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Foundations of indigenous knowledge on disasters due to natural hazards: lessons from the outlook on floods among the Bayira of the Rwenzori region

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The role of indigenous knowledge in increasing context specificity and exposing blind spots in scientific understanding is widely evidenced in disaster studies. This paper aims to structure the processes that shape indigenous knowledge production and its optimisation using the case of floods. An inductive analytical approach is applied among riparian indigenous communities (focus on the Bayira) of the Rwenzori region of Uganda where plenty of indigenous flood practices have been recorded. Indigenous knowledge of floods is found to be based on intimate comprehension of local hydrometeorological regularities. Insofar as these regularities follow natural dynamics, indigenous socio-epistemic processes are noted to be consistent with the laws of nature. Coupled with regular open sociocultural deliberations, the conceptualisation of hydrometeorological regularities induces an indigenous ontology and empiricist epistemology. This, together with the techniques used, is the driver of crucial epistemic virtues which enable indigenous knowledge to provide disaster solutions that are adapted, pragmatic, and holistic.

Keywords: ethnophilosophy, indigenous method, native science, natural hazard, social natures

Introduction

Events that happen consistently are acknowledged as enabling knowledge build-up among those who experience them (Douglas, 2004). Such is the case for indigenous knowledge, constructed by indigenous communities, to understand and tackle regularly occurring environmental issues. One of the key environmental areas where this knowledge is increasingly valued is disasters due to frequent hydrometeorological events, such as floods (Balay-As, Marlowe, and Gaillard, 2018; Bwambale et al., 2020).

Floods are regulated by weather variability, runoff generation processes influenced by vegetation and river dynamics, and riparian anthropogenic activities (Jacobs et al., 2016). Such recurrent and dynamic events are recognised as inducing concomitant observations that foster codification in oral traditions, indigenous worldviews, or belief systems (Hikuroa, 2017). It is thus argued that indigenous people can formulate explanations (that is, know-how) of the cascade of and/or processes that lead to floods (Bwambale et al., 2022a). This then leads to the development of indigenous

pragmatic practices to deal with floods, such as cultural cultivating of trees, adapted housing, and farming practices (Tran et al., 2009; Bwambale et al., 2022b). A similar pattern is acknowledged with regard to indigenous knowledge of other disasters and dangers due to common natural hazards, including tsunamis, typhoons, and climate change (Gaillard et al., 2008; Reichel and Frömming, 2014; Balay-As, Marlowe, and Gaillard, 2018).

Nevertheless, the systematic valorisation of indigenous knowledge faces the challenge of lacking *explanatory powers*. This challenge limits the optimisation of indigenous knowledge of disasters triggered by natural hazards (Bwambale et al., 2020). Moreover, a framework that structures the epistemic procedure by which indigenous knowledge progresses towards pragmatic strategies to tackle disasters is lacking. Addressing such gaps necessitates understanding conceptualisations of indigenous knowledge among indigenous people. This investigation is framed around three specific questions:

- How does indigenous knowledge manifest (what are the actors and their roles)?
- Which socio-epistemic processes and virtues shape the production of this indigenous knowledge?
- What is the nature of the relationship between indigenous knowledge and science with respect to explanatory powers to understand reliably disasters caused by natural hazards?

This study investigates these questions using the empirical case of indigenous understanding of floods among indigenous communities in the Rwenzori region of Uganda. Rwenzori is known for indigenous worldviews and practices related to farming, as well as rivers and natural hazards, including floods (Bwambale and Tibasiima, 2021). This is particularly the case among the Bayira, for whom culture is an essential patrimony and product that can be used to sustain life (Magezi, Nyakango, and Aganatia, 2004; Stacey, 2008; de Hontheim, 2015).

To map this indigenous understanding adequately, a conceptual framework is developed based on the literature. This framework structures expected processes and how such indigenous knowledge can be best understood in the context of disasters triggered by natural hazards. The empirical case study is then analysed in relation to the assumptions of this framework, structuring the indigenous approach as well as its general implications (application to other contexts).

Conceptual framework

The thinking highlighted by Lévi-Strauss (1962) that indigenous people are incapable of questioning the foundation of their own knowledge is long outdated. Indigenous people are increasingly noted to learn from experience and the concrete outcomes of their practices. A clear illustration of this is provided by Douglas (2004, pp. 457–458):

in everyday life, when we can use objects around us, we trust our accounts of their existence and properties as reliable. If I can reach out and drink from the glass of water, and it quenches my thirst, and I can fill it back up again, repeating the whole process reliably, I have good reason to trust the reliability of relevant beliefs about the glass. . . . [Furthermore,] when an object continues to appear from a variety of vantage points and using a variety of techniques . . . the possibility of illusion [becomes] remote.

The development of indigenous knowledge of disasters is based on the symbiotic social construction of nature and culture among indigenous communities. This, according to various scholars, enables indigenous people to live inseparable from or at least within the limits of nature. It is this character that not only permits attachment to the locale, but also fosters the potential for indigenous theorisation of disaster (Tran et al., 2009; Lane et al., 2011; Reichel and Frömming, 2014; Hikuroa, 2017). Moreover, the potential for systemisation of indigenous know-how to produce adapted knowledge is highlighted by several studies, especially those on natural hazards that are regular in nature, such as floods. Specific examples of these works are Smith (2011), Bruchac (2014), and Iloka (2016)—see also Lane et al. (2011). These studies suggest that indigenous learning takes place in a mutual and socio-culturally sensitive manner. When an idea emerges among a member or group in the community, it is vetted first for its praxis by other members. Once found to be reliable, it is then spread, optimised, and enculturated as part of the 'normal' or community way of life. Next, the more specialised parts are vested in specific indigenous knowledge keepers. Optimising these can lead to reliable knowledge, enabling the formation of collaborative indigenous worldviews and an adapted epistemological approach.

The assumption, therefore, is that a regular disaster due to a natural hazard will stimulate mastery of the geography of that event and the locale-based processes related to it. One can expect these to induce a systematic process of production of reliable indigenous understanding. Accordingly, based on the case of floods, attention centres on the epistemic process behind the manifested indigenous knowledge and/or practices. The focus is on the actors and their roles in the process of indigenous knowledge production: how they interact and the virtues they employ in that process to develop flood disaster management practices.

This study weaves these assumptions into the argument found in Bwambale, Muhumuza, and Nyeko (2018) regarding the context of the Rwenzori. These authors documented some cultural practices: cultural planting of 'disaster immunising' trees along rivers, cleansing of watersheds, and indigenous hydrometeorology. It should be noted that they also presented an interesting point requiring further research: that what is considered spiritual might be nothing but implicit understanding of the indigenous community to try to find ways to live with floods. In addition, Bwambale et al. (2022a, 2022b) discovered the capacity of indigenous knowledge to increase understanding of the peculiarities of flood disaster risk, as well as exposing distal drivers of risk neglected by scientific models. These elements are similar to those reported among other indigenous communities, such as the Mātauranga Māori of New Zealand

(Hikuroa, 2017; Wilkinson et al., 2020) and the Kankanaey of Philippines (Balay-As, Marlowe, and Gaillard, 2018). In this present study, these and related other aspects are investigated in the context of their foundational and epistemic processes.

Methodology: a case study approach

The Rwenzori region

The Rwenzori region is located along the border of Uganda and the Democratic Republic of Congo (DRC). It is generally characterised by a wet climate and steep topography, making it prone to various hydrometeorological hazards. The most frequent ones are river floods (often co-occurring with landslides). A detailed description of flooding and related disasters due to natural hazards in Rwenzori can be found in Jacobs et al. (2016, 2019).

Indigenous efforts to deal with disasters triggered by natural hazards are linked to the processes through which the various ethnicities emerged in the Rwenzori. Syahuka-Muhindo (2008) describes the Rwenzori as a melting point of various ethnicities that coalesced to form hybrids. In a similar way, indigenous worldviews are crafted and developed to enhance well-being and/or livelihoods (Magezi, Nyakango, and Aganatia, 2004). Regarding cultural efforts to tackle natural hazards, the most referenced ethnicity is the Bayira, the collective name for the ethnic group created by the coalescing of various ethnicities in the DRC and Ugandan parts of the Rwenzori. They are known as Banande and Bakonzo in the DRC and Uganda, respectively. One should note that the term Bayira also implies natives. It can thus serve as an umbrella reference for native ethnicities, at least for the Banyabindi and Basongora with whom the Bakonzo have consorted during their historical struggles (Bazira, 1982). Other ethnicities also exist, including the Batooro and Bamba (Magezi, Nyakango, and Aganatia, 2004). According to the *National Population and Housing Census 2014* (UBOS, 2016), 262,675 people are believed to live in the two studied watersheds: 141,516 in Nyamughasana and 121,159 in Nyamwamba.

Traditionally, the Bayira have co-existed with other ethnic groups, remaining in subcultural groupings called chiefdoms (*Obw'isemalhabo*). Geographically, each chiefdom, governed by a chieftain, is structured in such a way that it goes from upstream (in the Rwenzori massif) to downstream. It is subdivided into ridges, A*malhambo*, governed by ridge leaders (Magezi, Nyakango, and Aganatia, 2004). The chiefdoms are separated by rivers to ensure that each of them stretches from upstream in the Rwenzori massif, which is believed to be a source of blessings. Hence, this cultural setup has close links with watersheds: chiefdoms are associated with watersheds and ridges with catchments within watersheds. It is at the scale of individual ridges that most cultural practices related to floods are conducted (de Hontheim, 2015). Within each chiefdom and ridge, there are specialists who independently produce and conserve knowledge to aid understanding of events pertaining to natural hazards, including floods. The paramount specialist is called the *embandwa*. There are other

specialists in other disciplines, such as indigenous medicine, geology, and farming (de Hontheim, 2015).

Research design

A study of indigenous aspects involves interacting with specific groups to make sense of their cultural premises (Bwambale, Muhumuza, and Nyeko, 2018). Thus, a research design is implemented based on the 'participatory approach' to reality. This approach is generally grounded theory in nature. It was specifically applied in the inductive and analytical framework of the Socratic dialogue. The Socratic dialogue is noted for its capacity to elicit hidden perceptions by means of probing concrete experiences that form the basis of shared judgements of general matters. Its probing element is also known to limit bias. It is critical systematic reflection of concrete experience that constitutes the basis for shared explanations, eliciting deeply conceived perceptions (Wortel and Verweij, 2008). This is relevant to this study area where alien religions and modernist views tend to discourage native cultural practices (de Hontheim, 2015; Maes et al., 2017).

Data collection and analysis

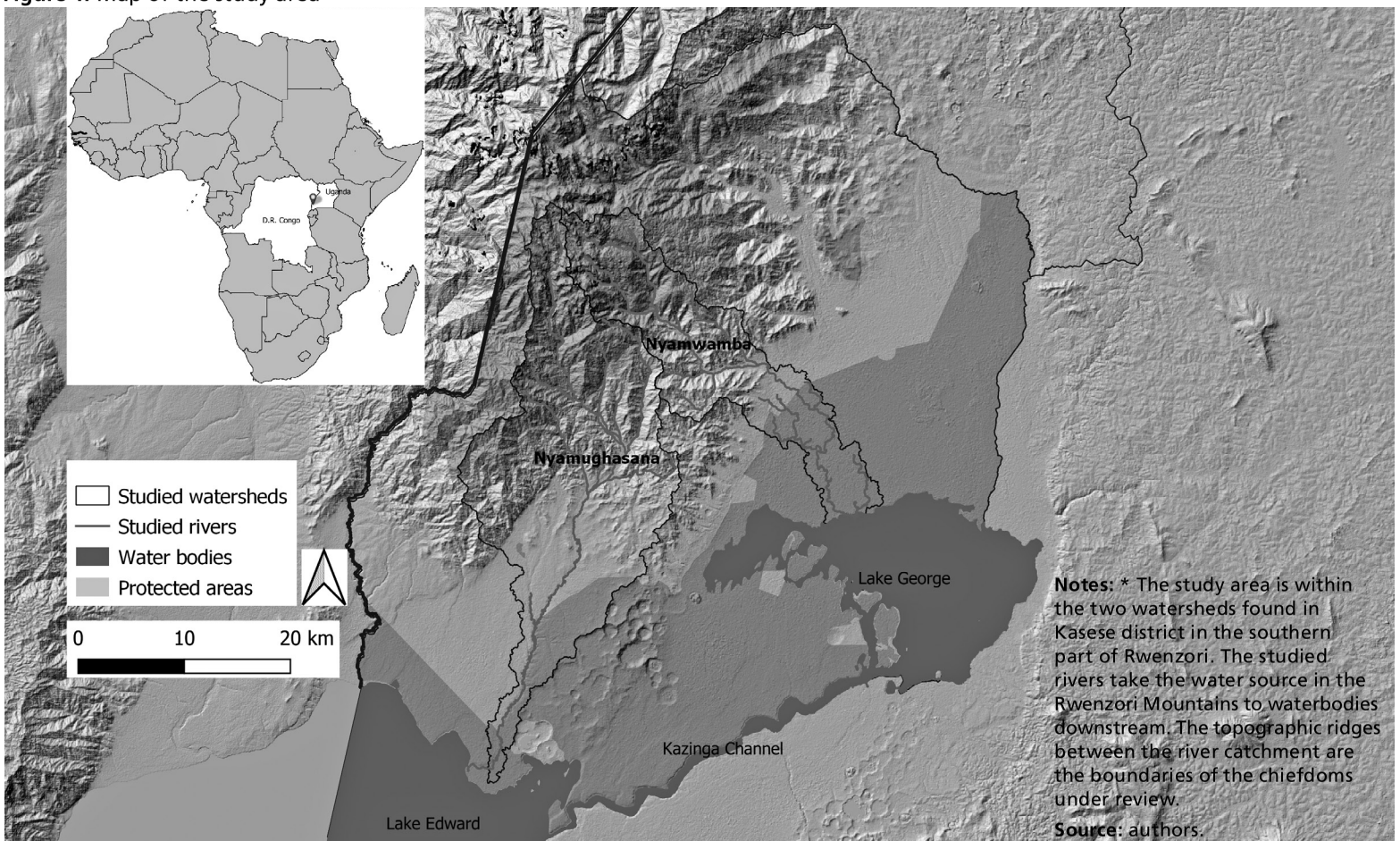
The specific communities from which data were collected are situated along two of the rivers that experience frequent floods: Nyamughasana and Nyamwamba (see Figure 1). Accordingly, participants in the data collection exercise were selected from the cultural setting along the watersheds of these rivers: cultural leaders, indigenous specialists attached to cultural institutions, and related cultural committees. Other participants were chosen using existing documentation, such as Magezi, Nyakango, and Aganatia (2004) and de Hontheim (2015), as well as snowball sampling.

As required by qualitative research (Baxter and Eyles, 1997), triangulated sources were used to ensure that the research questions were queried exhaustively. The process started with preliminary interviews and field observations. These endeavours involved, inter alia, attending community cultural events such as meetings of local village councils. They enabled identification of other knowledgeable people who could participate in subsequent focus-group discussions (FGDs) and ultimately follow-up interviews. FGDs are the key data gathering technique since they allow for concretisation of information (Guest, Namey, and McKenna, 2017).

The FGDs lasted for about two hours on average and were conducted at recognised cultural or politico-administrative offices. Afterwards, participant-led visits were made to frequently cited features and flooded areas to enrich understanding of the elaborated aspects. Follow-up interviews were held to clarify some key points. During the FGDs and the follow-up interviews, related anecdotes concerning oral traditions were recorded. These were supplemented with secondary data.

Data saturation was the criterion for no further data collection in relation to each of the four semi-structured questions (see below) and emerging themes, as required by qualitative research (Baxter and Eyles, 1997; Guest, Namey, and McKenna, 2017).

Figure 1. Map of the study area*



Notes: * The study area is within the two watersheds found in Kasese district in the southern part of Rwenzori. The studied rivers take the water source in the Rwenzori Mountains to waterbodies downstream. The topographic ridges between the river catchment are the boundaries of the chiefdoms under review.

Source: authors.

A total of 12 FGDs and several follow-up interviews were conducted. The first six FGDs involved ridge and chiefdom specialists, ridge and chiefdom committee members, and ridge leaders and core chiefdom leaders along the Nyamughasana River. The other six involved respective categories of actors along the Nyamwamba River (see Figure 1).

The FGDs followed the standard highlighted in Guest, Namey, and McKenna (2017). As required for accurate data (Baxter and Eyles, 1997), the FGDs and key interviews were conducted twice. The second phase took place after preliminary analysis of the data acquired from the first phase. This second phase was based on themes from the preliminary analysis to enable validation and to collect other related information. The local language was used for data collection since the first author (Bosco Bwambale) is fluent in it and comes from the studied region.

The main data collection themes pertained to how indigenous people explain the processes of floods and the techniques used to formulate those explanations. This specifically entailed four semi-structured questions:

- What is the social setup regarding the flood reality?
- How do various riparian communities conceptualise and/or contextualise flooding? What explanations are given and what informs them?
- In trying to understand flooding, who does what and how, when, where, and why is it done?
- How is this understanding optimised?

Notably, these questions were approached from two core standpoints to which the first (Bosco Bwambale) and the last (Matthieu Kervyn) author largely adhere, respectively: anthropogeography and environmental philosophy; and geology. The remaining authors (with perspectives ranging from anthropology to agricultural sciences) engaged in backstopping during both data collection and analysis.

Data were captured verbatim, saved using anonymised file codes, and imported into NVivo 12 software for analysis. Thematic and analytical induction techniques were employed since they enable working through transcripts, coding, and drawing relationships among extracted themes to generate coherent constructs (Creswell, 2014).

The themes that emerged from this analysis are used to structure logically the results section, from general to particular: cosmology and cultural interactions with hydrological ontologies; indigenous conceptualisation of floods; and a flood management approach. Epistemological lessons are derived from this indigenous understanding.

Results

Cosmology and cultural interactions with hydrological ontologies

Oral tradition portrays nature as being governed by omnipotent invisible (metaphysical) forces that emanate from deities which influence the Earth's dynamics. These

deities are also believed to be interconnected in accordance with natural systems and landforms in a hierarchy. The topmost deity, next to *Nyamuhanga* (God), is termed *Kithasamba*:

> *Kithasamba is invisible but omniscient and the principal mover of the entire massif. The highest peak of the Rwenzori would be Kithasamba himself and his sanctuary. Kithasamba's vital force controls the environment, livelihoods, and lives. People are careful when they climb the mountain to observe specific moral codes, e.g., not to set the vegetation to fire lest they sin against Kithasamba* (FGD 6, 2020).

The FGDs revealed that *Kithasamba* is the prime natural source of blessings. Hence, the main cultural practice, *eri birya amalhambu* (cleansing of ridges), starts in the mountains. Oral tradition indicates that this practice involves the supplication of deities across the watersheds, entailing, among other things, cultural penance for sins against nature, enhancing blessings and community tranquillity. Besides, water sprouting from the Rwenzori massif as well as *Kithasamba* are believed to cleanse the rivers naturally and chase away any bad elements as they flow downwards into the lakes (Stacey, 2008; de Hontheim, 2015).

FGD accounts further show that the water system is believed to be governed by specific hydrometeorological deities, collectively called *Nyamusya* (synonymous with *Ndyoka*). *Nyamusya* is a combination of two terms: *nya*, meaning mother or author of; and *omusya*, meaning valley related to water or a river. *Nyamusya* is the hydrometeorological equivalent of *Kithasamba*. Like *Kithasamba* and the massif, *Nyamusya* and the entire watershed is perceived as sacred and a source of well-being. Humans should learn how *Nyamusya* operates as well as about its sanctity. Consequently, they come to realise that the best way to interact with the hydrometeorological reality is to harness hydrometeorological goods, such as clean water and good weather. The principal means of interacting with *Nyamusya* and the watersheds is by establishing a communion with or making a pact between deities of the watersheds and the humans served by them.

The paramount form of communion is centralised around the first occupancy through whom 'a pact between the people, the locale and [the] deities of the land is regarded to have occurred' (FGD 8, 2020). Oral tradition denotes that this first occupant and their progeny are ascertained through ancestry irrespective of ethnicity. By successfully settling in the chiefdom, this person is seen as striking a communion with the deities, and thus understands how they operate in that locale. They are expected to supplicate those deities, formulating suited practices to ensure tranquillity to guard against any risks therein. Hence, the first occupant becomes the chieftain. The chieftain has subordinates, ridge leaders, in various subdivisions (that is, ridges). The ridge leader(s), under the authority of the chieftain, is the first occupant and makes a pact within a specific ridge in the chiefdom.

There are some (rare) cases when the first occupant does not become the chieftain or ridge leader. This occurs if they seldom execute any successful cultural practices

in the event of a calamity like floods. In this case, participants' views suggest that the position goes to the next person in the order of occupancy, until one that can effectively perform is found. These leaders are obliged to gather resources, including insights from deliberations of their cabinet (which include, inter alia, members of the council of elders and indigenous specialists) to understand hydrometeorological phenomena and how best to tackle them.

Indigenous conceptualisation of floods

Data from the indigenous specialists converge on the conceptualisation of the rainfall events that trigger floods. This revolves around the link among the fundamentals of hydrometeorological deities, centred on *Nyamusya*:

> *the river, rain, Nyamusya, and sunshine are linked. Related deities are: bithu [clouds], mathodi [droplets], and mabulha [thunder or rain]. Nyamusya has influence over all of these. It has amasalhali [electromagnetic energy] which attract or repels and is connected to the entire weather and emanates through it. [Moreover,] Nyamusya is transformable. It is and controls evaporation and formation of clouds and rainfall in the atmosphere. It can even turn into rainbow [ekima] to absorb or intercept rainfall. Prolonged rainfall has the strongest link with Nyamusya. Even omuhangyi [rainmaker] uses stones or herbs that connect Nyamusya to related hydrometeorological deities. All riparian biotic and abiotic elements [for instance, crabs] are relatives to Nyamusya. The fury of Nyamusya can even be experienced in areas distant from the river in [the] form of emanations, for example, in the form of lighting in the process of rainfall formation* (FGD 8, 2019).

The remarks of specialists signal that *Nyamusya* represents itself in various forms. One of them is that it is the water itself that uses its vital energy to transmute into various forms, such as into vapours that emanate from waterbodies. Some forms are lethal if humans encounter them. People are prohibited, therefore, from moving or playing when it rains. *Nyamusya* is more active in rain or wet seasons. Hence, the rain seasons (February–May and August–December) are normally synonymous with *Nyamusya*. Accordingly, 'flooding is normal and expected every rain season. Disastrous flooding is [however] an abnormal situation' (FGD 8, 2020).

Flooding becomes disastrous not just because of mere rainfall, but also due to how *Nyamusya* forces are embedded in a specific river or its tributary: 'that's when you will hear that [even] a tributary (like Nzwirangya and/or Mulyambuli) has caused a river (like Nyamwamba) to flood' (FGD 4, 2019). More specifically:

> *Nyamusya starts influencing peak discharge from the first confluences upstream. The concentration at the confluence is [also] enhanced by the accumulated concentration of Nyamusya forces from the upstream tributaries that form at the confluence. There are other deities, especially kumula and ngwangwa [landslide], responsible for depression. When ngwangwa is furious upstream [and mixes with water], floods become intense. Yet still, it is the embedded Nyamusya forces that we believe causes demolition of elements along the river* (FGD 4, 2020).

A flood management approach

Key management practices

The FGDs indicated that attention is accorded to two elements, connecting both the general environment and the rivers: the riparian hydrological systems, especially the various types of wetlands along the river(banks); and confluences. The focus is on conserved tributaries and confluences upstream, where peak discharge is expected to start. Wetlands connected to the river are enriched to supplicate hydrological deities in view of regulating floods. In addition, 'around confluences, there are shrines [*ama hongeru*]. These are designated points along the river, vegetated with native plants [see Figure 2] that "immunise" against floods, i.e., they supplicate *Nyamusya* and riparian deities to prevent peak discharge' (FGD 8, 2020).

Other plants frequently cited as being present along rivers are *Lilium*, *Ficus natalensis, Dracaena fragrans*, and *Tetradenia riparia*. The findings highlight that these plants should be regularly maintained during the biannual supplication of *Nyamusya*. It is believed that whenever *Nyamusya* is supplicated, excessive rainfall that would induce peak discharge ceases; rainbows and dangerous thunder also become rare. Other shrines must be constructed upstream along tributaries before the confluence to appease *Nyamusya* and *Kithasamba*.

The FGDs indicate that moral codes related to maintaining riparian hydrological systems are believed to spawn habitats for *Nyamusya*. Field examples of such habitats

Figure 2. Some species commonly found along the watershed

Notes: (a) mixed vegetation maintained upstream (principally *Cercostashys Scandens*); and (b) species planted along rivers (such as water reed, bamboo, and members of the *Ficus* genus).

Source: authors.

are whirlpools, wet ponds, and wetlands or swamps connected to the rivers. These are considered to be epicentres for various hydrometeorological deities that control floods:

> *floods can subside if those habitats are maintained, e.g., through planting flood immunising plants like bamboo around riparian hydrological systems. Humans receive services from them (i.e., abating floods, also fresh water). In exchange, they should maintain those plants. As a rule of thumb, those born at the time of cultivating those plants are supposed, in their old age, to see them. [As] each household is in a watershed, they are connected to Nyamusya. So, each is traditionally careful of how their activities affect the riparian area. To limit any Nyamusya related to lethal forces, various plants (e.g., pencil trees, Polyscias fulva, Ficus natalensis) should be cultivated around homes and in gardens* (FGD 8, 2020).

In short, the interconnectedness between nature (that is, the massif) and the specific systems (that is, the rivers) and their deities influence floods. People ought to sustain this interconnectedness to foster symbiotic relations between humans and systems in nature. Flood-related actions on the rivers and with respect to their deities cannot, therefore, contravene the deities of nature in general. Peak discharge is thus an indicator of cultural practices not being regularly and properly conducted to enhance upstream and hydrological systems: 'if deities of the land are not appeased nor their natural habitats taken care of regularly, they can cleanse (i.e., perfecting) riparian valleys by themselves. This often becomes disastrous' (FGD 4, 2019).

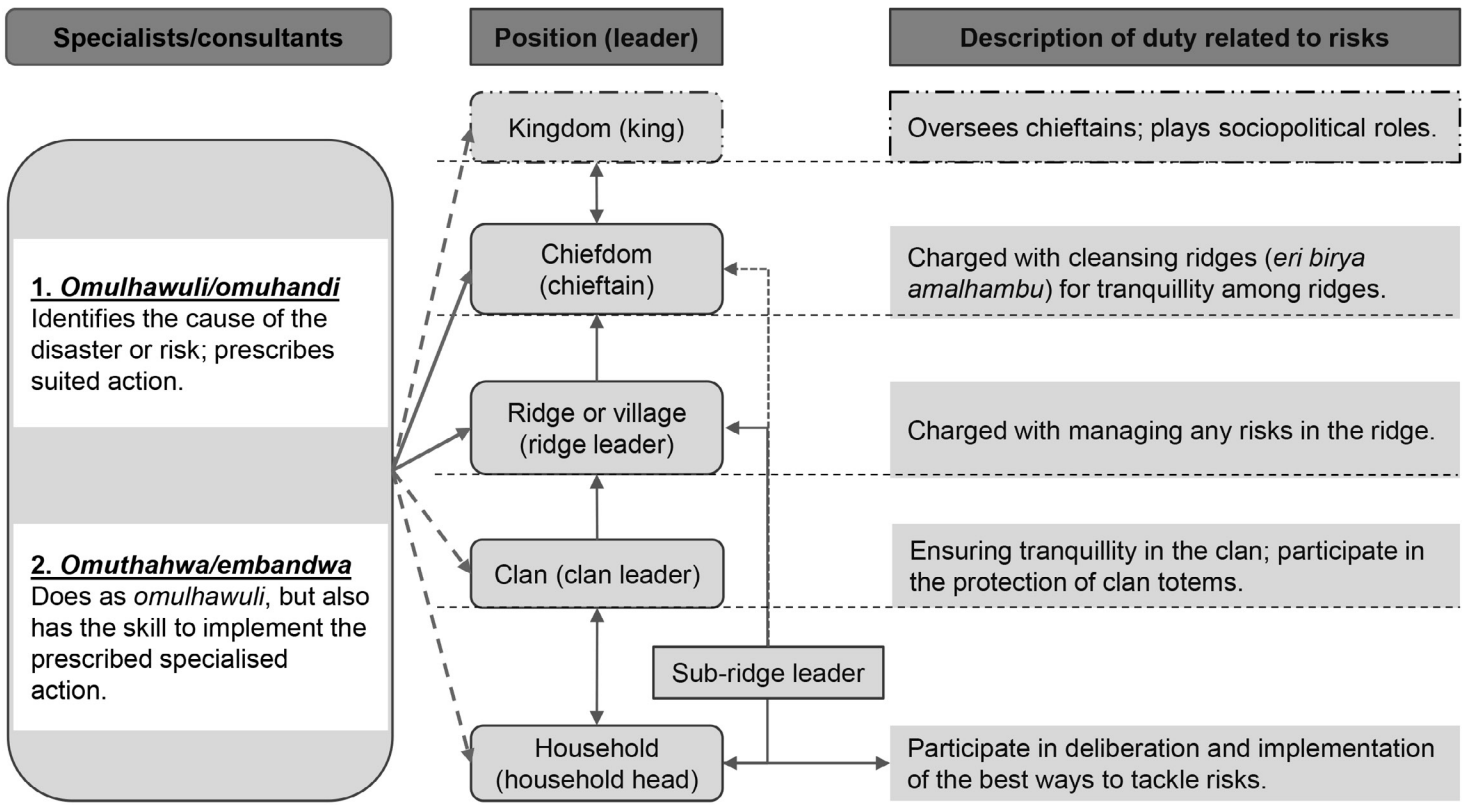
Management structure

According to the FGDs, a special management structure is framed around cabinets formed in specific jurisdictions from the household level to the chiefdom, where most activities happen. Hence, the principal actors include the chieftain and the chiefdom cabinet, the ridge leader and the ridge cabinet, and community representatives. At each level, the cabinet is charged with deliberating on the best way to manage natural resources and people, including approaches to avoid risk, such as the best allocation and utilisation of land to manage natural hazards like floods across the watersheds. At each level, there are specialists (de Hontheim, 2015). Figure 3 summarises this structure.

The chiefdom cabinet is composed of ridge leaders, specialists, and other elders therein. Together with the cabinet and the specialists, the chieftain is also responsible for the principal practice: cleansing of ridges. The objective is to resolve various chiefdom calamities, especially those related to food production, as well as to request blessings from the deities to protect regularly the watersheds and lives and livelihoods (Bwambale, Muhumuza, and Nyeko, 2018; de Hontheim, 2015).

Whenever cleansing of ridges happens, more (of the aforementioned) plants are cultivated in flood hotspots and at shrines and wetlands along the rivers. This is what is partly termed as *appeasing* of *Nyamusya*, conducted by the ridge leaders who manage catchments within the chiefdom. Appeasing *Nyamusya* is, according to meetings with ridge leaders, a core component of efforts to mitigate peak discharge.

Figure 3. Disaster and natural resources governance structure in the indigenous knowledge context of the Rwenzori



Notes: the dashed arrows or boxes indicate weak relations or limited action, whereas bi-directional arrows indicate bidirectional interaction.

Source: authors.

To ensure that flooding is fully understood and managed, the cabinets therefore have a specific committee charged with keeping a record of the geography of floods: the time and locations where events occur; elements frequently affected; and the cascade of processes that precede specific floods. This, according to the FGDs, facilitates deliberations to comprehend better floods and practices appropriate for tackling them. The particular aspects of these deliberations are dealt with by specialists. They have the dedicated knowledge and skills to appreciate and manage hydrometeorological phenomena and riparian hydrological systems (see Figure 3). Specialists preserve and maintain awareness of how flooding occurs at specific spots and design the best approaches to handle it.

One should note that just as each chiefdom has a chieftain and a specialist, 'every sensitive flood-prone area within the chiefdom is overseen by specific ridge leaders with a specialist' (FGD 4, 2019). There are particular persons in certain families with specialist skills, so not every family can deliver such specialists (de Hontheim, 2015). The next subsection elaborates on the way in which specialists act and how they acquire their knowledge and skills in the context of floods.

Cultural specialists and indigenous hydrometeorology

The FGDs, as well as de Hontheim (2015), indicate that people experiencing floods communicate with their immediate cultural leaders who conduct an initial deliberation. Where necessary, they report and consult with the specialists. A specialist surveys the scene to collect additional data on materials involved in the flood event to use in their 'analysis'.

This analysis by specialists is not to be understood in the scientific sense. Rather, as was frequently mentioned during the study, 'each specialist invokes and is believed to be empowered by *abalimu* [ancestral spirits] who are omniscient. There is also another spirit [*omurunga*] acquired, a process called *eri bonokerwa* [synonymous to epiphany]'. This, according to some interviewees, could mark the genesis of the ancestral spirit before it becomes hereditary. It is from *abalimu* that specialists claim to obtain their understanding of hydrometeorological deities. Meetings with specialists reveal that they often go to their designated rooms to conduct their analysis, where they are in a sort of 'unconsciousness', having communion with the spirits to comprehend the event. If conducted at the scene, they carry out their activities (such as surveying) quietly while they communicate with the spirit. Next, they develop recommendations for the cabinet, and eventually for the public.

Several specialists said that when offering recommendations, they aim to control *Nyamusya*, often using plants, for instance. Some plants are considered as *emibatsi* (medicine); others as *esyahongo* (items for supplication). The central elements are *emibatsi*, mainly plants cultivated around specific flood-prone areas. While common plants do exist (such as *Lilium*, *Fankincense*, *Ficus natalensis*, *Tetradenia riparia*, and *Dracaena fragrans*), their application tends to vary among specialists and across specific cases. This is due to the spirit that guides: the same specialist may provide different

recommendations (such as different or added plants) for different flood-prone areas along a river. The central criterion is the quality of the plant to calm or chase away the deities perceived to be responsible for the peak discharge. This exercise is believed to control floods as well as to harness blessings by enabling a symbiotic relationship between the people within a watershed and the hydrological deities. This is explicit in some of the words spoken to the deities when the specialist is performing the activity: 'may you, your children and us harmoniously stay together. . . [Then,] a ritual meal made, eaten, and partly thrown at the site is an intended sign of that harmony which people must maintain with nature' (FGD 5, 2019). This harmony, as noted earlier, involves sustaining the cultivated plants and following moral codes.

Furthermore, each specialist performs their tasks in a reflective manner to give the most appropriate advice based on specific cases: 'If the recommendation fails, the specialist can [take time to] consult the spirit on the best way to handle specific cases' (FGD 8, 2020). The specialists of each ridge aim to perfect their expertise to avoid failure of their recommendations. Short of that, the cabinet can switch to another specialist. Since there are various other specialists (de Hontheim, 2015), 'the cabinet tests various specialists from various families to identify the one suited for specific cases' (FGD 5, 2019).

Community participation and knowledge sharing and transfer

The FGDs and oral tradition indicate that in addition to cultural leaders and specialists, each clan and household head within a chiefdom observes flood events. They report to the specialists and the cabinet on how they occur. Their representatives participate in cabinet deliberations on the best ways to handle floods, leading to general knowledge that is applied by any individual. However, the specialist still 'has to comment on it for checking its compatibility with the cultural landscape of the land' (FGD 8, 2020).

General and specialised knowledge often, with time, gives rise to practical norms that households carry forward as a social responsibility and a part of the culture (see, for example, Magezi, Nyakango, and Aganatia, 2004). Examples of such norms are those related to the mountain deity and the cultural planting of specific plant types along a river and within a watershed (de Hontheim, 2015; Bwambale, Muhumuza, and Nyeko, 2018). Each household and clan leader ensures that the norms and practices initiated are well understood by family and clan members. Moreover, adhering to such norms and practices is considered to be a sign of being cultured (Stacey, 2008). Accordingly, knowledge is shared and transferred to continue the practice, ensuring repository storage and optimisation. One of the other ways to do this is to ensure that youngsters participate, based on the belief in '*ekyaghanda ekithahwa y'omulere oyu wabyahu* [a discourse on a specific matter is sustainable if centred on youth]. For the same reason, specialists as well as cultural leaders worked with at least one of their children; so, they mentored them' (FGD 12, 2019). For details on the cultural transfer mechanisms, see Magezi, Nyakango, and Aganatia (2004).

Discussion

The results described in the preceding section underscore the nature-centred approach to understanding of hydrometeorological realities by indigenous people. Deities are perceived as intelligible parts of nature and are supplicated to obtain explanation and to address risks therein. Moreover, natural events (that is, floods) are approached from the context of a symbiotic relationship with ontological realities. Specifically, watershed management revolves around ensuring ecological integrity and maintaining ecosystems upstream and across the area: that is, securing vegetation cover upstream and in locations adjacent to a river. In other words, the outcomes of this cosmological approach resemble the outcomes of ecosystem-based approaches. This is because they can contribute to rainfall interception, favour infiltration, and delay runoff, thereby limiting the chances of extreme peak discharge. Such an ecosystem-based approach can be the explanation for nature-based interventions, such as those related to the use of plants in the habitats of deities that are culturally perceived to cause floods. Besides, the management approach is oriented towards reproducing the symbiotic relations between people and nature. One can expect this to enhance consistently conservation concerns, since it is conducted on a regular basis.

The key question that remains, in the context of this study, is how an indigenous community comes up with such an elaboration. In line with the conceptualisation in the second section, two observed aspects are interesting. The first is mastery of the geography of flooding based on openness to production of knowledge. The second pertains to indigenous knowledge of floods, built on intimate comprehension of the regularities of hydrometeorological deities. These are hydrometeorological ontologies: hydrometeorological concepts and related cosmic energy emanations upon which a framework is developed to comprehend the hydrometeorological system. They highlight the way in which indigenous knowledge of flooding is acquired and the process shaping it, yielding a third insight: systematic indigenous understanding.

Mastery of geography of floods based on free inquiry

Familiarity with the locale and floods is believed to be enhanced by openness to production of indigenous knowledge. This can be illustrated logically as follows:

- mastery of the local geography of floods can be expected to occur due to the centralisation of information among the initial occupant of the ridge and cabinet members. Moreover, every first occupant tries to familiarise themself with the locale, seeing it as part of their obligation in guiding the best utilisation of land. This also applies to members of the cabinet, who know that it is their responsibility to deliberate on the best ways to understand and tackle risks in their locale;
- open deliberation with those with mastery of the local geography is a platform to mastered geography of floods; and
- understanding of floods is boosted by using specialists, who independently generate and maintain knowledge. Their task is made easier by residents who intimately follow hydrometeorological dynamics and report voluntarily.

These three points are supported by free deliberations in cabinet meetings and the existence of specialists who provide an avenue to optimise knowledge. Praxis of the produced knowledge to solve the problem(s) at hand are the best way to evaluate the techniques to be implemented. This is aided by open and clear knowledge transfer and the customary regulations of the cultural institutions on the best ways to understand floods. Knowledge is then optimised further through the mentoring of youngsters and members of the general community who regularly participate in investigations and the implementation of the resulting practical norms.

Openness to knowledge production also implies that while being hierarchical (see Figure 3, for instance), knowledge production is not necessarily centralised. Rather, cultural authorities largely accommodate the best know-how and rarely use their positions to issue commands on what to do, as would generally be thought to be the case in such hierarchical spiritualist institutions. This suggests that even modern education expertise is used insofar as it is compatible with lived experience or the best awareness, leading to reliable understanding of floods—at least of those elements that illustrate social and epistemic regularities that are of relevance to the local context. This concurs with what Douglas (2004) illustrates as objectivity that renders indigenous practices reliable in the local context—see also Ludwig (2017). Yet, the question (elaborated below) revolves around how this reliable objectivity is (re)produced.

Invisible powers, reason, and hydrometeorological regularities

As is generally known about various indigenous communities (see, for example, Hikuroa, 2017; Ayeb-Karlsson et al., 2019), an appeal to invisible forces is made to interpret natural phenomena, their origin, and the way to control them. Specifically, an animist perspective is evident in the belief that nature is governed by invisible forces whose operations humans ought to grasp. For instance, consider the fact that understanding the operation of invisible forces is perceived to be guided by another sort of invisible force: the ancestral spirit. This leads the specialist to use plants to comprehend the working of the invisible world and to remedy any disastrous elements. Such spiritualist use of plants is also reported in other indigenous communities, such as those along the Niger Delta (Nigeria) and in India and Swaziland (Jha and Jha, 2011; Iloka, 2016). With respect to *conventional* understanding of indigenous communities, this can be considered as traditions associated with primitive attachment to nature (Lévi-Strauss, 1962). Conversely, this case reveals that in terms of active indigenous knowing, indigenous people are logical and pragmatic in their ways to conceptualise reality through experience and sociocultural constructions. For example, vis-à-vis the spiritualist application of plants, this study underscores the spatial difference: the same specialist can make different recommendations on the plants used in different spots along the watersheds. But the central element is the quality of the plants to enable chasing away or calming down of any invisible powers behind the peak discharge. Another interesting aspect is that the specialist(s) can reflect for some time to discern what the spirit suggests to address best specific cases, including which plant(s) to use.

The last two points regarding spiritualist use of plants indicate that, rather than merely following the knowledge revealed by the omniscient spirit, specialists also apply logical reasoning. To illustrate this further, consider one of the elaborated examples that the specialist might have to change the way of working if a measure they implemented consistently fails. This alludes more to correcting the effects of error(s) in human reasoning, as done in scientific research, refining the research design and questions or hypothesis to understand better or more objectively what is being investigated and to give the most appropriate recommendation (Douglas, 2004). This, together with lived experience of the local geography, can improve the performance of the specialist. Moreover, the specialists dedicate their time to enhancing expertise and legitimacy, since it is also their occupation.

Reference to this skill as originating with ancestral spirits, as well as being inherited, can be a way to protect and augment the produced specialised knowledge in a specific repository: ancestral (or inherited) spirits are hardly shared among families. The same is probably the case in hardly sharing the experience of communion with the spirit, as specialists claim to obtain clear analysis to explain events, encrypting it as ancestrally sacred. As such, invoking the ancestral spirit in actual performance becomes paramount. That the skilled ancestor mentored their children to be specialists can be the reason for the reference to the spirit being ancestral. Yet, such a reference barely excludes, but rather frames, the empirical reasoning sustaining the recommendations of the specialists.

Until now, there is no formal education regarding specialised cultural know-how through which all have an equal opportunity to learn. This can make the 'gifted spirit' also appear to be the preserve of the family where skill is practised. It is not surprising, therefore, that specific families remain the depository of specialised indigenous knowledge. Noteworthy is that this might also mean that such knowledge is generated by persons that are intelligent, that is, they are able to apply reason (aided by experience and good observation) to make sense of regularities of flood events in their locale. Subsequently, they enculturate that to family members in the form of transferring the (ancestral) skill.

One question remains: what are the hydrometeorological deities whose forces specialists strive to grasp? At the outset, one can observe that the invisible powers are rather associated with the regularities or cosmic energy emanations behind the hydrometeorological phenomena. In this regard, consider the insights from the elaborated link among deities, centralised around the deity called *Nyamusya*: *Nyamusya* is water, and influences evaporation, as well as the formation of clouds (*bithu*) and rainfall (*mabulha or mathodi*); it occurs seasonally. An additional element relates to the rainbow, which is perceived as rain having been intercepted by *Nyamusya*. Light diffractions can be expected as they occur when solar light penetrates clouds at the end of the rain (Rao, 2011). Hence, indeed, they might indicate the end of the rain. According to the scientific perspective, this can be further related to hydrological cycle processes and seasonal weather patterns. This suggests that *Nyamusya* and its cultural details are nothing but the conceptual framework through which the indigenous community understands the hydrometeorological system.

Furthermore, consider the belief that not only intense floods occur around a river's confluence, but also that invisible forces become more furious at this point. This can be explained by the fact that floods do become visually intense as discharge contributions from several streams accumulate at the confluence. Specifically, as rainfall is very localised, normal intense rains do not manifest in all catchments at once and peak discharge is distributed over time—with contributions from different catchments at different times. If, for some reason, peak discharge originates at the same time in multiple upstream catchments, extreme flooding happens downstream, although this also depends on the interception capacity of upstream vegetation cover and along a river (Brody et al., 2007; Tembata et al., 2020).

Upstream vegetation cover is maintained in accordance with moral codes related to the invisible force of the mountain deity: *Kithasamba*. *Kithasamba*, though, as noted, can be seen as the totality of the Rwenzori massif itself. This is a shift away from the view of mountain deities as such. Rather, it is the totality of the mountain riparian upstream ecosystem, conserved to avoid extreme runoff that triggers peak discharge. Moreover, the link between *Kithasamba* and *Nyamusya* in the context of the mitigation of floods through plants upstream and along the riparian area alludes to watershed-centred and ecosystem-based flood management. This regularly maintained vegetation cover upstream and around the shrines along tributaries and rivers regulates the hydraulic conductivity of upstream runoff and evapotranspiration. In addition, the maintained vegetation is natural and adapted to the environment, having been tested by specialists. Natural and/or adapted tree cover, when planted in varieties, is increasingly seen as crucial in intercepting runoff and reducing the chances of flooding (see, for example, Bradshaw et al., 2007; Tembata et al., 2020). This, coupled with maintaining hydrological systems (such as wetlands), can thus have an influence on floods.

This understanding of the indigenous community, while framed in a belief system, contrasts with the view of beliefs leading to fatalistic behaviour relative to natural hazards (see, for example, Ayeb-Karlsson et al., 2019). It complements the insight that the deities referred to in the discourse among indigenous communities are rather ecological phenomena (Bwambale, Muhumuza, and Nyeko, 2018). Indigenous conduct is simply a conscious will to formulate an understanding of flood regularities upon which practices can be designed to tackle and/or live with such events (see also Bwambale et al., 2022a).

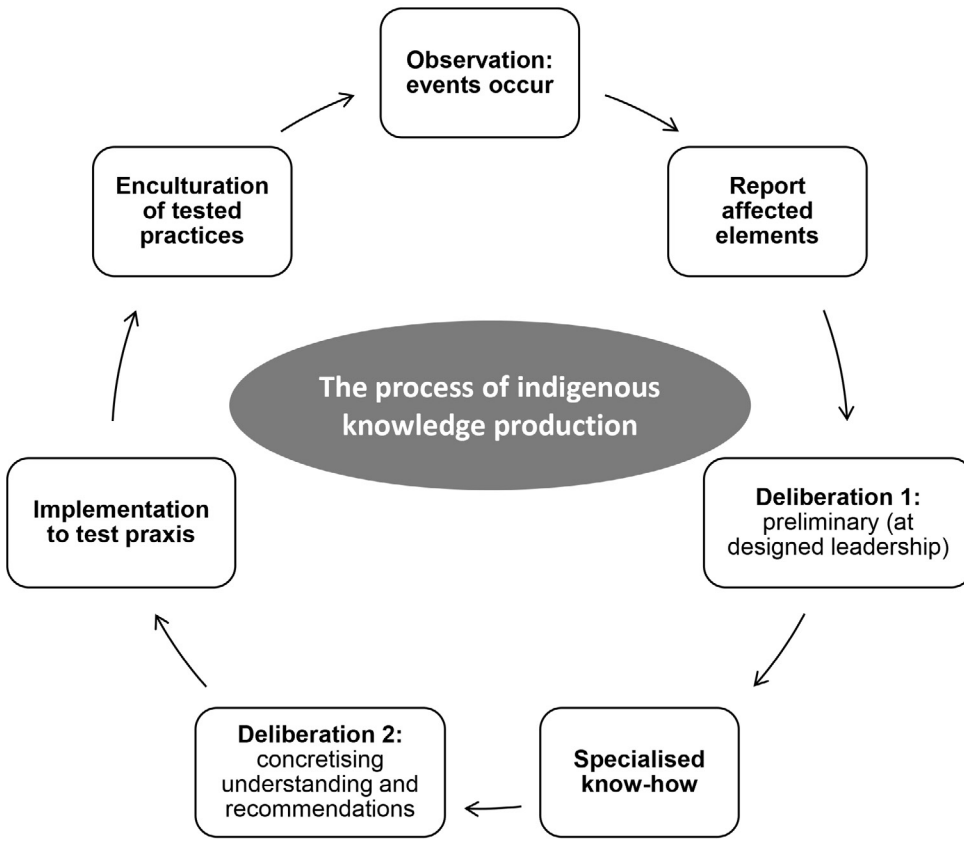
Systematic indigenous conceptualisation of floods

The previous subsections suggest that 'invisible forces' and a 'spirit' are a framing point or a cultural representation of the natural system and rational reasoning, respectively. Similar to findings on the Mātauranga Māori (Hikuroa, 2017; Wilkinson et al., 2020), cultural values (such as those related to deities) are viewed not as an end in themselves; rather, indigenous people use them as a framework to interconnect with—and formulate explanations of—the dynamics of their environment (see also Balay-As,

Marlowe, and Gaillard, 2018). Moreover, the indigenous perspective on flood management is noted to be enhanced by context-specific environmental resources to formulate best ways to tackle floods. The employment of such resources to learn and deal with environmental events is argued to lead to co-evolution of humans and the natural (hydrological) environment, so much so that the natural realities and the dynamics within them should be considered as *social natures* (Ashmore, 2015). The more indigenous people interact with nature, the more they become familiar or connect with it; accordingly, they grasp concretely the processes that occur therein (Bwambale, Muhumuza, and Nyeko, 2018). Accumulated understanding of the locale allows indigenous people to comprehend ably changes and events, and to make refinements over time. This process is summarised in Figure 4.

This indigenous approach can be associated with understanding of the laws of nature that govern the systematic operation of natural reality, as recognised in the sciences. Science, by recognising the regular operations of reality, deduces or induces explanations of patterns, including in relation to floods (Bwambale, 2020). In a similar way, indigenous knowledge is observed here as pertaining to understanding

Figure 4. The indigenous method of inquiry to understand and address floods



Source: authors.

hydrometeorological ontologies, following intimate comprehension of the regular pattern of the invisible reality. Indeed, as Ludwig (2017) highlights, the concern is more with regularities that are stable in, and relevant to, socio-epistemic practices in the (local) context. The indigenous approach is more context-specific and empiricist and involves social constructions (see Figure 4). One could say that science is distinct from indigenous knowledge through its focus on regularities that are stable across settings (Hikuroa, 2017). However, insofar as local hydrometeorological ontologies follow a natural pattern, these indigenous people indirectly follow the laws of nature. Somehow, then, they connect with core aspects or ultimate principles in producing their knowledge of floods.

A factor related to understanding the principles behind floods is reflected in trying to understand local regularities based on the concrete outcomes of the practices they implement after comprehending the fundamental causes. A clear example, here, is indigenous specialists trying to understand the core operations of *Nyamusya*. They conceptualise based on observations, experience, and rational reasoning, in order to offer the most appropriate recommendations. This points to indigenous perspectives having one of the foundational elements that enable it to produce a more objective and/or holistic understanding of the local context of floods, concurring with the claim that being local hardly precludes systemisation or objectivity of indigenous knowledge (Douglas, 2004; Ludwig, 2017). Indeed, this can lead to developing independent epistemic grounds for indigenous knowledge; it is also an avenue to building lived experiences that lead to a more suitable understanding of floods in the local setting, resulting in a context-situated pragmatic epistemology (Bwambale and Kervyn, 2021). This precludes replicability or trans-locality as a necessity for developing strong evidence from several spatial locations (see, for example, Douglas, 2004; Ludwig, 2017). Nevertheless, replicability would strengthen the indigenous socio-epistemic approach to learning through experience (Bwambale et al., 2022a).

Conscious will to learn from experience is demonstrated by progress in formulating techniques to understand floods (see Figure 4). This enhances the viewpoint that indigenous people can position themselves to rationalise the facts that they experience (Lane et al., 2011). It induces enhanced creative thinking and theorisations, leading to new understanding, closer to the way it is done within the scientific perspective. The pace at which it is generated may be slow in the indigenous perspective since the regularities are rationalised through local experience. This can limit the processing of knowledge to comprehend changing flood risk. However, the indigenous knowledge system has a repository, is open to knowledge production, and is embedded in the community's worldviews. Ideas are embraced insofar as they are tested for praxis (that is, the concrete outcomes); and then the tested knowledge is placed in safe custody among specialists and enculturated to weave it into the community's lifestyle. From here, it is possible to produce reliable but local context-specific knowledge. Moreover, openness to knowledge production points to the capacity of indigenous people utilising various means, including modern science, to boost their understanding of, and practices concerning, natural hazards. Recent studies suggest

that this is possible insofar as the ground is levelled (Balay-As, Marlowe, and Gaillard, 2018; Maes et al., 2019; Bwambale and Kervyn, 2021; Mertens, Bwambale, and Delima, 2022).

Conclusion

This study investigated indigenous knowledge processes and their relationship with science apropos of their explanatory power, focusing on flooding in the Rwenzori region of Uganda. Indigenous people acquire an understanding of floods through an intimate assimilation of the regularities of their natural processes. To the extent that these regularities follow a natural pattern, indigenous knowledge production is noted to track implicitly the pattern of the laws of nature, leading to context-specific understanding of floods. What enables this learning process is the openness of the local cultural institutions that govern indigenous knowledge production. Not only do they favour open knowledge production, but also they facilitate the production of knowledge based on concrete outcomes. This enables the indigenous community to gain even more experience in optimising indigenous knowledge. Together with open inquiry deliberations, this induces theorisations and results in systematic indigenous understanding through a framework of cultural concepts. Thus, systematic indigenous conceptualisation has gradually shifted indigenous understanding from beliefs to rationally systematic local context knowledge of rivers and floods. Being based on experience, this knowledge might take a long time to be produced, but it results in more concrete understanding given its foundation on the accumulation of experience of concrete outcomes.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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