromista	11	13	19
Eubacteria	4	5	7
Fungae	5	8	9
Plantae	86	221	429
Total	**142**	**305**	**533**

Source: O'Neill, 2019

2 Climate data from Tsomgo are largely unavailable to civilians, with the exception of some springtime data collected from 1998 and 2015 (TATA, 2017; MSPES, 2015). Studies have typically used weather stations in Sikkim's capital Gangtok as a proxy for site-specific records, contributing to misinformation (Kar, 2008). Reported biogeochemical features of Tsomgo suggest that it is an ombotrophic lake: pH: 7.3; conductivity (μmhos/cm): 65.0; color (Hazen Unit): 1; total dissolved solids (mg/L): 35.0; total suspended solids (mg/L): 3.2 (MSPES, 2015). Based on the Munsell Chart, the average wetland soil comprises: sand: 22.6%; silt: 53.9%; clay: 23.5%. Soil organic matter averages 35% with a moisture content of 5.4% and conductivity of 26.7 μS/cm (MSPES 2015). Generally classed as silt loam, the properties of the sampled soils were: pH: 5.2; available N (mg/kg): 22.4; available P (mg/kg): 0.4; available K (mg/kg): 31; available Ca (mg/kg): 34; available Sulfur (mg/kg): 15.1; and Cation Exchange Capacity (meq/100 g): 18.4 (MSPES, 2015).

Natural heritage and culture

Wetlands figure prominently in Himalayan religious traditions and have been managed by traditional institutions for centuries (O'Neill et al., 2019; Daurio, 2012; Allen, 1997). According to Buddhists, Guru Rinpoche, an 8th-century Buddhist master, consecrated 108 waterbodies in Sikkim while travelling from Tibet to India and Bhutan (Acharya & Dokham, 1998). In doing so, he invited non-human spirits believed to inhabit these wetlands into Buddhism and blessed Sikkim as a sacred valley called *Beyul Demojong* (Mullard, 2011; Balikci, 2008). Fourteenth-century Buddhist scholars like Rigdzin Godemchen (1337-1409), Sangey Lingpa (1340-1396), Lhatsun Namkha Jigme (1597-1650) and Pema Lingpa (1450-1521) wrote of these sacred lakes in guidebooks for Tibetan pilgrims. These works provide textual evidence of HAWs as sacred natural sites and shed light on their historical ecology. Today, many of these records are housed at the Namgyal Institute of Tibetology (Gangtok, Sikkim); many of these are still pending English translation. Other faith traditions of the Eastern Himalayas also consider HAWs to be sacred. For example, the Lepchas associate specific HAWs with individuals, lineages and clans (Scheid, 2014; Little, 2008; McKay, 1998).

Regarding Tsomgo, early reports suggest that the lake's etymology is derived from *Denjongke*, or the Dränjong dialect of the Tibetan language. The name refers to a site about 3 km northeast of the lakehead known as *tsho mgo*, or the "lake source." This site was once a resting point for nomads during their pastoral migrations, and it has become synonymous with the HAW (Department of Ecclesiastical Affairs, 2015). Map records available from the People's Association for Himalaya Area Research's (PAHAR's) Mountains of Central Asia Digital Dataset suggest that this place name was designated after Sikkim's integration into the Republic of India in 1975. Before this time, Sikkim was an independent Buddhist monarchy from c. 1648 through 1975. A 1969 map entitled "Kingdom of Sikkim" by Pradyumna P. Karan reported the name *Tagney Tsho* as the state record instead of Tsomgo. Older documents, including the *Gazetteer of Sikhim* (1894), report the traditional name of the lake as *Tanyek Tsho, Nub Tanyek Tsho* and *Tanitzo*, which translate as "Horse-tailed Lake in the West," the "Lake of the Horse-tail" or "Lake of the Horse-hair Noose," respectively. These names reference the lake's geographic shape.

Folk traditions recall rapid changes in wetland hydrology at Tsomgo, though these claims are unverified by other forms of empirical data. Before the time of *Chogyals*, or Buddhist kings (c. 1648 AD), locals recall that the lake was located near Laten village in northeastern Sikkim (Department of Ecclesiastical Affairs, 2015). Local herders did not

respect the lake's presiding water spirit, known as the *dakini*. Following repeated transgressions, the spirit vowed to punish those who continued polluting or disrespecting the lake. One afternoon, the *dakini* appeared before an elderly woman as she spun wool. Radiating white light, the spirit warned that it would flood a nearby valley and relocate the lake. Fearful for her community, the woman pleaded with her neighbours to make amends and avoid the deluge. Two herders ignored her and grazed their yaks in a valley close by. While they were there, a spate of water suddenly flowed down the valley and up from the ground where they stood. The men and their yaks were drowned by the lake spirit. Today, locals report that these men and their animals still dwell in the lake, emerging and blending in with locals during the daytime. Some believe this story recalls a glacial lake outburst flood (GLOF) that occurred sometime in the distant past. Though fantastic, this story could relate to natural events, like GLOFs, that are frequent in the region.

Indigenous and Local communities continue to recognise and value traditional relationships with the Tsomgo and other sacred wetlands of Sikkim (Balikci, 2008; Jain et al., 2004). Historically, Buddhist monks from nearby monasteries cared for the lake and divined future events based on the colour of the lake's water (Department of Ecclesiastical Affairs, 2015). Other faith healers, including *lamas, jhakris* and *bomthings*, also visited the wetland for ritual purposes and to placate the wetland's spirits. Festivals such as *Guru Purnima* (*Bhadure Purnima*), a festival dedicated to teachers, and *Raksha Bandhan*, a Hindu ritual for protection and good health, are celebrated by Nepali-origin communities at Tsomgo today (Figure 2). Although historical, these rituals were revived in 2014 by the Tsomgo Pokhri Sanrakshan Samiti, a non-governmental organisation (NGO) based in the Chipsu, Tsogo and Thegu villages (Ongmu, 2015). *Guru Purnima* is celebrated for two days starting on the first full-moon day of Bhadau in the Hindu calendar, corresponding with the Gregorian month of August. A Hindu shrine called Chhangu Baba Mandir, located on the lakeshore, is a major destination for pilgrim-tourists.

Figure 2. Faith-healers celebrate Bhadauria Purnima festival at Tsomgo

Photo credit: Pravin Khaling

The government of Sikkim formally recognised the religious importance of Tsomgo via State Notifications 59/HOME/98 and 70/HOME/2001 (Government of Sikkim, 1998). These notifications specified sacred natural sites included under India's Provisions of the Places of Worship (Special Provision) Act of 1991 and enforceable under the Indian Constitution's Article 371F (O'Neill et al., 2019). The Provisions of the Places of Worship Act prohibits the conversion of sacred sites in India and mandates maintenance of the religious character of such places as they existed at Indian Independence. In effect, these provisions also buttressed the Sikkim Fisheries Act of 1980 and Sikkim Fisheries Rules of 1991, which prevent fishing in "religious" waterbodies, though fish were stocked at Tsomgo in the late 1980s. This legal structure forms the basis for HAW management at Tsomgo while also acknowledging the religious character of this site for Local communities.

Wetland management and policies

Sikkim's sacred landscape narratives have had broad implications for human-environment relationships at Tsomgo and influence the

state government's approach to wetland management (Chakraborty & Chakraborti, 2011; Ramakrishnan, 2008). For over two centuries, religious institutions in Sikkim have encouraged HAW conservation both directly through monitoring and indirectly through taboos and cultural influence (O'Neill et al., 2019). Centralised management of Tsomgo began in 1905 with the creation of Sikkim's Forest Department by Chogyal (king) Sidkeong Tulku. In 1909, Tulku commissioned Dillu Singh Ghale to develop a forest manual for the kingdom, which divided forested land into three distinct categories: reserve forests, *khasmahal* (government land leased to individuals) and *gorucharan* (government land allotted for grazing) (Forest, Environment & Wildlife Management Department, 2009). As a part of a reserve forest, Tsomgo was absorbed into the Kyongnosla Forest Block and the Kyongnosla Alpine Sanctuary in 1977.

Following British contact, Tsomgo Lake experienced dramatic changes in its surrounding ecosystems as roads expanded to facilitate border security and trade. Before 1905, Tsomgo was a hub for trans-Himalayan nomads travelling along the Silk Road. Nathu La, located 17 km northeast of HAW, was the primary link between the communities of Sikkim and the Greater Himalayas. Because of its proximity to the Silk Road, Tsomgo experienced regular traffic as caravans moved for both state and economic purposes (McKay, 2003, 2009). By 1815, Nathu La gained such renown that it was marked by the British East India Company (EIC) for its strategic economic importance. In 1894, it was officially opened for trade between the EIC and Tibet. At this point, efforts were made to enhance road capacity for both trade and security purposes. Military encampments along these roads remained the dominant human settlements around the HAW from the Younghusband Expedition to Tibet in 1903-1904 through Indian Independence in 1947 (Iggulden, 1900; Temple, 1881).

By 1947, Indian occupation had replaced the British presence in the region. That same year, the then Kingdom of Sikkim signed a protectorate treaty with India to quell concerns over potential invasion from the People's Liberation Army of China. Thereafter, the Indian government established additional military bases along the Indo-Chinese border, including in the Chumbi Valley. The Indian Army became the de facto authority of Tsomgo, with its command resting above and beyond that of Sikkim's Forest, Environment & Wildlife Management Department. Due to continued national security concerns, much of the Tsomgo region remains off limits to tourism or is of limited access. The 17th Mountain Division, or 'Black Cats,' are the primary military unit stationed at Tsomgo today.

Early photographs capture environmental changes within the Tsomgo basin since 1965 (Figure 3). In 1965, Dr. Alice S. Kandell and former Sikkimese *gyalmo* (queen) Hope Cooke travelled to Tsomgo while on a tour of the Sikkimese kingdom (Figure 4). The photo shows infrastructural expansion that followed the Sino-Indian War in 1962, including an installation at the southern point of the lake. Several skirmishes took place near Nathu La, which led to Nathu La's closure in 1962. These restrictions were active for 40 years, until Indo-Chinese relations thawed in the early 1990s. Other skirmishes occurred between 7 and 13 September 1967, and periodically through today (Iqbal, 2017). In response, paved roads were successively expanded to support military transport. In terms of wetland hydrology, these actions decreased the infiltration capacity of soils surrounding the wetland, and increased runoff along its high-grade slopes. Periodic closures also drastically reduced the number of visitors to the lake region, beyond military forces.

Figure 3. Images of Tsomgo Lake highlighting environmental changes around the lake between 1957 and 2012

Photo credit: Alexander R. O' Neill (3a); Pravin Khaling (3b and 3c)

By the 1980s, expanding global economies, market liberalisation and thawing relationships with China led to the gradual reopening of Tsomgo to both domestic and foreign visitors. Increased crowds placed new demands on both the human settlements and surrounding ecosystems, including a dire need for infrastructure. To cater to ecotourists, communities from Chipso Village constructed temporary teahouses along Tsomgo's lakeshore around 1988. Within a decade, these structures developed into 30 permanent rest houses, several of which were located less than 10 m from the lake (Gurung, 2009). Acknowledging their impact, the Forest, Environment & Wildlife Management Department and the Ministry of Tourism and Civil Aviation invoked the Indian Forest Act of 1997. Together, they transferred 1,465 ha of reserve forest land to Local communities for their businesses and developed solid waste facilities and parking spaces. In 1999, the government further instituted the Tsomgo Lake Management Committee, which played a vital role in the enforcement of the Forest Act. These early efforts were generally successful, though the group eventually failed due to miscommunication and misaligned expectations (Tambe et al., 2012). Other NGOs like the Green Circle of Gangtok began to work with communities to promote HAW conservation with the state's Wetland Conservation Programme in the 1990s. At this point, environmental NGOs became an integral part of HAW management as arbiters between the state government and Indigenous and Local communities.

In the early 2000s, Sikkimese politicians earned the trust of Indigenous and Local communities by offering direct aid to HAW communities for infrastructure and by acknowledging sacred aspects of the Tsomgo HAW. In 2001, under Chief Minister Pawan Chamling the Sikkimese government introduced several laws promoting both sustainable development and biocultural conservation of HAWs. The first of these policies placed strict limitations on the number of vehicles permitted to visit Tsomgo each year (Notification 9/HOME/2001). Under the same action, foreign tourists had to receive additional restricted area/inner line permits to visit the lake. During that legislative period, Tsomgo and several other lakes were also designated as sacred natural sites critical to Sikkim's biocultural heritage (Notification 9/Law/1992; No. 70/HOME/2001). More recently, efforts to better manage the wetland were made via the formation of a state-level Steering Committee on Wetlands (No. 10/HOME/2007) and the Sikkim State Wetland Authority in 2016 (No. 347/FEWMD/2016). Together, this framework of notifications established Sikkim's nominal commitment to preserving HAWs like Tsomgo.

Figure 4. Tsomgo Lake, along the Nathu La pass, Sikkim, 1965

Photo credit: Alice S. Kandell (Obtained from the Library of Congress repository)

The re-opening of Nathu La pass in 2007 led to a wide-scale boom in tourism at Tsomgo. For capacity purposes, the Border Roads Organisation and Indo-Tibetan Border Police continued to widen the Gangtok-Nathula Road via the Jawaharal Nehru Road. Initially, Chief Minister Chamling expressed concern over environmental damage caused by this roadwork. In response, a team of officials led by the Ministry of Commerce and Industries and the Ministry of Roads and Bridges took drastic steps to avoid environmental degradation. The Sherathang Helipad and the Harayana Bend were chosen as ecologically sound dumping sites near the wetland. Also, in 2007, a 50-unit shopping complex at Tsomgo was completed in partnership with the Ministry of Tourism and Civil Aviation under its Destination Development Program. Shopkeepers from nearby villages were charged approximately USD 25/month to rent store space.

Coinciding with the construction of the new market space, Indigenous and local groups collaborated with the World Wildlife Fund and the Mountain Institute to form a community-based management organisation. Established on 24 May 2007, Tsomgo Pokhri Sanrakshan Samiti (TPSS) maintains direct authority over wetland management and partners with the government and NGOs to institute adaptive

programming (Notification 355/F/FEWMD/2006). It submits an Annual Lake Conservation Plan comprising of a map, water quality, threats, and wildlife and ecotourism action plans with the government (Sikkim Express, 2008b). This group petitioned for visitors to increase by one-third, and received approximately USD 615,000 from the Ministry of Tourism and Civil Aviation for capacity building. In 2008-2009, this group advised a government desilitation and cleaning drive estimated at USD 8,000. As of 2009, the TPSS collected approximately USD 40,000 in entry fees from tourists, of which 50% has been used for conservation purposes. Groups like the World Wildlife Fund, India Development Market and the Sindrabung Khangchendzonga Eco-friendly Society have taken part in meeting with the TPSS organization and its stakeholders (Sikkim Express, 2008a, b, c). These actions indicate a movement toward decentralisation of HAW management in a manner supporting ecotourism at local scales.

Over the past decade, natural disasters such as earthquakes and landslides have caused fluctuations in visitors to Sikkim. Generally, the number of tourists at Tsomgo has increased exponentially and is expected to continue increasing as infrastructure expands. As of 2017, the state government approved a rope-way project that crosscuts much of the wetland toward Nathu La. Limited seasonal data was used to justify development, despite blatant conflicts with both state and national environmental policies. Recent transboundary programmes coordinated by the G. B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD) and the International Centre for Integrated Mountain Development (ICIMOD) could be engaged to ensure proper management and study of the wetland (O'Neill et al., 2017). The Kangchenjunga Landscape Conservation and Development Initiative (KLCDI) has and will continue to coordinate biocultural conservation in Bhutan, India and Nepal. Building upon these efforts, the government of Sikkim platformed Tsomgo as a Ramsar Wetland of International Importance, especially for Waterfowl Habitat (Islam & Rahmani, 2008). Nevertheless, its designation is pending; baseline reports remain dated and/or unavailable to environmental managers.

Management recommendations and gaps

Several management actions can enhance the resilience of Tsomgo's social and ecological communities:

- *Estimate the economic value of wetland ecosystem services at Tsomgo.* Sikkim's tourism industry has grown considerably during

the 21st century; however, the economic value of ecosystem services provided by popular ecotourism destinations like Tsomgo remains unquantified (Joshi & Dhyani, 2009; Chettri et al., 2008; Maharana et al., 2000). Future studies should investigate the domestic water supply benefits, flood control or prevention services, carbon sequestration and ecotourism value of Tsomgo and its surrounding basin. This includes valuation of non-timber forest products (NTFPs) collected from its sub-watershed by local people, including fodder, fuelwood and medicinal plants (O'Neill et al., 2017; Uprety et al., 2016).

- *Increase and maintain basic monitoring programmes at Tsomgo.* Water management programmes in Sikkim have been largely isolated to the Mamlay Watershed and mid-altitude springs in South District, Sikkim (O'Neill et al., 2019; Tambe et al., 2012). To assess water quality, testing sites should be established around the lake. These data are critical for valuing wetland resources, promoting water security and promoting evidence-based policies within the Rangpo-Rongli Khola watershed. A flume or weir could also be installed at Tsomgo's discharge point to estimate seasonal flow from snowmelt and precipitation. Basic weather stations at the lake would also promote a variety of climate change initiatives throughout the Greater Himalayas.
- *Mitigate threats of invasive species and pollution.* Tourism is the primary source of livelihood for communities near Tsomgo. In recent years, the number of visitors to Tsomgo has exponentially increased, introducing novel anthropogenic pressures on its surrounding community. Waste disposal sites should be better implemented at the lake as a part of Sikkim's greening initiatives. Domesticated animals also threaten the persistence of HAWs. For example, the presence of yaks and other livestock around the wetland has added to fecal coliform loads in downstream waters. Feral dogs also pose numerous threats to ecological communities in the Trans-Himalaya (Lachungpa, 2008; Tambe & Rawat, 2009). These effects have been difficult to quantify around HAWs, due in part to fragmented biodiversity records. Relocating feral dogs from military encampments would reduce stress on communities at Tsomgo, including the Pika (*Ochotona thibetana sikimaria*). Updating biodiversity assessments based on our systematic review could help justify mitigation efforts.
- *Promote and publicise military involvement in conservation programmes at Tsomgo.* Over the past two centuries, Tsomgo's ecology has been influenced by military actions along the Chumbi Valley. Unfortunately, the military remains distant from conservation dialogues in the region. Frequent charges of military units toward Nathu La interfere with the ecology and hydrology of Tsomgo (Lachungpa, 2008). In recent years, pollution from military encampments has entered the wetland and its surrounding

watershed, degrading ecosystem services and attracting feral dogs. Because soldiers are stationed for short periods of time on the border, regular conservation programmes should be coordinated between military officials and the TPSS (Figure 5). This would increase rapport and communication between the two groups and enhance the efficacy of community-based management. Historically, the military has led trash pick-ups along the lake (Figure 6).

Figure 5. The Indian Army's 17th Mountain Division, also known as the 'Black Cats,' led a forestation and lake cleanliness drive on 26 May 2014, in consultation with the Government of Sikkim's Ministry of Forests, Environment & Wildlife Conservation

Photo credit: Pema Wangchuk

E.S.
CH.1
CH.2
CH.3
CH.4
CH.5
← TC

Figure 6. Tsomgo Pokhri Sanrakshan Samiti has partnered with the Ministry of Tourism and Civil Aviation in the Government of Sikkim to implement cleanliness drives and build conservation capacity

For example, on World Environment Day on 10 June 2014, TPSS worked with several stakeholders — including the Department of Tourism and Civil Aviation, the Police Check Post at Sherathang, the Forest, Environment & Wildlife Management Department, the J.N. Road Taxi Association, the Luxury Vehicle Owners' Association, TAAS, SAATO, SUTO, 129 RCC GREF and Tsomgo Traders and Shopping Association — to clean up trash around the wetland

Photo credit: Pema Wangchuk

- *Translocate species and develop Rhododendron-scrub buffers to reduce runoff.* Buffers significantly reduce the amount of runoff into wetland ecosystems (Mayer et al., 2007). Road expansion and development around the wetland complex has increased overland flow into Tsomgo Lake. On 25 May 2014, the 17th Mountain Division of the Indian Army planted 250 Rhododendron saplings to prevent runoff and attract high-altitude species. A similar approach could be taken along the highly eroded northern and western extents of the wetland. Buffers should integrate species listed in our historical review to enhance the ecosystem.
- *Update the Himalayan wetland classification system.* To date, classification schemes have variously defined the altitudinal criteria of Himalayan HAWs (Prins et al., 2017; Khan & Baig, 2017). These inconsistencies further complicate studying HAWs, and have contributed to their lack of protection under existing environmental policies. In the eastern Himalayas, officials typically employ the Ramsar Classification System for Inland and Human-made Wetland Types, which designates Tsomgo as an inland wetland and a permanent freshwater lake over 8 ha (Category O; O'Neill, 2019). The Cowardin System (1979) can be used to expand upon this classification by describing the complex as a lacustrine wetland dominated by a limnetic subsystem with a rock bottom (class) of bedrock (subclass). It is important to note that the 2008 Ramsar proposal included a much larger swath (3,100 ha) than the sub-watershed detailed in this article (see Islam & Rahmani, 2008). The wetlands of Kyongnosla Alpine Sanctuary and Tamze Khola are treated as separate due to their spatial extent and variable dynamics driven by climatic, topographic and hydrologic gradients at different altitudinal ranges.

Conclusion

The Tsomgo wetland complex is an important part of Sikkim's biological and cultural heritage. This case study highlights the central role of community-based conservation of the wetland, including state laws and religious taboos that prevent ecological degradation. Future management programmes should address both social and historical factors detailed in the above analysis and increase data collection capacity around the wetland. Relevant government agencies, including the military, should be sensitised and included as partners in HAW conservation. Based on its environmental history and community management, Tsomgo merits inclusion among the sites established since India joined the Ramsar Convention on 1 February 1982.

References

- Acharya, C. and Dokham A.S.G. (1998). 'Sikkim: The Hidden Land and Its Sacred Lakes'. *Bulletin of Tibetology* 3:10–15. https://www.repository.cam.ac.uk/bitstream/id/637029/bot_1998_03_02.pdf/
- Allen, N.J. (1997). '"And the Lake Drained Away": An Essay in Himalayan Comparative Mythology'. In: A.W. Macdonald (ed.) *Mandala and Landscape*, pp.435–451. New Delhi, India: D.K. Printworld.
- Armstrong, C.G., Shoemaker, A.C., McKechnie, I., Ekblom, A., Szabó, P., Lane, P.J., McAlvay, A.C., Boles, O.J., Walshaw, S., Petek, N., Gibbons, K.S., Quintana, E., Anderson, E.N., Ibragimow, A., Podruczny, G., Vamosi, J.C., Marks-Block, T., LeCompte, J.K., Awâsis, S., Nabess, C., Sinclair, P. and Crumley, C.L. (2017). 'Anthropological Contributions to Historical Ecology: 50 Questions, Infinite Prospects'. *PLoS ONE* 12 (2):e0171883. https://doi.org/10.1371/journal.pone.0171883
- Balée, W. (2006). 'The Research Program of Historical Ecology'. *Annual Review of Anthropology* 35:75–98. https://doi.org/10.1146/annurev.anthro.35.081705.123231
- Balikci, A. (2008). *Lamas, Shamans and Ancestors: Village Religion in Sikkim*. Leiden, Netherlands: Koninklijke Brill Nv.
- Bhatta, L.D., Ning, W., Udas, E., Agrawal, N.K., Ranabhat, S. and Basnet, D. (2018). *Wetlands in the Himalaya: Securing Services for Livelihoods*. Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD). http://www.indiaenvironmentportal.org.in/files/file/icimodWetlands.pdf
- Bourdet-Sabatier, S. (2004). 'The Dzumsa of Lachen: An Example of a Sikkimese Political Institution'. *Bulletin of Tibetology* 1 (4):93–104. [http://himalaya.socanth.cam.ac.uk/collections/journals/bot/pdf/bot_2004_01_04.pdf]
- Chatterjee, A., Blom, E., Gujja, B., Jacimovic, R., Beevers, L., O'Keeffe, J., Beland, M. and Biggs, T. (2010). 'WWF Initiatives to Study the Impact of Climate Change on Himalayan High-altitude Wetlands (HAWs)'. *Mountain Research and Development* 30 (1):42–52. https://www.jstor.org/stable/mounresedeve.30.1.42
- Chaudhary, P. and Bawa, K.S. (2011). 'Local Perceptions of Climate Change Validated by Scientific Evidence in the Himalayas'. *Biology Letters* 7 (5):767–770. https://doi.org/10.1098/rsbl.2011.0269
- Chettri, N., Shakya, B. and Sharma, E. (2008). *Biodiversity Conservation in the Kangchenjunga Landscape*. Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD). http://re.indiaenvironmentportal.org.in/files/icimod_biodiversity.pdf#page=125)
- Dahal, N., Lissovsky, A.A., Lin, Z., Solari, K., Hadly, E.A., Zhan, X. and Ramakrishnan, U. (2017). 'Genetics, Morphology and Ecology Reveal a Cryptic Pika Lineage in the Sikkim Himalaya'. *Molecular Phylogenetics and Evolution* 106:55–60. http://dx.doi.org/10.1016/j.ympev.2016.09.015
- Daurio, M. (2012). 'The Fairy Language: Language Maintenance and Social-Ecological Resilience Among the Tarali of Tichurong, Nepal'. *Himalaya* 31 (1):7–21. https://pdfs.semanticscholar.org/14b1/27177d4d7e3f91ad70c6ab82dccb2901e808.pdf

- Department of Ecclesiastical Affairs, Government of Sikkim (2015). 'Lakes of the Sacred Land Demojong, Sikkim'.
- van Driem, G. (2005). 'The Prehistory of Tibeto-Burman and Austroasiatic in Light of Emergent Population Genetic Studies'. *Mother Tongue* 11:160–211. http://www.sikkimeccl.gov.in/History/HolyLakes/HolyLakes.aspx
- Forest, Environment & Wildlife Management Department, Government of Sikkim (2009). *Sikkim Forestry: A 100 Years of Service*. Gangtok, India: Forest, Environment & Wildlife Management Department, Government of Sikkim.
- Gopal, B., Shilpakar, R. and Sharma, E. (2010). *Functions and Services of Wetlands in the Eastern Himalayas: Impacts of Climate Change*. Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD). https://www.cabdirect.org/cabdirect/abstract/20113239576
- Gujja, B. (2007). 'Conservation of High-Altitude Wetlands: Experiences of the WWF Network'. *Mountain Research and Development* 27 (4):368–371. https://doi.org/10.1659/mrd.mp005
- Gurung, B.B. (2009). 'Tsomgo Lake and Efforts Made on its Conservation'. In: T.R. Poudyal, H.P. Pradhan, C. Lachungpa and U. Lachungpa (eds.) *Sikkim Forestry: 100 Years of Service*, pp.75–77. Gangtok, India: Department of Forest, Environment & Wildlife Management, Government of Sikkim.
- Gurung, J., Chettri, N., Sharma, E., Ning, W., Chaudhary, R.P., Badola, H.K., Wangchuk, S., Uprety, Y., Gaira, K.S., Bidha, N., Phuntsho, K., Uddin, K. and Shah, G.M. (2019). 'Evolution of a Transboundary Landscape Approach in the Hindu Kush Himalaya: Key Learnings from the Kangchenjunga Landscape'. *Global Ecology and Conservation* 17:e00599. https://doi.org/10.1016/j.gecco.2019.e00599
- Iggulden, H.A. (1900). *The 2nd Battalion Derbyshire Regiment in the Sikkim Expedition of 1888*. London, UK: Swan Sonnenschein and Company.
- Islam, M.Z. and Rahmani, A.R. (2008). *Potential and Existing Ramsar Sites in India*. Mumbai, India: Oxford University Press.
- Jagoutz O., Royden, L., Holt, A.F. and Becker, T.W. (2015). 'Anomalously Fast Convergence of India and Eurasia Caused by Double Subduction'. *Nature Geoscience* 8:475–478. https://doi.org/10.1038/ngeo2418
- Jain, A., Singh, H.B., Rai, S.C. and Sharma, E. (2004). 'Folklores of Sacred Khecheopalri Lake in the Sikkim Himalaya of India: A Plea for Conservation'. *Asian Folklore Studies* 63:291–302. https://www.jstor.org/stable/30030339
- Joshi, R. and Dhyani, P.P. (2009). 'Environmental Sustainability and Tourism – Implications of Trend Synergies of Tourism in Sikkim Himalaya'. *Current Science* 97 (1):33–41. http://indiaenvironmentportal.org.in/files/Environmental%20sustainability%20and%20tourism.pdf
- Kandel, P., Chettri, N., Chaudhary, R.P., Badola, H.K., Gaira, K.S., Wangchuk, S., Bidha, N., Uprety, Y. and Sharma, E. (2019). 'Plant Diversity of the Kangchenjunga Landscape, Eastern Himalayas'. *Plant Diversity* 41 (3):153–165. https://doi.org/10.1016/j.pld.2019.04.006
- Kandel, P., Gurung, J., Chettri, N., Ning, W. and Sharma, E. (2016). 'Biodiversity Research Trends and Gap Analysis from a Transboundary Landscape, Eastern Himalayas'. *Journal of Asia-Pacific Biodiversity* 9:1–10. http://dx.doi.org/10.1016/j.japb.2015.11.002

- Kandel, P., Thapa, I., Chettri, N., Pradhan, R. and Sharma, E. (2018). 'Birds of the Kangchenjunga Landscape, the Eastern Himalaya: Status, Threats and Implications for Conservation'. *Avian Research* 9:9. https://doi.org/10.1186/s40657-018-0100-2
- Kar, D. (2014). *Wetlands and Lakes of the World*. New Delhi, India: Springer India.
- Khan, H.M. and Baig, S. (2017). 'High Altitude Wetlands of the HKH Region of Northern Pakistan – Status of Current Knowledge, Challenges and Research Opportunities'. *Wetlands* 37 (2):371–380. https://doi.org/10.1007/s13157-016-0868-y
- Kluge, J., Worm, S., Lange, S., Long, D., Böhner, J., Yangzom, R. and Miehe, G. (2017). 'Elevational Seed Plants Richness Patterns in Bhutan, Eastern Himalaya'. *Journal of Biogeography* 44:1711–1722. https://doi.org/10.1111/jbi.12955
- Lachungpa, U. (2009). 'Indigenous Lifestyles and Biodiversity Conservation Issues in North Sikkim'. *Indian Journal of Traditional Knowledge* 8 (1):51–55. http://nopr.niscair.res.in
- Lachungpa, U. (2008). *Important Bird Areas in India – Sikkim: Kyongnosla Alpine Sanctuary – Tsomgo Tamze Chola Complex*. Gangtok, India: Forest, Environment & Wildlife Management Department, Government of Sikkim.
- Little, K. (2008.) 'Lepcha Narratives of Their Threatened Sacred Landscapes'. *Transforming Cultures eJournal* 3 (1):1–29. http://epress.lib.uts.edu.au/journalsTfC
- M/S Perfact Enviro Solution Pvt Ltd. (2015). *Environment Impact Assessment & EMT Report for 'Tsomgo Passer Ropeway' at Tsomgo Lake, District East of Sikkim, Sikkim*. Gangtok, India: Forest, Environment & Wildlife Management Department, Government of Sikkim.
- Maharana, I., Rai, S.C. and Sharma, E. (2000). 'Valuing Ecotourism in a Sacred Lake of the Sikkim Himalaya, India'. *Environmental Conservation* 27 (3):269–277. https://doi.org/10.1017/S0376892900000308
- Manish, K. and Pandit, M.K. (2019). 'Identifying Conservation Priorities for Plant Species in the Himalaya in Current and Future Climates: A Case Study from Sikkim Himalaya, India'. *Biological Conservation* 233:176–184. https://doi.org/10.1016/j.biocon.2019.02.036
- McKay, A. (1998). *Pilgrimage in Tibet*. London: Routledge.
- McKay, A. (2003). *Tibet and Her Neighbors: A History*. London: Edition Hansborg Mayer.
- McKay, A. (2009). *Tibet and the British Raj*. New Delhi, India: Library of Tibetan Works and Archives.
- Meyer, M.C., Hofmann, Ch.-Ch., Gemmell, A.M.D., Haslinger, E., Häusler, H.H. and Wangda, D. (2009). 'Holocene Glacier Fluctuation and Migration of Neolithic Yak Pastoralists in the High Valleys of Northwest Bhutan'. *Quaternary Science Reviews* 28:1217–1237. https://doi.org/10.1016/j.quascirev.2008.12.025
- Mullard, S. (2011). *Opening the Hidden Land: State Formation and the Construction of Sikkimese History*. Leiden, Netherlands: Koninklijke Brill Nv.
- Namgay, K., Millar, J., Black, R. and Samdup, T. (2013). 'Transhumant Agro-pastoralism in Bhutan: Exploring Contemporary Practices and Socio-cultural Traditions'. *Pastoralism* 3:13. https: //doi.org/10.1186/2041-7136-3-13
- Nie, Y., Sheng, Y., Liu, Q., Liu, L., Liu, S., Zhang, Y. and Song, C. (2017). 'A Regional-scale Assessment of Himalayan Glacial Lake Changes Using Satellite Observations from 1990 to 2015'. *Remote Sensing of Environment* 189: 1–13. https://doi.org/10.1016/j.rse.2016.11.008

- O'Neill, A.R. (2017). 'Sikkim Claims India's First Mixed-criteria UNESCO World Heritage Site'. *Current Science* 112 (5):893–894. https://www.currentscience.ac.in/Volumes/112/05/0893.pdf
- O'Neill, A.R. (2019). 'Evaluating High-altitude Ramsar Wetlands in the Eastern Himalayas'. *Global Ecology and Conservation* 20:e00715. https://doi.org/10.1016/j.gecco.2019.e00715
- O'Neill, A.R., Badola, H.K., Dhyani, P.P., and Rana, S.K. (2017). 'Integrating Ethnobiological Knowledge into Biodiversity Conservation in the Eastern Himalayas'. *Journal of Ethnobiology and Ethnomedicine* 13:21. https://doi.org/10.1186/s13002-017-0148-9
- O'Neill, A.R., Chhetri P.K., Chhetri, B. and Rana, S.K. (2020). 'Establishing Ecological Baselines Around a Temperate Himalayan Peatland'. *Wetlands Ecology and Management* 28:375-388. https://doi.org/10.1007/s11273-020-09710-7
- Ongmu, D. (2015). '*Jhankri* rituals mark *Bhadhurey Purnima* at Tsomgo Lake'. *Sikkim Express* [online newspaper]. http://www.sikkimexpress.com/ (Accessed: 20 October 2019)
- Owen, L.A. and Dortch, J.M. (2014). 'Nature and Timing of Quaternary Glaciation in the Himalayan-Tibetan Orogeny. *Quaternary Science Reviews* 88:14–54. http://dx.doi.org/10.1016/j.quascirev.2013.11.016
- Phuntsho, K., Chettri, N. and Oli, K.P. (2012). *Mainstreaming Community-based Conservation in a Transboundary Mountain Landscape: Lessons from Kangchenjunga*. Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD).
- Prins, H.H.T., van Wieren, S.E. and Namgail, T. (2017). 'A Network of Small, Dispersed Himalayan Wetlands Suitable for Designation Under the Ramsar Convention'. In: H.H.T Prins and T. Namgail (eds.) *Bird Migration Across the Himalayas: Wetland Function Amidst Mountains and Glaciers*, pp.380–396. Cambridge, UK: Cambridge University Press.
- Ragettli, S., Immerzeel, W.W. and Pellicciotti, F. (2016). 'Contrasting Climate Change Impact on River Flows from High-altitude Catchments in the Himalayan and Andes Mountains'. *Proceedings of the National Academy of Science* 113 (33):9222–9227. https://doi.org/10.1073/pnas.1606526113
- Rick, T.C. and Lockwood, R. (2012). 'Integrating Paleobiology, Archeology, and History to Inform Biological Conservation'. *Conservation Biology* 27 (1):45–54. https://doi.org/10.1111/j.1523-1739.2012.01920.x
- Rubatto, D., Chakraborty, S. and Dasgupta, S. (2013). 'Timescales of Crustal Melting in the Higher Himalayan Crystallines (Sikkim, Eastern Himalaya) Inferred from Trace Element-constrained Monazite and Zircon Chronology'. *Contributions to Mineralogy and Petrology* 165 (2):349–372. https://doi.org/10.1007/s00410-012-0812-y
- Scheid, C.S. (2014). 'Hidden Land and Changing Landscape Narratives about Mount Khangchendzonga Among the Lepcha and the Lhopo'. *Journal of the Irish Society for the Academic Study of Religions 1* (1):66–89. http://hdl.handle.net/10468/1868
- Searle, M.P. and Szulc, A.G. (2005). 'Channel Flow and Ductile Extrusion of the High Himalayan Slab—the Kangchenjunga-Darjeeling Profile, Sikkim Himalaya'. *Journal of Asian Earth Sciences* 25 (2):173–185. https: //doi.org/10.1016/j.jseaes.2004.03.004
- Shrestha, U.B., Gautam, S. and Bawa, K.S. (2012). 'Widespread Climate Change in the Himalayas and Associated Changes in Local Ecosystems'. *PLoS ONE* 7(5):e36741. https://doi.org/10.1371/journal.pone.0036741

- Sikkim Express. (2008a, 5 January). 'Sindrabong Khangchendzonga Eco-friendly Society surges ahead with eco plans'. *Sikkim Express* [online newspaper]. http://www.sikkimexpress.com/
- Sikkim Express (2008b, 11 January). 'Pokhari Sanrakshan Samiati debuts with Tsomgo Lake'. *Sikkim Express* [online newspaper]. [http://www.sikkimexpress.com/
- Sikkim Express (2008c, 11 January). 'Stakeholders meeting on Tsomgo Lake deliberate on conservation issues'. *Sikkim Express* [online newspaper]. http://www.sikkimexpress.com/
- Szabó, P. and Hédl, R. (2011). 'Advancing the Integration of History and Ecology for Conservation'. *Conservation Biology* 25 (4): 680–687. https://doi.org/10.1111/j.1523-1739.2011.01710.x
- Tambe, S., Ghose, D. and Arrawatia, M.L. (2008). 'Designing a Participatory Policy Framework for the Conservation of Lakes in the Sikkim Himalaya'. In: M. Sengupta and R. Dalwani (ed.) *Proceedings of Taal 2007: The 12th World Lake Conference*, pp.2056–2060. Jaipur, India: Government of India.
- Tambe, S., Kharel, G., Arrawatia, M.L., Kulkarni, H., Mahamuni, K. and Ganeriwala, A.K. (2012). 'Reviving Dying Springs: Climate Change Adaptation Experiments from the Sikkim Himalaya'. *Mountain Research and Development* 32 (1):62–72. https://doi.org/10.1659/MRD-JOURNAL-D-11-00079.1
- Tambe, S. and Rawat, G.S. (2009). 'Ecology, Economics, and Equity of the Pastoral Systems in the Khangchendzonga National Park, Sikkim Himalaya, India'. *AMBIO* 38 (2):95–100. https://doi.org/10.1579/0044-7447-38.2.95
- TATA Consultancy Services (2017). 'Initial Environmental Examination and Management Plan'. In: *Tourism Master Plan for North Eastern Region*, Vol. II(C), pp.55–70. Kolkata, India: TATA Consultancy Services.
- Temple, R. (1881). 'The Lake Region of Sikkim, on the Frontier of Tibet'. *Proceedings of the Royal Geographical Society* 3 (6):321–340.
- Uprety, Y., Poudel, R.C., Gurung, J., Chettri, N. and Chaudhary, R.P. (2016). 'Traditional Use and Management of NTFPs in Kangchenjunga Landscape: Implications for Conservation and Livelihoods'. *Journal of Ethnobiology and Ethnomedicine* 3 (12):19. https://doi.org/10.1186/s13002-016-0089-8

CHAPTER

4

Indigenous knowledge for hazard prediction and risk reduction strategies

A case study of the Garo tribe, Meghalaya, India

By

Raka Matchisal A. Sangma

Jamsetji Tata School of Disaster Studies

Tata Institute of Social Sciences, Mumbai, India

About the author

Raka Matchisal A. Sangma

is a disaster risk reduction, climate change adaptation and conservation professional. He holds an MSc in disaster management (2018) from the Jamsetji Tata School of Disaster Studies, Tata Institute of Social Studies, Mumbai, and a BSc in environmental sciences (2015) from St. Edmund's College, Shillong, Meghalaya. He is the former president of the Indian Youth Climate Network (IYCN) and a member of the Confederation of Risk Reduction Professionals (CRRP). He is currently working on an afforestation, reforestation and revegetation (ARR) project in Meghalaya with Earthbanc, a Climate Fintech Company.

Email: raka.agitok@gmail.com

Abstract

Indigenous knowledge (IK) can enhance disaster preparation and mitigation, as well as response and recovery in the face of disaster. Since IK is often dismissed as folklore, the significance and potential of integrating it into disaster risk management (DRM) remain underexplored. However, in recent years, the increasing frequency and intensity of disasters, exacerbated by the cumulative and cascading effects of climate change, have drawn the scientific community's attention to tribal survival mechanisms and IK. Adding to this body of work, this chapter explores the belief systems, perceptions and traditional practices of the Garo tribe in Meghalaya, India, in relation to managing disasters. The author conducted qualitative research using semi-structured interviews and focus group discussions to identify traditional risk reduction practices, their significance and current threats to IK. Although not mentioned directly in the context of DRM, the study finds that the Garo people demonstrate resilience through their beliefs, everyday practices and intimate understanding of their environment, learnt in the form of cultural practices. The vernacular architecture of the Garo people and its significance in DRM have also been documented in this chapter. This study's findings indicate that effective DRM strategies for the region can be formulated by integrating Garo people's IK directly into the process. The chapter also serves as a starting point to further conversations on transferable Indigenous knowledge (TIK).

Keywords:

Garo tribe | Garo hills | Indigenous people | Indigenous knowledge | disaster risk management (DRM) | climate change

Introduction

Meghalaya, India, is classified as a multi-hazard state as it is prone to disasters like earthquakes, landslides, floods and cyclonic storms (Meghalaya State Disaster Management Authority, 2016). The major earthquake in the state's history was the 1897 Shillong earthquake, which had a magnitude of 8.7 on the Richter Scale. The death toll was estimated at some 1,542 people, including 600 who died in a landslide. Since this significant earthquake, the state has witnessed several subsequent earthquakes of varying intensities, as the entire state of Meghalaya falls under Zone V of the seismicity map of India. In addition to earthquakes and landslides, the state also experiences recurrent disasters like flash floods, fires, cyclonic storms, coal mine collapses and flooding, all of which have led to the loss of lives and extensive damage to properties. About 60% of the state is affected by cyclones every year as it is situated northeast of Bangladesh, which is highly prone to cyclones and high winds (Meghalaya State Disaster Management Authority, 2016).

A holistic and inclusive approach to disaster risk management (DRM) needs to be institutionalised in the state of Meghalaya. The United Nations Office for Disaster Risk Reduction (UNDRR) defines DRM as "the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses" (UNDRR, n.d.). Many tribes coexist in the state, and each tribe has its unique Indigenous knowledge (IK) and practices. The IKs held by the diverse tribal populations in the state should be integrated into DRM innovations. This chapter explores the belief systems, perceptions and practices of the Garo tribe to examine their resilience to various disasters. The findings are put forth as a contribution to transferable Indigenous knowledge (TIK), a concept introduced by the Disaster Reduction Hyperbase (DRH) initiative. The DRH elaborated TIK as the time-tested traditional art of disaster reduction that is indigenous to a specific region(s) but has the potential to be applied to other locations (Kameda, 2010).

Background of the study

As already stated, the state of Meghalaya, which lies in the seismically active Zone V of India, is prone to floods, fires, landslides, cyclonic storms and lightning strikes, in addition to earthquakes. Warning mechanisms of the Disaster Management Authority at the state and

district levels can predict most of the meteorological and hydrological hazards, except for geological hazards like earthquakes and hydro-geological hazards like landslides. The hilly topography of the state makes it vulnerable to landslides, which are exacerbated during the rainy season. Floods are a significant hazard mainly due to the Brahmaputra River and its tributaries (Meghalaya State Disaster Management Plan, 2016). Attempts have been made to prepare for and mitigate the impacts of such hazards, and response mechanisms and recovery coordination by various humanitarian organisations have improved in recent years. However, there exists a knowledge gap in the disaster management discourse. The potential of IK to add value to DRM has yet to be fully acknowledged and accepted.

Moreover, even though the national and state management authorities have made administrative and legislative changes in disaster governance, remote tribal areas inhabited by Indigenous people are often left out of such improvements. Advancements in disaster management technology and knowledge often fail to manifest in remote areas due to rugged terrain, absence of road networks and communication infrastructure, linguistic barriers and inadequate governance structures. Although Indigenous people and tribal communities often live mostly disconnected from these advancements and improved governance mechanisms, these communities have knowledge through which they identify risks, reduce exposure and mitigate impacts. There is no available written documentation about Indigenous knowledge of the Garo people in the context of DRM. This research demonstrates that the Garo people's beliefs, perceptions and practices have made them resilient to various hazards.

The study documents the Garo people's traditional risk reduction practices, the significance of these practices and threats to the maintenance of such IK. This research revealed that the Garo people hold rich meteorological knowledge that helps them predict climatic patterns. Moreover, their intimate relationship with their natural surroundings, methods of trial and error to manage risks and keen observation of wildlife behaviours have helped them develop a unique and intimate understanding of natural systems. Such knowledge is integrated into their way of life, which allows them to adapt to sudden natural shocks and stressors. However, this IK, along with other elements of their culture, is under threat of disappearing. Hence, it is crucial to document this IK and mainstream its significance and scope in DRM.

Methodology

The researcher used a qualitative approach to elicit information on respondents' experiences with natural resources and biocultural diversity. Primary data was collected through semi-structured interviews and focus group discussions (FGDs). The researcher collected primary and secondary data in two segments. The first segment of data was collected in May 2017 and the second segment in October and November 2017. The interview schedule consisted of general questions about the respondents' families and specific data regarding IK related to their emergency preparedness and risk reduction strategies. Since no documents on IK of the Garo tribe in relation to DRM were available, Dewan Singh Rongmuthu's book The Folktales of the Garo People (1960) was used as a secondary data source for IK under the guise of local folklore, beliefs and perceptions.

Data collection

Snowball sampling was employed. After completing each interview, the interviewer consulted with the respondent on whom to approach next in that village for an interview. People above 45 were eligible for the interviews because rapid cultural erosion is occurring, and the oral transmission of IK from one generation to the next is disappearing; this age group is more likely to have detailed IK. Ten interviews were conducted in each village based on semi-structured questionnaires prepared for this study. To avoid gender bias in the data, an equal number of male and female respondents was maintained. In total, 30 interviews were conducted.

FGDs were a valuable data collection method as the villagers became more open and interactive in groups. The researcher conducted one FGD with six to eight people in each of the three villages. Active participation was seen from both men and women in the FGDs. The FGDs were an attempt to capture the history of the community as far back as respondents could recollect, as well as the present condition of the local environment. The FGDs captured the profile of natural hazards and disasters that had affected the community, the types of disasters, the most destructive disaster according to the respondent's memory and the periods when these disasters unfolded. The FGDs also captured meteorological IK. This included IK, which enables community members to predict impending disasters, mitigate the hazards they experience and help build community resilience. The term 'resilience' here is used in the context of DRM to refer to "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner,

including through the preservation and restoration of its essential basic structures and functions through risk management" (UNDRR, n.d.).

Selection of study sites

The study was carried out in three villages: Eman A'sakgre (also known as Emangre or Emangiri) in South Garo Hills District, and Dangkong Songgital and Rongrong Bolsongchok in East Garo Hills District (Figure 1). Key population highlights for each location are listed in Table 1.

Figure 1. Location map of the study area

Source: Created by the chapter author using QGIS 3.20.3 and designed in Canva

Table 1. Population facts

	EMAN A'SAKGRE OR EMANGRE OR EMANGIRI (SOUTH GARO HILLS)	DANGKONG SONGGITAL (EAST GARO HILLS)	RONGRONG BOLSONGCHOK (EAST GARO HILLS)
NUMBER OF HOUSEHOLDS	57	32	37
POPULATION	329	138	169
MALE POPULATION	169	77	88
FEMALE POPULATION	160	61	81
CHILDREN POPULATION	90	25	34
SEX RATIO	947	792	920
LITERACY	73.22%	58.41%	56.30%
MALE LITERACY	76.42%	56.45%	60.27%
FEMALE LITERACY	69.83%	60.78%	51.61%
SCHEDULED TRIBES (ST)	100%	100%	100%
SCHEDULED CASTE (SC)	0.00%	0.00%	0.00%

Source: 2011 Census (Government of India)

The three villages were chosen based on consultations with Do·kakku, a local organisation focused on preserving, reviving and promoting the indigenous art and culture of the Garo tribe and the A·chik Literature Society, another grassroots organisation working to promote the Garo language. Factors such as accessibility and the likelihood of collecting required data were also considered. For example, communities in the villages of Rongrong Bolsongchok and Dangkong Songgital are known to follow traditional Garo practices, and unlike in other locations, many residents have not converted to Christianity. This sub-population of the Garo people is called the Songsareks, who still hold firmly to their beliefs and practices; they are a repository of Indigenous knowledge passed down from the pre-colonial era.

Results and discussion: The Indigenous knowledge of the Garo people

When one reads through Garo folklore, as documented in the book The Folktales of the Garo People, it is evident that the Garo tribe has experienced and survived various disasters. Most of these disasters have supernatural beliefs attached to them. For instance, in most cases, and especially in remote rural areas, floods, landslides and earthquakes have been attributed to the movement of a mythical giant serpent known to the Garo people as Sangknie. Similarly, mythical creatures like mermaids and water spirits are also attached to various hydrological disasters.

Through years of interaction, observation and trial and error with the natural environment, the Indigenous people of the Garo Hills have integrated their knowledge of risk management into their everyday practices. Their IK has reduced their vulnerability, which the UNDRR defines as “the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards” (UNDRR, n.d.). The Garo people’s ability to forecast weather and disaster events stems from the community’s long-term observations of cloud appearances, wind direction, lunar cycles, animal behaviours, insect movements, traditional practices relating to soil and water, and intimate relationships with the local environment. These forms of knowledge and strategies are discussed next.

Cyclonic storms

1. The blossoming of mango trees (*Mangifera indica*) serves as a signal to the Garo people, indicating the arrival of the monsoon season. When these trees bloom abundantly, the Garo people interpret it as a sign of strong winds that will sweep through the region in that particular year.
2. The Garo people believe that birds can predict storms and high-velocity winds. When birds build their nests on smaller and more tender branches (twigs) away from the main trunk, there will be no strong winds or storms that year. However, when birds are found to be nesting on the more substantial and more extensive branches (boughs) near the trunk, there will be strong winds that particular year.
3. If the Samaki plant (*Clerodendrum sp*) (Figure 2), a flowering plant from the Lamiaceae family, flowers with a long stalk, it is believed that there will not be strong winds, but strong winds are expected if the stalks are short. This may indicate the plant’s adaptation to strong winds because flowers with long stalks will likely break when exposed to heavy winds.

Figure 2. Hill glory bower (vernacular name: *Samaki*; scientific name: *Clerodendrum sp.*)

Photo credit: Raka Matchisal A. Sangma

The Garo people's traditional knowledge, accumulated through intimate observations of their surroundings, has offered indicators for people to prepare for and mitigate imminent cyclonic hazards. By acknowledging these indicators, the people reinforce their thatched roofs, mud walls and livestock sheds. They also secure their food supply and keep their grains dry.

Torrential rains

1. The shape of the moon: *Wachi ra·chaka* - When the horns of the crescent moon point upwards, or when the crescent moon is U-shaped, or takes the appearance of a bowl lit at the bottom.

   The Garo people believe that a bowl-shaped moon holds the rain and that whenever the moon takes this shape, it will not rain. Interestingly, this belief is not just limited to the Garo tribe. Hawaiian mythology also explains that when the moon assumes the shape of a bowl or a smile, known as a 'wet moon' or a Cheshire moon, the moon is holding the water by filling itself with rain.

Wachi so'ola - When the crescent of the moon is lit on the side.

The Garo people believe that a tilted bowl-shaped crescent moon empties the rain onto the earth. Such a moon shape is typical at the beginning of the year, and as the year passes into summer, the Cheshire moon waxes into a proper crescent moon.

2. Cloud appearances: When the sky is clear, no dark clouds are present, and the moon and stars can be seen clearly, the Garo people perceive that it will not rain. The opposite indicates rainfall.

   Similar observations have been made by Indigenous communities residing in the flood-prone districts of Bangladesh: Lalmonirhat and Kuriggram. Indigenous communities in these districts also predict rain by acknowledging specific environmental signals. When the people see "black clouds and its roaring sounds of clouds," they take it as an indicator of showers to come (Ahmmed, 2015, p.24).

   Moreover, the Garo people also believe that during the months of April-May, if the region experiences heavy winds, the rains will be delayed; if there are no strong winds, this indicates early rainfall in that season. They believe that strong winds carry away the rain clouds and delay the rainfall.

3. Rise in humidity: When the human body becomes hot and sticky due to warm and humid weather, the Garo people perceive this as another indicator of rain. This belief is also common among Indigenous peoples in the districts of Lalmonirhat and Kuriggram in Bangladesh (Ahmmed, 2015).

4. The Indian bullfrog (*Hoplobatrachus tigerinus*), or *Bengbong* in the local dialect, is considered a blessed animal, as it usually croaks before the arrival of monsoons. The Garo people believe that the frog is calling for the rains. Indeed, the frogs do predict the coming of rains. As amphibians, Indian bullfrogs need to keep their skin moist, so during the dry season, they limit their movement and stay close to bodies of water. When the frog senses a rise in humidity and expects precipitation, it comes out of its haven and searches for mates. The frogs attract mates by croaking at the beginning of the monsoon season. Hence, the people perceive the croaking as a call for rain. Similar observations of frog behaviours have been made by Ahmmed (2015) in his research on IK and flood management in Bangladesh.

5. The fisherfolk amidst the Garo community note that when it is about to rain, the fish in the water become restless and jump and splash in the water. The fisherfolk also mentioned that when the fish lay their eggs close to the land, it will rain soon. They can predict whether the weather will be favourable through these signs.

6. Further, the Garo people, including the younger generation, believe that movements by insects indicate rain activity. Winged termites flying out of their underground nests indicate the probability of rain. Also, the behaviour of certain insects signals whether it is going to rain that day or not. For example, some ant species abandon their underground nests and move to new places or build raised anthills to shelter from the downpour. The Garo people call this phenomenon *a'wawe biap jitta* ('the termites shift places') and *similchak nok rika* ('the ants build houses'). Similar beliefs about ant movement as indicators of rain are also present in Indigenous communities residing in Bangladesh (Ahmmed, 2015).

Floods

Floods are one of the significant hazards in the plains of the Garo Hills. A fascinating phenomenon observed during the field visits was the use of raised platforms in traditionally constructed houses.

Garo communities in the plains experience flooding every year and have developed their own system of anticipating, preparing for, coping with and recovering from flooding. Generations of experiences dealing with flood situations have enriched local flood mitigation knowledge. Some of these include:

1. The fisherfolk shared that when crabs dig their holes a bit further from the water, the water level will rise. When they dig holes closer to the water, the water level will recede.
2. The Garo people also believe that when they spot the bagworm moth (*Psychidae*), there will be a heavy downpour and a rise in water levels. Bagworm moths are from a family of Lepidoptera, locally known as Gol·katti or Kilgong. They reinforce their cocoons with twigs to be water-resistant and buoyant (Figure 3).

Figure 3. The bagworm moth

Photo credit: Raka Matchisal A. Sangma

Earthquakes

The Nokmas or tribal chief usually has the largest property in a typical Garo community, with a wide-open area as their front yard. The tribal chief's property is typically used to organise village meetings and gatherings. If there is any seismic activity, the people usually gather in front of the chief's house since it is the largest open area in the community. The people also hug banana trees in the event of violent tremors because they believe that banana trees can withstand shocks and that they will not get hurt if a banana shoot falls on them. People living near the edge of the forest stated that animals such as mice, rabbits, reptiles and deer run from forested areas into open lands before an earthquake. They observe that these animals can feel even the slightest tremor and run to open spaces to escape falling trees. This belief is still dearly held by the tribe for anticipating seismic events.

Drought and famine

In local folklore, the longest drought in Garo history is mentioned in relation to the famous king Abong Noga. During his reign, a drought lasted for seven long years. The king ordered his subjects to take care of water sources and stressed the importance of preserving food supplies. Whether this story can be verified or not, the Garo people have faced drought and famine. Their collective survival experiences have culminated in the knowledge and practices used to anticipate droughts and famines today.

1. Non-Christian Garo people called Songsareks, who follow traditional *wachirua* (*wachi* - rainy season, and *rua* - pour) rituals, appeal to the gods to bless them with rain when facing drought-like situations. As part of the ritual, villagers go to the rivers and wet the stones and the ground in and around the rivers. They believe that this practice will lead to an early onset of rains.
2. *Wa'rama* (mast flowering in semelparous bamboo species): Meghalaya is blessed with rich biodiversity, including various bamboo species. The Forest and Environment Department of the Government of Meghalaya has identified a mast flowering bamboo species. Mast flowering is the simultaneous flowering of all the clumps in a bamboo population spread over a large area. This usually results in the death of bamboo clumps and is recognized as a hazard that needs to be mitigated. IK about the mast flowering of bamboo serves as a valuable early warning indicator of a famine-like situation for the Garo people. This knowledge is not limited to the Garo people and is common amongst communities in many Southeast Asian countries.
3. The abundance of bamboo seeds and fruits attracts rodents; the enormous nutritional availability results in the explosion of the local rodent population. When the rodents exhaust the available bamboo seeds, they leave the forest and invade the surrounding pastures to forage for food, menacing agricultural fields and storage houses. It is reported that in 1969 the region of Mizoram faced famine due to the mast flowering of Muli bamboo (*Melocanna baccifera*).
4. Locals also reported that the consumption of bamboo fruits is fatal for livestock and wild animals like boars.
5. The death of bamboo clumps leaves behind a considerable quantity of flammable biomass — a fire hazard.

Conservation of soil, water and forest resources

The cultural beliefs of the Garo tribe have also contributed to the conservation of their soil, water and forest resources. For instance, they strongly believe in karma, bad luck and curses. The Garo people know karma as *Asi-Malja*, and curses or bad luck are known as *Asi-raka*. Epidemics, death or bad harvests in the region are considered to be bad omens, and some people have migrated to other areas, believing that the region is cursed. Similarly, some forested areas are preserved as sacred groves, where people do not cut any trees, collect forest products or disturb the forest. These groves are located near sacrificial or ritual sites, where people have had unexplainable experiences or misfortunes or where the locals believe a deity resides.

The practice of *o'pata* is used to check whether the prospective land or forest is suitable for shifting cultivation. In this practice, the person slashes or cuts one small plant or shrub and then waits for a divine signal in the form of a dream. If the forest is cursed, guarded by a forest spirit or home to certain deities, the person receives a warning in their dream.

The people also avoid logging or *jhumming* (slash and burn technique) near catchment areas, as this technique destroys water resources. In times past, there were numerous sites that people believed were cursed or *asi'raka*. Hence this contributed to the preservation of water resources.

Vernacular architecture

Like most tribes in northeast India, the Garo people build their houses on piles, usually on steep slopes. The footings or piles on which the houses are built vary in length. Crossbeams are laid on top of the floor posts as a framework that supports a layer of bamboo (Figure 4). The final floor is made of a layer of rough bamboo matting, and the same matting is also used for the walls. The roof is layered thickly with *am'pang* (thatch grass), bamboo leaves or cane leaves. Generally, these houses are long and narrow and have no side windows. The openings at the front and the back serve as doorways.

Figure 4. *Nok a'chik*, a traditional house in Dangkong Songgital, East Garo Hills, Meghalaya

Photo credit: Raka Matchisal A. Sangma

Moreover, traditional houses are always built near valleys or by a depression in the hillside, and they are in proximity to a water source. The entire village is built around an open space called *a'tilla* or *sa'ra*. These open spaces are used for performing rituals, including cremating the dead. Hence the Garo tribe emphasises maintaining open spaces, which are crucial in an area where 59% of the landmass is prone to earthquakes of varying magnitudes.

As mentioned earlier, according to the Seismic Zone Map of India, the entire northeast region of India falls under the Earthquake Zone V, indicating that it is the most seismically active region in the country. On the Modified Mercalli (MM) scale, Zone V is a very severe intensity zone.

On 12 June 1897, at around 5:11 PM, the Shillong earthquake killed about 1,542 people during the three minutes it lasted. The earthquake's tremors were so violent that most of the damage was done in the first 10 to 15 seconds of the shock. It was reported that all the stone buildings collapsed and that about half of the houses built with wooden frames and reed walls covered with plaster were also ruined. According to a report by the Geological Survey of India, only the plank houses with wooden frames and plank walls built on raised platforms (the traditional architecture) survived the earthquake (Kalita, n.d.).

In Tura, the headquarters of the West Garo Hills, the damage to the buildings was less severe as the buildings were not made of brick (Oldham, 1899). The vernacular housing construction of the Garo people, composed of bamboo, timber, thatch grass and rocks, is therefore earthquake-resistant, as recounted above. The walls are made by weaving bamboo and reinforcing them with timber as pillars. The house is raised with rocks or wooden posts (Figure 5).

Figure 5. In the traditional tribal architecture of the Garo people, houses are constructed with raised platforms

Photo credit: Raka Matchisal A. Sangma

Hence, vernacular architecture needs to be integrated into building earthquake-resistant structures. More detailed research needs to be carried out to verify the seismic performance of these architectural elements and mainstream their significance in an area identified as a very high-risk zone. Moreover, this architecture can contribute to and enrich the TIK base for building in earthquake-prone areas.

Moreover, the Garo Hills region is prone to hailstorms, which makes the traditional architecture ideal, as the thatch roof made of *am'pang* (thatch grass) (Figure 4) lasts for around 10 years and is resistant to the impacts of hailstorms. However, since the availability of thatch grass has been dwindling in recent times, houses are now using CGI sheets in construction, which gets damaged by hail.

The modern Garo house (Figure 6) can be seen as integrating Indigenous and contemporary knowledge. In some villages, the roof is made with thatch grass reinforced by CGI sheets. This protects the CGI sheets from damage by hail and prevents rainwater from seeping in.

Figure 6. A traditional Garo house with modern elements

Photo credit: Raka Matchisal A. Sangma

Food security

To date, almost all the households in the rural areas of the Garo Hills have small huts called *jam nok* (granaries) built to store harvest or grains and other food materials for the next season or the following year's cultivation (Figure 7).

Figure 7. *Jam nok*, traditional granary

Photo credit: Raka Matchisal A. Sangma

These storage houses are even found in some urban households. Each family might possess one or more of these granaries depending on the size of their property or paddy fields. These granaries are usually located at the corner of the village to safeguard the granaries from fire hazards that are common in residential areas. The granaries are also built on raised platforms atop boulders or wooden poles with mushroom-shaped roofs to ward off pests and keep the stored gains dry (Figure 8). The grains are stored in large baskets woven with bamboo strips, various edible roots and tubers are stored on the bamboo floor, and corn and millet are suspended in bunches from the ceiling.

Figure 8. Traditional granary

Photo credit: Raka Matchisal A. Sangma

Social support mechanisms for relief and recovery

Garo communities share a strong sense of collective responsibility and cherish their cultural identity. By virtue of the strong bond between community members, in the event of a disaster, community members leave their work, carry their tools and raw materials, and help each other rebuild damaged houses. Psychosocial support and relief and recovery materials are provided to the victims of such untoward events. The strength of the community's bond reveals itself in the coping and recovery mechanisms community members demonstrate in the wake of a disaster.

Conclusion

"The A·chik Script," a chapter in Rongmuthu's book (1960), recounts a moment of misery in Garo history when the Garo people lost their *A'chik* (Garo) script and, along with it, all the written records of their "history, religious practices, the art of warfare, esoteric practices, government and their industry" (p. 1-2). The IK of the Garo people must be acknowledged and conserved as there is rapid cultural erosion.

IK is under threat of disappearing due to changes in environmental conditions, intrusions by outside religious traditions, mainstream developmental activities, policies that undermine traditional authorities and shifts from rural to urban settings. The younger generations are unaware of their traditions and local knowledge, as the transmission of knowledge from one generation to the next is becoming rare.

For instance, interaction with locals during the field survey revealed that the IK used for predicting and anticipating meteorological phenomena and imminent hazards is becoming less accurate due to changing climatic patterns. In addition, it was reported that resources for the construction of traditional houses are becoming rare due to the clearing of forested areas for agricultural and plantation crops. Furthermore, newly acquired religious beliefs such as Christianity have led people to abandon traditional ways.

The research suggests that the Indian government should be aware of the rapid loss of IK and should consider its inclusion within school curriculums. The opportunity for children to explore and exercise innovations based on IK has mainly been dismissed and denied. Instead, education in the region today focuses exclusively on competencies that require empirical and scientific reasoning, which has contributed to declining awareness among the younger generation about their cultural heritage. It is advised that the educational system introduce IK in curricular and extracurricular activities to enhance cultural awareness amongst the children of the Garo people.

The research emphasises promoting and popularising the use of IK in DRM. This focus is essential in helping communities adapt to the social and environmental shocks and stressors that will intensify due to projected climate change and unplanned development activities. Communities located in remote and isolated parts of the Garo region will benefit immensely from such initiatives, as they are unlikely to receive timely external assistance when facing disasters.

Policy recommendations

Rapid modernisation is causing the extinction of many floral and faunal species; it has also significantly impacted the survival of IK and its daily practices. Therefore, policies promoting the protection, preservation, more comprehensive application and development of the collective knowledge of Indigenous peoples are urged. The following are recommended:

- **Intellectual property rights:** Facilitate the ownership of traditional knowledge associated with DRM by the holders of such knowledge.
- **Architecture:** Incorporate vernacular architecture into modern conventional architecture according to state-specific building codes. For instance, laying polycarbonate roofing underneath thatch roofs can reinforce the tops of the traditional houses of the Garo people against seepage due to torrential rains and damage due to hailstorms.
- **DRM:** State and District Disaster Management Authorities should incorporate IK in their DRM plans and strategies. The National Disaster Management Plan should promote TIK whenever possible. It is essential to share diverse IK and practices with other communities vulnerable to similar hazards.
- **Digitise IK:** Preserve IK among the young generations through new forms of information technology.

References

- Ahmmed, S. (2015). *Application of Scientific and Indigenous Knowledge for Flood Management in Northwest Bangladesh*. Ph.D. thesis, BRAC University.
- Kalita, J. (n.d.). 'The Great Assam Earthquake of 1897'. Assam Portal. https://assam.org/content/great-assam-earthquake-1897.
- Kameda, H. (2010). 'Disaster Reduction Hyperbase (DRH) - Toward its Implementation in Asian Practice', paper delivered at the Asian Conference on Disaster Reduction, Kobe, Japan.
- Meghalaya State Disaster Management Authority. (2016). *Meghalaya State Disaster Management Plan*. Meghalaya, India. http://msdma.gov.in/SDMP/Volume-2.pdf
- Oldham, R.D. (1899). *Report on the Great Earthquake of 12th June 1897*. Calcutta: Office of the Geological Survey.
- Rongmuthu, D.S. (1960). *The Folk-tales of the Garo people*. Guwahati, India: University of Gauhati.
- United Nations Office for Disaster Risk Reduction. (n.d.). 'Disaster Risk Management'. United Nations Office for Disaster Risk Reduction. https://www.undrr.org/terminology/disaster-risk-management.

CHAPTER

5

Tracing local understandings of hazards and disaster

Learning from Himalayan villages in Uttarakhand, India

By

Aditi Sharma

Department of Ecology, Environment and Sustainable Development

Tata Institute of Social Sciences, India

About the author

Aditi Sharma

is an interdisciplinary researcher specialising in socio-cultural ecology. Born and raised in the Himalayas, she focuses on questions of heritage in her research. She has extensive work experience in the Himalayan states of Uttarakhand and Himachal Pradesh and the Union Territory of Ladakh in India. She holds a master's degree in ecology, environment and sustainable development from the Tata Institute of Social Sciences, India. She was a recipient of the Naropa Fellowship, focusing on Himalayan entrepreneurship. Currently, she is working as a research and project consultant for sustainable livelihood development in Himachal Pradesh.

Email: Aditi.sharma1912@gmail.com

Abstract

The Himalayas are vulnerable to a range of environmental hazards such as flash floods, landslides, earthquakes, wildfires, avalanches and droughts. The intensity and frequency of these events has only increased over time due to the impacts of climate change and environmental degradation. This exploratory research examines the 2013 Uttarakhand disaster that affected 4,200 villages. The scale of the disaster surpassed the capacity of the formal emergency response system. Weak local-level preparedness was identified as a significant concern for the region.

The mixed-methods inquiry employs an environmental behavioural model. Perception studies were used with Local communities in three villages in Uttarakhand, India to document possible responses of individuals during situations of risk.
This paper aims to bring to the forefront traditional ecological knowledge related to disaster risk reduction and how such knowledge can be harnessed for better outcomes. The research advances understanding of disaster risk perception and concludes that responses to disasters are deeply influenced by determinants such as ecology, culture, religion and community beliefs. The findings are expected to inform future thematic studies in the domains of environmental psychology, cultural ecology and disaster management studies.

Keywords:

Hazard risk perception | Indigenous knowledge | mountain ecosystems | hazard risk mapping | traditional disaster risk reduction

Introduction

The scientific community has increasingly acknowledged the importance of traditional, Indigenous and local knowledge for environmental conservation practice. J. T. Inglis (1992) describes traditional ecological knowledge (TEK) as the wisdom possessed by an individual or a community whose practices offer historical continuity. According to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014), local knowledge and its integration act as stimuli for community development. The Secretariat of the United Nations Framework Convention on Climate Change (UNFCC) recognises that Indigenous knowledge plays a crucial role in the "preparation, operation and action" of disaster response (Vaidya et al., 2019). Advancing these assertions, the paper documents traditional and local knowledge related to disaster risk reduction in the Himalayan communities of the Indian state of Uttarakhand.

The Himalayan range is a fragile ecological zone that experiences a range of environmental hazards including flash floods, landslides, earthquakes, wildfires, avalanches and droughts. Exposure to geophysical hazards is very high in the Himalayas (Mehta, 2009). The frequency of hazard occurrence and scale of disaster events have increased over time due to the impacts of climate change in the high mountains and human-induced environmental degradation.

A hazard can be understood as risk that encroaches on vulnerable populations (Sharma, 2012). Disaster risk has three main determinants: hazard occurrence, exposure to the hazard and the vulnerability of the community impacted (Vaidya et al., 2019). A disaster event impacts the social, economic and environmental domain and exceeds the coping ability of those affected. Disaster events disproportionately impact those who are already vulnerable; age, gender and health status are some of the key determinants (Mehta, 2015). Vulnerability to disasters is exacerbated by the lack of local-level disaster preparedness (Sampath, 2013).

Integrating diverse knowledge systems within action plans and disaster management policies is important for reducing hazard risks as well as advancing biodiversity conservation (Dalisay, 2014). The Uttarakhand Disaster Risk Assessment Report (2019) points out that vulnerability to hazards is determined by geophysical as well as socio-economic aspects. This is an important insight for planning risk-reduction strategies. The National Policy of Disaster Management of India (2009) highlights the importance of area-specific knowledge and experiences in post-disaster efforts. Field-based, empirical studies on the relationship between disasters and local knowledge have the potential to inform

disaster management practices and highlight gaps in present disaster plans. This paper examines the traditional knowledge of communities affected by the 2013 Uttarakhand disaster, a catastrophe that affected 4,200 villages in the central Indian Himalayas. The scale of the disaster surpassed the capacity of the formal emergency response system. Weak local-level preparedness was identified as a significant concern for the region. The research focuses on TEK related to disaster risk reduction and how such knowledge can be harnessed for better outcomes. It explores the disaster risk perception of the communities and how their response to disasters is influenced by ecology, culture, religion and other traditional beliefs.

Methodology

The study takes place in the central Himalayan district of Rudraprayag in Uttarakhand, India. The region experienced an unprecedented disaster event in 2013 that resulted in massive landscape changes and approximately 5,000 casualties (Naik et al., 2014). A total of 4,200 villages in the district were impacted by the 2013 disaster (Singh, 2013). Further, some 72 villages of the Ukhimath administrative block in the district were completely cut off from the rest of the country for another four months.

Understanding community perceptions and descriptions of hazards is essential for any resilience plan of action since such plans must reflect the social and cultural context (Bodoque et al., 2016). The environmental behaviour model employed in this study attempts to illustrate that the choices that people make are reactions to ecological factors (Steg et al., 2013). A mixed-methods approach was used to understand local perceptions of disaster risk. Data was collected from October 2017 to January 2018 through a multi-stage sampling approach. The preliminary phase of the research involved review of literature and collection of secondary data from the district-level Disaster Management Department as well as a pilot study to identify villages for in-depth interactions. The three villages of Kotma, Kalimath and Dewali Bhanigram in Ukhimath administrative block were selected for the study for multiple reasons. The communities in Kotma village faced severe losses in terms of livelihoods due to the 2013 disaster event, including tourism-related activities and agriculture. The knowledge and perspective of this vulnerable group can provide important insights for disaster management. The Kalimath village has a religious site associated with the deity Kali Devi, which is visited by a large number of tourists every year and allows the opportunity to study cultural and religious traditions that are interlinked with knowledge of disasters. The village Dewali

Bhanigram was labelled as the 'Village of Widows' in the media as 52 men lost their lives in the catastrophe. The village witnessed a sharp change in its social structure. These changes have bearing on gendered roles and knowledge for disaster management.

A total of 120 households were surveyed across the three villages using a simple random sampling method. Both direct and indirect (or secondary) impacts of the 2013 disaster were recorded. The impact of the disaster on an individual's life (such as the death of a family member, loss of assets, loss of livelihoods, identity loss) and the individual's overall experience of disasters across their lifetime were explored. The study also captured respondents' subjective narratives with respect to their cultural associations and local knowledge around disaster risk reduction and management. The survey was supplemented by in-depth semi-structured interviews and participatory mapping exercises in the three villages. Sketch mapping, a participatory risk-mapping tool, was used to understand the perceptions of the community about hazards in the context of the local physical environment based on their knowledge, observations and everyday experiences. Qualitative data was transliterated from Hindi/Garhwali to English verbatim, coded and then sorted into various themes. The quantitative data on hazard risks and damages were analysed.

Results and discussion

The aggregate perceptions of the community

The varied nature of impacts related to the 2013 disaster in Uttarakhand, India led to distinct perceptions of disasters in each of the villages based on the subjective experiences of the respondents. The impacts of the disaster on the three villages[1] surveyed are illustrated below. The majority of the damages reported were related to livelihoods (45%), followed by limited access to food (26%) and loss of lives (12%). The respondents also reported the loss of agricultural land, damage to residential houses, loss of identity and a few cases of physical injuries. The responses thus captured a comprehensive range of physical, socio-economic and psychological impacts of the disaster event.

1 Based on multiple response inputs

Figure 1. Damages incurred due to the disaster of 2013

Source: Data compiled by the chapter author

According to Botzen et al. (2009), risk perception with reference to environmental events describes "intuitive risk judgements" or the cognitive understanding that people form with respect to a particular hazard (Botzen et al., 2009). Perceptions about disaster risk are defined by the magnitude of the event and individuals' past experiences, the pattern of responses to the disaster events, and the predictability of a disaster (Nyakundi et al., 2010).

The communities identified the potential for occurrence of landslides, cloud bursts and flash floods as 25.8%, 16.6% and 7.5%, respectively. The seasonal occurrence of these hazards is illustrated in the chart below. The occurrence of earthquakes was also highlighted by the respondents as a risk factor, as they often trigger landslides in the region. This shows the communities' awareness of multiple hazards and the cascading nature of these hazards.

Figure 2. Seasonal hazard risks in the villages of Kotma, Kalimath and Dewali Bhanigram

Source: Data compiled by the chapter author

Based on the experience of the 2013 disaster and previous disaster events, 30% of the respondents feared events associated with landslides, cloudbursts and flash floods; 28% of the people felt that disasters curbed the normal functioning of life; and 35% considered it as part of life. Moreover, 28% of the respondents felt the disaster events motivated them to work towards strengthening their capacity to withstand future threats.

According to the respondents, the key factors contributing to the disasters include climate change (39.17%), deforestation (23.33%), illegal construction (23.33%), landscape characteristics (8.33%) and the abandonment of territory and inappropriate land management (5.84%).

Results from hazard risk-mapping

Sketch mapping helped capture the following three maps that represent the village boundaries, their surroundings, key social set-ups and hazard risk zones for the study villages. On each illustration, the areas marked with red dots signify high-risk zones.

Kotma Gram Panchayat (village governance council): The risk map of Kotma Gram Panchayat prepared by the participants covers the villages of Kotma and Khunnu (Figure 3). The shops are located closer to the main road that connects the villages to the block headquarters and other villages. The residential houses, schools and *panchayat bhawan* (the village governance council office building

or the 'community building') are located on the mountain slopes. The temple, though quite far from both the villages, is featured on the map because the participants feel closely associated with it. The most risk-prone areas were marked along the riverbank of the Saraswati River. The respondents reported that many houses built in this zone were severely affected due to the flash floods in 2013 and were later abandoned. The participants identified a high risk of rocks falling towards the streams coming down the mountain slopes towards the Saraswati River. The houses located along this zone were identified as the second most vulnerable. The barren forest area between the two villages Kotma and Khunnu was identified to be at risk of landslides. The respondents were also concerned about soil erosion in the agricultural fields due to heavy rainfall.

Figure 3. Participatory hazard risk map of Kotma Gram Panchayat

Source: Data compiled by the chapter author

Kalimath Gram Panchayat: The risk map prepared by the participants of Kalimath Gram Panchayat captures two distinct parts of the village. The eastern side of the Saraswati River includes the temple and important institutional buildings such as schools, *panchayat bhavan* and the post office. The *panchayat bhawan* located next to the river totally washed away during the 2013 disaster and has since been reconstructed. These are connected to the village on the other side of the river by two bridges. The western side of the river features shops, houses scattered across the hill and agricultural fields (Figure 4). The shops for daily needs are located near the bus station on the main motorway.

The majority of the area on this map is marked by rocky hills. The village community is not as involved in agriculture as the communities of Kotma. The livelihoods of the local people revolve around the temple and religious tourism-related activities. The respondents mentioned that they consider the area near the temple to be safe from disasters even though it is close to the river. The houses located near the Saraswati River on the western side of the river were identified by the participants as the most vulnerable residential areas in the village. The areas next to the streams that join the Saraswati River were also marked as hazard-prone.

Figure 4. Participatory hazard risk map of Kalimath village

Source: Data compiled by the chapter author

Dewali Bhanigram Gram Panchayat: The villages of Dewali and Bhanigram (Figure 5) are not connected by a motorway. The uphill trek towards the village from the nearest motorway is around 2–3 km. The *panchayat bhawan* is located in Bhanigram. The eastern part of the village extends towards the hills. The hills have alpine forest cover, which supports local wildlife, and the good vegetation cover along the slope reduces the occurrence of landslides. In spite of the high number of casualties during the 2013 disaster, the respondents considered the village to be safe from hazards and disasters. They felt that risk-prone zones are located outside the village. When asked to mark the high-risk zones, the respondents identified the area near the motorable road and near the river as landslide-prone, which are away from the villages and the local market.

The '*Panchvrak*' temple is situated in the heart of Bhanigram, opposite the *panchayat bhavan*. The temple also functions as a childcare centre. The post office is situated in the southern part of the village. In Dewali village, the participants also marked the building of the Mandaakini Manhila Bunkar Samiti, a non-governmental organisation (NGO), which emerged as one of the successful livelihood interventions for women in the aftermath of the 2013 disaster. This NGO has benefitted families who lost the earning member of their family in the disaster. The village also has a primary school, where only three students were enrolled as of January 2018.

Figure 5. Participatory hazard risk map of Dewali Bhanigram

Source: Data compiled by the chapter author

Community beliefs and knowledge

The study documents community beliefs and interpretations of hazard risks to understand the state of local ecosystems and determinants of various hazards, and to explore the scope of integrating this knowledge in disaster risk reduction practices:

Signs in the atmosphere: The communities gain knowledge about their surrounding areas through everyday observations. One respondent from Kotma village identified the importance of "cues that the environment provides before a disaster" to help in understanding the weather and making predictions.

- The community identified a dark pink shade in a cloudy sky, especially at night, as a sign of potential heavy rainfall.
- The community was well aware of the natural sounds that surround them. They recalled that right before the flash flood in 2013, a few people in the community had observed that the river was making a very loud gushing sound. They were aware that these were not the river's usual sounds and this is a sign to be alarmed and prepared. These observations were communicated widely before it started to rain heavily.

Signs from biodiversity: The community identified the following 'unusual' situations as warning signs for a disaster.

- Respondents shared that insects are highly sensitive to any potential danger. They believed that when fodder or agricultural crops are damaged by insects within a short duration (3–4 days), it is an indication that a calamity may befall the community. For example, the year before the survey, the community's crops were destroyed by insects, following which an earthquake hit the region.
- Another cue the respondents highlighted was the movement of small birds. They believed that if small birds are seen flying around the sky and not settling down on land, the birds are warning of an earthquake. The communities follow the birds' lead and find a safe place to assemble.

The human-made environment: Traditionally, the demarcation of a village used to take into account various aspects, including the understanding of local hazards.

- Respondents shared that the famous temples and pilgrimage spots in the region were usually located on higher ground and these elevated structures are usually free from risk of landslides or rockfalls and

floods. One respondent pointed out that most of the houses in their village were built on higher grounds and only those that were built without these considerations, got washed away during the 2013 flash floods.

- The participants also shared the example of earthquake, climate-resistant and environment-friendly traditional houses. While considerable research is being conducted in the field of resilient infrastructure focusing on the use of modern techniques, integrating traditional architecture could constitute an important area of research. The participants pointed out that, in the region, traditional houses built of mud, rocks and wood allow enough space for water runoff and percolation making them safe from damage due to meteorological hazards. The traditional houses include only small windows with a height of about 1 ft to keep houses warm during the cold winter months.
- A common yet important land management practice in the region is terraced farming, dividing agricultural fields into small, terraced farms, and planting of trees along the border of these farms to reduce soil erosion. This also helps address the problem of blockage of the main river channel by the eroded soil and debris.

Religious rituals and practices: The community has many socio-cultural and religious norms that guide their actions. They perform rituals to pray for the well-being of society in the form of festivals, social traditions, etc. The surveyed respondents strongly associated disasters with beliefs about local deities regarded as the key protectors of their society. Such religious narratives are deep-rooted in the interpretations of the disasters by the Local community and need to be considered for disaster preparedness strategies.

- The community attributed the 2013 disaster to going astray from established religious norms. A statue of the local deity Dhari Devi had been moved. The people held strong beliefs that the relocation of the statue resulted in the grave consequences. One respondent stated, “Everything happened within two hours of moving the statue.” Another respondent mentioned that a proposed dam project, which involves large-scale construction, led to the removal of this statue. The person commented that the project “failed in front of nature’s reaction and proved that it is not the right place to build it.”
- On the map, respondents did not mark the riverbank area around the temple as high risk, because the temple structure was not affected by the floods. They believe that the place is protected by god, therefore, it is safe provided there is no ‘human encroachment.’ According to respondents, it is imperative to respect god’s land and to maintain it as it is to keep this area protected.

- The respondents from the community have rituals around praying to god for rain. These prayers are performed during the agricultural season. The respondents say they have witnessed rains after the *puja* (ceremonial ritual).

Human-nature relationship: Local songs and practices highlight how the community has forged their relationship with nature for generations. One of the respondents quoted a line from a folk song. The translation is given below:

Green grass above the field
Is there to protect the soil
But I am your true lover
I care for you even if you seem useless.

The song explains the role of grass and weeds, which are usually removed from the gardens of houses. The song reminds people that grass is helpful in preventing soil erosion and that nature has designed everything for the benefit of humans. Acknowledging such traditional knowledge and recognising its impact on disaster risk reduction can bring great value to disaster management strategies.

Conclusion

The study analyses local understanding of hazard risks by communities in Uttarakhand, India, that have suffered major disasters recently. More specifically, it examines community members' risk perception, observations, experiences and beliefs. As the real risk bearers who have been facing and managing disasters for a long time, their opinions matter. Understanding perceptions of Local communities about hazard risks, and their traditional knowledge, helps in planning for strengthening the disaster risk reduction capacity of the community. The connections made between local knowledge and disaster management in this study can be further explored in other hazard-prone areas to develop policy-level interventions to supplement current disaster management plans.

However, preserving and integrating local knowledge systems is becoming increasingly difficult due to large-scale permanent and seasonal migration from mountain landscapes to the plains. With changes in climate patterns and their impacts on the environment, the applicability of traditional knowledge is also continually changing.

References

- Aitsi-Selmi, A., Egawa, S., Sasaki, H., Wannous, C. and Murray, V. (2015). 'The Sendai Framework for Disaster Risk Reduction: Renewing the Global Commitment to People's Resilience, Health, and Well-being'. *International Journal of Disaster Risk Science* 6 (2):164–176. https://doi.org/10.1007/s13753-015-0050-9.
- Bodoque, J., Díez-Herrero, A., Amerigo, M., García, J., Olcina, J. and Cortés, B. (2016). 'Flash Flood Risk Perception and Communication within Civil Protection Plans', paper delivered at the International Conference on Urban Risks, Lisbon, 30 June-3 July 2016. https://doi.org/10.1016/j.jhydrol.2016.02.005.
- Botzen, W.J.W., Aerts, J.C.J.H. and van den Bergh, J.C.J.M. (2009). 'Dependence of Flood Risk Perceptions on Socioeconomic and Objective Risk Factors'. *Water Resources Research* 45 (10). https://doi.org/10.1029/2009wr007743
- Dalisay, S.N. (2014). 'Engaging Local Knowledge for Disaster Risk Reduction'. *Kasarinlan: Philippine Journal of Third World Studies* 29 (2):75–102.
- Danish Hydraulic Institute (DHI) Water & Environment (2019). *Disaster Risk Assessment of Uttarakhand.* Singapore: DHI Water & Environment.
- Gupta, K.A., Nair, S.S. and Yunus, M. (2013). 'Uttarakhand Disaster 2013- Floods and Landslides: Lessons of Ecology Not Yet Learnt'. *Journal of International Association of Environmental Botany* 19 (4).
- Inglis, T.J. (ed). (1993). *Traditional Ecological Knowledge –Concepts and Cases.* Ottawa, Canada: International Development Research Center & International Program on Traditional Ecological Knowledge.
- Intergovernmental Panel on Climate Change (IPCC). (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC. https://doi.org/10.1017/cbo9781107415416
- Liaison, H., Cer, O., Mogere, S., Mwanzo, I. and Yitambe, A. (2010). 'Community Perceptions and Response to Flood Risks in Nyando District, Western Kenya'. *JMB: Journal of Disaster Risk Studies* [online] 3 (1). https://doi.org/10.4102/jamba.v3i1.35
- Mehta, M. (2015). 'Reducing Disaster Risk through Community Resilience in Himalayas'. In: E.E. Chakrabarti (ed.) *Women, Gender and Disaster: Global Issues and Initiatives*, pp.57–74. New Delhi: Sage Publications India Ltd. https://doi.org/10.4135/9788132108078.n5
- Naik, V.K., Kumar, A.K.J. and Kumar, S. (2014). *India Disaster Report 2013*. New Delhi: National Institute of Disaster Management, Ministry of Home Affairs, Government of India.
- National Disaster Management Authority (2009). *National Policy on Disaster Management.* New Delhi: National Disaster Management Authority, Ministry of Home Affairs, Government of India. https://doi.org/10.7324/ijasre.2018.32691
- Odum, E.P and Barrett, W. (2005). *Fundamentals of Ecology* (5th ed). Cengage Learning.
- Rawat, M.S. (2015). 'Study of Landslide Hazard Zonation in Mandakini Valley, Rudraprayag District, Uttarakhand Using Remote Sensing and GIS'. *Current Science* 109 (1):158–170. http://www.jstor.com/stable/24905700

- Sampath, G. (2013, June 27). 'Don't Blame Nature for the Uttarakhand Flood Disaster'. *The Mint*. https://www.livemint.com/Opinion/hzKmWekwYOOtYKv8N6dZIN/Dont-blame-nature-for-the-Uttarakhand-flood-disaster.html
- Sharma, A.K. (2012). *Disaster Management Awareness and Preparedness*. Delhi, India: Akhand Publishing House.
- Singh, J. (2013, July 03). 'What Really Happened in Uttarakhand'. *Down to Earth*. https://www.downtoearth.org.in/news/what-really-happened-in-uttarakhand-41550
- Steg, L., Berg, E.A. and Groot, J.I.M. (2013). 'Models to Explain Environmental Behaviour'. In L. Steg and E.A. Berg (eds.) *Environmental Psychology: An Introduction,* pp.186–195. West Sussex, UK: Blackwell. https://doi.org/10.18356/a196a2bd-en
- United Nations Office for Disaster Risk Reduction (UNDRR) (2015). *Sendai Framework for Disaster Risk Reduction 2015–2030*. Sendai, Japan: United Nations. https://doi.org/10.18356/a196a2bd-en
- Vaidya, R.A., Shrestha, M.S., Nasab, N., Gurung, D.R., Kozo, N., Pradhan, N.S. and Wasson, R.J. (2019). 'Disaster Risk Reduction and Building Resilience'. In: Wester, P., Mishra, A., Mukherji, A., Shrestha, A. (eds.) *The Hindu Kush Himalaya Assessment.* International Centre for Integrated Mountain Development (ICIMOD), pp.389–419. Kathmandu, Nepal: Springer. https://doi.org/10.1007/978-3-319-92288-1_11

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
mail@iucn.org
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org
www.iucn.org/resources/publications