Metamorphosis from local knowledge to involuted disaster knowledge for disaster governance in a landslide-prone tribal community in Taiwan

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\begin{abstract}
This study aimed to elucidate local knowledge that might be used to reduce disaster risks and what, if anything, changes when local knowledge is influenced by external knowledge. Qualitative data drawn from semi-structured interviews and a workshop were analyzed to study a Taiwanese indigenous tribal community. We found that disaster experiences sharpened people’s abilities to detect changes in terrain, hydrology, flora, and fauna, thereby enabling them to identify disaster risks. This local knowledge could improve early warning of an impending disaster. People also used invisible local knowledge (e.g., social relations and experiences) to build their capacities to respond to disasters. We propose involuted disaster knowledge as a new type of knowledge that integrates local knowledge with scientific knowledge through an involution process. Therefore, involuted (local) disaster knowledge functions to interpret the government’s perspective based on the reality known to the local people, which could help governmental disaster management succeed in meeting community-level needs. It also functions for understanding the language used by community residents, which minimizes power inequalities in the disaster governance process. We recommend recognizing local knowledge and using it in disaster management because it might help to effectively reduce the negative effects of natural disasters. Involution could help expand local knowledge’s capacity for changing the environment that further benefits both local people and the government. Participatory workshops are recommended for integrating local knowledge and governmental scientific-based knowledge as well as formulating disaster risk management with community characteristics.
\end{abstract}

\section{Introduction}

Top-down processes determine most disaster-related management activities; in these processes, most thoughts are derived from and based on scientific knowledge. When such scientific-based knowledge is transmitted to communities and becomes the dominant knowledge, it is often incongruous with the residents and might even contradict local knowledge [1]. This can be attributed to a lack of communication between scientific knowledge and local knowledge and a lack of integration between various stakeholders’ perspectives. Consequently, difficulties often develop in the community-level implementation of these government policies [1,2].

In late 2016, we visited the Songhe, an indigenous tribal community located in mountainous Taichung County, Taiwan, which had experienced many natural disasters. We found that local knowledge played an important part in community-level disaster prevention because the residents repeatedly told us that they tried to effectively reduce the negative impacts of disaster based on local features and cumulated personal disaster knowledge. We even noticed that, although the government had planned evacuation shelters for the residents, they took refuge in other privately-owned shelters during disasters. This triggered our motivation to explore the gap between local disaster knowledge and the government’s scientific-based disaster knowledge. With the decentralized trend regarding resource and environmental management, indigenous people have been provided the right to use their own knowledge to manage the environment in order to reduce their vulnerability, which they currently do [3]. However, more than 15 years have passed since scholars began advocating for disaster governance through community efforts, but little implementation has followed [4]. Even small-scale community-level disaster prevention programs are dominated by top-down governmental approaches [5].

Therefore, this study’s core question was the following: “How do residents utilize local knowledge to mitigate disaster risks, and in what forms?” We aimed to learn about the local knowledge that might be used...
to reduce disaster risks and what, if anything, changes when local knowledge is influenced by external knowledge. Ultimately, we aimed to identify the role of local knowledge and involuted knowledge in disaster management. To that end, this case study of the Songhe explored residents’ perspectives and examined the characteristics of local knowledge for further describing such knowledge based on the ways in which people applied it in reducing disaster risk. This study takes Geertz’s [6] notion of involution to develop an understanding of involuted disaster knowledge as a new type of knowledge that integrates local knowledge with science. This study’s findings support an interdisciplinary explanation of disaster governance from the community perspective.

This paper consists of five sections. First, we review published research on local knowledge in its integration into disaster risk reduction to fit this research into the broader literature. We then describe the research materials that compose the background of the case study, followed by our research methods. Results are presented based on fieldwork, comprising two subsections describing local knowledge that we collected from the field and a workshop designed to observe how involuted knowledge is produced and practiced. The discussion provides a particular focus on the transformation from local to involuted knowledge. We argue that the involoted local disaster knowledge could become the “local knowledge” after a run-in period, showing the dynamic characteristics of knowledge. Finally, we provide a conclusion for the study.

2. Literature review

Scientific knowledge has long been considered the paragon of knowledge while other forms of experiential knowledge, such as local knowledge, tend to be considered unstructured and obsolete [1,2,4]. One substantial misinterpretation of local knowledge is believing that it is a closed type of knowledge that is obsolete, resistant to new ideas, and an impediment to societal evolution, including the government’s disaster management unit [7]. This misunderstanding originates from ignorance about community residents, who have developed unique knowledge based on their experience and values. Since the 1980s, in order to manage the uncertainty that is connected to environmental problems, other types of knowledges have been taken into account to deal with the complexity of environmental issues as well as to link local perspectives into environmental governance [8] For example, during the 1960s, the United States Agency for International Development planted single-gene modified crops in developing countries to address food crises, with the unintended consequence of creating eco-environmental disasters. Scientists then recognized that addressing community problems only with scientific knowledge is insufficient and that it is necessary to find ways to reasonably use community-level experiential knowledge [9].

Raymond et al. [8] reviewed environmental management literature and classified knowledge into three forms: experiential/local knowledge (generated from personal experience and culture), scientific knowledge (generated through formalized scientific methods), and hybrid knowledge (generated through social learning and integration). Experiential/local knowledge has gained particular attention due to the fact that there remains a lack of full understanding of how it could help mitigate complex social-ecological problems [3,10]. Many studies have been published aiming to identify types of experiential knowledge [e.g., 3, 4, 11, 12]. For example, local knowledge refers to a comprehension of local context that reflects a deep understanding of a local site or issue that can often be differentiated from external knowledge, which lacks an understanding of local culture [8,13]. Indigenous knowledge, as a subset of local knowledge, refers to local knowledge held by indigenous people or a given culture or society [10,14,15] that reflects indigenous holistic worldviews. Using time as its key dimension, traditional knowledge implies historical aspects of knowledge that have been handed down through generations by cultural dissemination [16].

Out of these types of knowledge, local knowledge is developed through long-term observations and accumulations of personal experiences in natural environments [17]. It is rooted in people’s everyday lives and embedded in the social structures that may comprise sets of norms governing the uses of natural resources and land, provide emotional connections among people, and be closely tied to cultural values [4]. Okada et al. [18] uses “local sociality” to describe the everyday experience of local community life. In addition to its essence of accumulation of the past, local knowledge is dynamic because, to successfully adapt to changes, people must constantly create and learn. Thus, local knowledge is capable of transformation, adjustment, and assimilation as thinking evolves [12,19]. According to Thomas and Twyman [12] local people do not live in isolation, and knowledge develops through experiences that could further evolve into new forms of local knowledge. Local knowledge is “place-based” (rather than location-based), and it is characterized by being fluid and dynamic [20] as well as contested and hybrid [1]. As all types of knowledge are socially constructed [1], more power must be returned to the local communities, where local people use local knowledge as a starting point that can be expanded with scientific knowledge [10]. These social learning processes of knowledge integration create a new form of knowledge called hybrid knowledge [8,12]. Through the integration of local and scientific knowledge (i.e., multiple knowledges that have been synthesized or that incorporate new information to an existing knowledge body), hybrid knowledge could not only reflect local interpretations but also present collective interpretations leading to consensus [10,21].

American anthropologist Clifford Geertz understood local knowledge as an innovative and dynamically changing body of knowledge. He cited American anthropologist Alexander Goldenweiser’s term “involution,” which refers to a system wherein there is simultaneous external and internal pressure, to describe the intensification of existing forms of knowledge rather than changes to them [6]. Geertz discussed Indonesian (Java) farmers’ uses of local, well-preserved traditional farming methods to adapt the cultivation methods introduced by the colonial government. For these farmers, preserving the local farming methods meant neither rejecting new external methods nor replacing or eliminating their traditional methods. It meant appropriating and adapting foreign expert knowledge into their experiential inherent local knowledge to develop new involved farming knowledge [6,22]. The involution process echoes the idea of knowledge integration; moreover, it uses a more detailed perspective to thoroughly describe the fabric of change for interpretation. This research, therefore, uses the term involution and involved knowledge in our analysis to discuss the knowledge integration and its creation of hybrid knowledge. This study emphasizes the use of involved knowledge by which the community sustains innovative and cross-cultural development after adaptation to changes. The concept of involution implies that local knowledge is not closed knowledge (i.e., it does not reject new things); rather, it blends external knowledge into the existing knowledge body and further forms the involved knowledge that could be better suited to the place.

Disaster-related knowledge at the community level usually accumulates through direct or indirect experiences and observations of the environment [23]. People are familiar with their natural environments through observation and experience, and the characteristics of natural disasters and the socioeconomic damages that they cause to communities are understood that way [24]. Burton, Kates, and White argued in 1993 that less developed countries should not merely copy scientific applications and that they should integrate that scientific knowledge with their local knowledge in order to reduce vulnerability and facilitate societal transformation [25]. They were concerned with community-level governance of the natural environment through local knowledge, which is currently advocated. Many global organizations facilitate the idea by developing initiatives to raise the public’s awareness and putting them into practice. For example, the Intergovernmental Panel on Climate Change’s Fourth Assessment Report released in 2007 indicates the importance of local knowledge to development and adjustment strategies to combat the effects of climate change [26]; the
United Nations International Strategy for Disaster Reduction developed an early warning system in 2009 that applies local knowledge to disaster management; the Hyogo Framework for Action 2005–2015 acknowledge indigenous knowledge and heritage’s role in building resilience [4]. The recently published Sendai Framework for Disaster Risk Reduction 2015–2030 also expressly states that local knowledge is substantively significant to reducing disaster risk [27], particularly regarding correct uses of the experiences, wisdom, skills, and local knowledge accumulated by elders and residents over many years when developing early warning systems. It recommends joint application of scientific knowledge and local knowledge to strengthen communities’ capacities to respond to natural disasters. This type of knowledge integration should be used to monitor risks caused by environmental changes, develop community-level disaster prevention programs, and create early warning systems to reduce the risks [27].

Evidence that local knowledge helps disaster risk reduction appeared and expanded in the 1970s [24], and rapid growth was seen in the mid-2000s after the 2004 Indian Ocean Tsunami [4]. For example, Walsh and Nun [29] proposed using local knowledge to reduce disaster risk based on their research findings that drew from the study site’s extremely low number of victims. The authors note that the low number of victims is mainly attributable to tradition-based indigenous knowledge comprising stories and myths. Hiwasaki et al. [4] also noted that integrated local knowledge in disaster risk reduction (DRR) could increase a community’s resilience to disasters through a study on small island communities in Indonesia, the Philippines, and Timor-Leste.

When disasters change the social and environmental natures of a place or the residents absorb external knowledge about disasters, then the residents can meaningfully appropriate or transform the external information through involvement, which creates a complexity of knowledge. Many recent studies have indicated that local knowledge is valuable and significant to disaster-related governance [e.g., 4, 29, 30]. For example, Mavhura et al.’s [31] research, conducted in the coastal areas of Zimbabwe, revealed that traditional knowledge is a vital factor in disaster risk management.

In Taiwan, the Songhe community comprises the fifth through fourteenth neighborhoods of Po-ai Village, Heping District, Taichung City. The population is mixed, with two-fifths of the population the indigenous Atayal people and three-fifths the Han people.

The Da-Chia River runs through the community, dividing it in half: the fifth and sixth neighborhoods on the north bank and the seventh through fourteenth neighborhoods on the south bank [33]. The Songhe residents mainly live where a river and three creeks (Da-Chia River, Songhe No. 1 Creek, Songhe No. 2 Creek, and Li-Dou Creek) intersect.

1 “Tribal community,” proposed by Hsu (2016), refers to Taiwan’s indigenous community, intending to differentiate it from “village” and “community.” See Hsu [32].
participants to use as a communication tool to help them describe the disaster-risk areas of the community by drawing maps on paper. The participants were encouraged to draw the types, scales, and impacts of previous natural disasters. Because of the sophistication of geographic information system (GIS), we relied on Google Earth, a relatively simple interface, as our operational platform. During the mapping discussion, the participants’ descriptions were recorded in Google Earth to familiarize them with it. We marked the disaster risk locations using longitude and latitude, input the locations and descriptions of previous disasters, and integrated the participants’ comments to create a complete disaster risk map. Last, we presented the final Google Earth map to the community participants and discussed future disaster risk management.

4. Results

Dynamic pressures include lack of employment opportunities and emigration by the young adult population, which is increasing the number of single-parent and grandparent-headed families (Interviewees F1 and M6, 2017). Consequently, disaster risks are not only the result of the physical environment, but are also exacerbated by the characteristics of the population, which includes large proportions of elderly people and children, an underdeveloped livelihood reliant on weather conditions, and a weak social support system. However, disaster risk and its reduction are dynamically changing processes. To reduce exposure and vulnerability to natural disasters, the residents have learned to reduce exposure and vulnerability to disasters as well as improve their capacities for facing hazards.

In the results section, we first present the local knowledge we collected. We then use the evacuation shelter as a case to illustrate how people expand upon local knowledge as well as how this transformation appears in their daily lives.

4.1. Local knowledge for DRR

We identified visible and invisible knowledge [36] related to deducing disaster risk in Songhe. Disaster recognition and disaster warning are the two aspects of visible local knowledge. We found that the Songhe residents had lived in their community for a long time, and they were more sensitive than outsiders to environmental changes. Their everyday lives were closely associated with the natural environment, and they could identify disaster risk factors, such as long-term changes in topography, hydrology, flora, and fauna, and recognize disaster warnings (e.g., premonitory symptoms of debris flow, typhoon floods, and earthquakes) (Interviewees M2, M3, and M6, 2017).

We stay on alert if the rain is heavy. For example, if black soil rushes out, that means something is wrong. (Interviewee M3, 2016).

The Songhe residents could use visible local knowledge to warn others of impending disasters and take emergency actions at the earliest stage for DRR, thereby mitigating a disaster’s influences on life and property. They could observe abnormalities and recognize the signs of a coming disaster to give an adequate disaster warning to the community.

Invisible local knowledge comprises the local wisdom developed to meet everyday needs using natural environmental resources and social
workshop held on February 28, 2018. Participants in the public participation geographical information system (PPGIS) workshop held on February 28, 2018.

Table 1
Characteristics of the ten interviewees.

<table>
<thead>
<tr>
<th>Identity code</th>
<th>Gender/age (in years)</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Female/65</td>
<td>1. Songhe Community Development Association: Former member 2. Debris flow disaster prevention specialist of the Soil and Water Conservation Bureau</td>
</tr>
<tr>
<td>M1</td>
<td>Male/65</td>
<td>1. Songhe Community Development Association: Former member 2. Homestay owner</td>
</tr>
<tr>
<td>M2</td>
<td>Male/40</td>
<td>1. Songhe Community Development Association: Former member 2. Fish farm owner</td>
</tr>
<tr>
<td>M4</td>
<td>Male/50</td>
<td>1. Songhe Community Development Association: Former member 2. Restaurant owner</td>
</tr>
<tr>
<td>M5</td>
<td>Male/60</td>
<td>1. Songhe Community Development Association: Former member 2. Derfulan Agri-Tourism Promotion Association: Cadre</td>
</tr>
<tr>
<td>M6</td>
<td>Male/40</td>
<td>1. Songhe Community Development Association: Former member 2. Po-Ai village office staff</td>
</tr>
<tr>
<td>F2</td>
<td>Female/60</td>
<td>1. Po-Ai Elementary School: Employee 2. Songhe Tribe Culture and Healthcare Station: Staff</td>
</tr>
<tr>
<td>F3</td>
<td>Female/70</td>
<td>1. Former neighborhood head 2. Songhe Tribe Culture and Healthcare Station: Staff</td>
</tr>
<tr>
<td>M7</td>
<td>Male/50</td>
<td>1. Songhe Community Development Association: Former member 2. Local volunteer group: Cadre</td>
</tr>
</tbody>
</table>

Table 2
Participants in the public participation geographical information system (PPGIS) workshop held on February 28, 2018.

<table>
<thead>
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<th>Identity code</th>
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<th>Affiliation</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Male</td>
<td>Government</td>
<td>Section chief, Civil Affairs section of Heping District office</td>
</tr>
<tr>
<td>B</td>
<td>Male</td>
<td></td>
<td>Branch head, Heaping branch, Fire Bureau of Taichung City Government</td>
</tr>
<tr>
<td>C</td>
<td>Male</td>
<td>Officer</td>
<td>(in charge of disaster affairs), Heaping branch, Fire Bureau of Taichung City Government</td>
</tr>
<tr>
<td>D</td>
<td>Male</td>
<td>Community</td>
<td>Village head of Po-Ai Village, Heping District</td>
</tr>
<tr>
<td>E</td>
<td>Male</td>
<td></td>
<td>Derfulan Indigenous Culture and Economic Association</td>
</tr>
<tr>
<td>F</td>
<td>Male</td>
<td></td>
<td>Derfulan Agri-Tourism Promotion Association</td>
</tr>
<tr>
<td>G</td>
<td>Male</td>
<td></td>
<td>Former member: Songhe Community Development Association</td>
</tr>
<tr>
<td>H</td>
<td>Male</td>
<td></td>
<td>Restaurant owner</td>
</tr>
<tr>
<td>I</td>
<td>Female</td>
<td></td>
<td>Community volunteer and grocery store owner</td>
</tr>
</tbody>
</table>

relationships. Invisible local knowledge can be understood as comprising three aspects: natural resource use, social resource use, and disaster experience. We found that the Songhe residents built stone ridges to maintain and use their land resources during ordinary times. This tactic maintained animal and plant growth, preserved the natural environment, retained soil and water, reduced soil loss, promoted water discharge, and reduced debris collapse and falling rock hazards.

We all grow plants this way; if some slopes are not suitable for growing plants, we will lay stones like ladders; if there is only soil on the slopes, the soil will often collapse if it rains; moreover, water will not accumulate there but will flow away itself. (Interviewee M1, 2017).

During previous natural disasters, the residents observed the natural environment and learned how to use the resources to mitigate the impacts. They developed an emergency water supply system to boost their ability to respond to disasters and reduce property damage.

During a typhoon, water seeps from the mountain gully; before a typhoon, no water is available. The stronger a typhoon is, the more water seeps from the mountain gully. This is how the mountain has behaved in the past. The mountain is like a sponge; if it rains continuously, water will spray out somewhere. (Interviewee M3, 2017).

To respond to an emergency, the Songhe residents quickly mobilize their families, assign tasks, and distribute disaster relief items. Some people survey the disaster area while others act as liaisons or make emergency repairs to reduce the negative effects. When sharing disaster relief materials, they take care of each other like a big family and notify others of the disaster condition, thereby preventing a further extension of disasters.

At that time, we ate together! Then, we crowded together in the safest place; then, we ate and slept together and spoke of unusual things, but never hid them in our hearts. (Interviewee M7, 2017; Interviewee F2, 2018).

Communities have important roles in disaster response because they are familiar with the natural environment, people, and infrastructure. They coordinate evacuations, seek support, survey the conditions, transmit relevant information, and make requests, which avoids wasting human resources. By sharing their disaster-related experiences, the residents learned how to harmoniously live in the natural environment. By listening to and learning from their elders, the residents developed disaster responses specific to their weather, climate, geography, and so on to prevent the reoccurrence or escalation of the worst disaster outcomes and build the capacities needed to cope with disasters. “As the saying goes, disasters will occur again in the same place. Why is our current residence safe? Our ancestral wisdom tells us that such a residence is very safe” (Interviewee M3, 2017). The first inhabitants of this Songhe area were the Atayal people; they had the first choice of location most suitable for living. They scattered on the flat land near Li-Dou creek (i.e., neighborhood 13 and 14), which, until now, has only been slightly impacted by disasters. Later, when the Han people came, they inhabited the spare space of upstream Songhe No. 1 Creek and Songhe No. 2 Creek, then gradually extending downstream (where the creeks merge into the river). A community along that river was then formed. Interviewee M3 was an indigenous Atayal who lived in a relatively safe place of Songhe; he has never been affected by disasters, which he credits to his elders’ experience and their wisdom of site selection.

Sharing disaster-related experiences helped to bring people closer together. “Such disasters make the residents of our community more united, and they focus their minds on the community” (Interviewee M6, 2018). Sharing disaster experiences helped the residents reach consensus on disaster prevention and change their ideas about meeting the next challenge. “I think we should not take an extremely negative attitude toward disasters. Disasters can make our tribe united. Of course, disasters are painful, but they offer an opportunity to make us recognize the necessity of unity” (Interviewee M3, 2017).

4.2. Producing involuted knowledge: a case of identifying an evacuation shelter

All the long-term residents of Songhe had experienced natural disasters, such as typhoons, debris flow, and floods. They had learned a way to harmoniously live in their natural environment and had developed unique local knowledge for disaster response based on their
cumulated disaster experiences (Interviewee F1, 2017; M3, 2017). One of the most direct and effective ways to reduce disaster impacts is to make sure people know where they can go to be safe during a disaster (Interviewee M5, 2017; F3, 2017).

During the PPGIS workshop, we learned the differences in perspective among the community residents and the government. According to discussions in the workshop, the main differences lay in the knowledge bases. First, local people tend to stay at home when there is a disaster risk, mainly because local knowledge passed down from the elders says that it is safer to stay inside one’s own house to protect oneself as well as one’s assets. However, external knowledge from the scientific-based governmental policy argues that people should go to the designated public evacuation shelters when there is a disaster risk. Second, if evacuation is needed, local people tend to evacuate to nearby places that they believe are safe based on their accumulated experience, no matter whether it is publicly or privately owned. However, external knowledge instructed that all residents should be evacuated to the officially designated shelter (the structure should be a public building) since it could be managed by the public sector. Lastly, residents believe that evacuation shelters should be scaled down to their living territory (i.e., the Songhe community is divided by creeks into three units). However, official principles of disaster preparedness propose “one shelter for one tribal community,” as tribal community is the smallest spatial/social unit according to the government.

Alongside all of the participants, we worked to develop a disaster management solution according to involuted local knowledge that was acceptable to all parties. Based on residents’ local views and knowledge and the input from the government, a distribution map of the emergency shelter locations was produced to manifest the involution of knowledge in the Songhe community (Fig. 2).

During the initial stage of discussion in the workshop, we noticed that Songhe residents had slightly changed their perception and behaviors regarding evacuation from staying in one’s house to evacuate to a nearby safer place to gather with neighbors (Participant D). The changes can be attributed both to the disastrous experiences from 2001 to 2004 and to propaganda from external experts and the public sector such as the publication of an official evacuation map that clearly shows the evacuation routes and designated shelter for each village/community (Participant I).

However, even with the common initial notion that evacuation is needed, discrepancies can be found between local and external knowledge on the selection of “safe and appropriate” shelters. The community participants pointed out that the areas adjacent to the river and creeks (especially Songhe No. 1 creek and Songhe No. 2 creek) had high risks of disaster problems and were likely to experience landslides during disasters (shown in yellow and blue lines in Fig. 2); therefore, a correct location for refuge should avoid those risks. Accordingly, residents identified four places for evacuation shelters (shown as star symbols in Fig. 2: Jhong-Syun Syu’s house, Po-Ai village head’s house, Yu-Jie Syu’s house, and New Zealand Leisure Farm). These selected locations, although private-owned residences, were considered “safe” by the locals, and they differed from the official shelter—Po-ai elementary school (the previously designated shelter was the community activities center nearby Po-ai elementary school). Moreover, although the Po-ai elementary school was assigned to be the official shelter due to the fact that it was located in a safe place based on the government’s scene-based investigation, residents believe that it is situated in a risky location vulnerable to flooding and landslides. Rather than following the notion of centralized management of evacuees in designated shelters, residents selected four shelters that are distributed between the creeks. This selection strategy not only reflects the natural environment setting of the community but also reveals the living territories of Songhe residents. The sites were not determined by the official principle of “one shelter for one tribal community” because the residents lived in different parts of the community and they had different understandings about the different parts of the community. For
example, the Da-Chia River had overflowed its banks several times, which interrupted bridge use and threatened the safety of roads and houses near Provincial Highway Number 8. Moreover, significant debris flow involving the three creeks could bury the nearby houses and land and interrupt travel. Last, the areas adjacent to the side slopes of Songhe were considered at risk of debris collapse, which threatened the residents’ lives. Because of the variation in the characteristics of these areas and disaster risks, the Songhe’s residential areas could end up isolated from each other and some disaster effects could produce obstacles difficult to overcome (e.g., flooding creeks). Therefore, it was necessary to identify shelters for each part of the community. As shown in Fig. 2, the four shelters are in four areas, and all of them were prepared for emergency rescues and employed cumulated local knowledge; as Interviewee F1 said, “We have our own shelters where we stockpile food and clean water. They are private houses located in high and flat places. We use them as our own shelters, not governmental owned” (Interviewee F1, 2016).

During a disaster, people at risk can either find refuge at government-designated shelters or at emergency shelters based on their locations, according to their proximity to a disaster and current conditions, to reduce their exposure time. Therefore, the emergency shelters identified by the community participants at the workshop based on their disaster experiences and local knowledge provided safe emergency shelters in geographical areas where people could find help. These collectively chosen emergency shelters could effectively lessen unpredictable hazards from occurring on the long or unsafe paths to mountain shelters. During a disaster, residents can go to emergency shelters alone or with others to be safe. These emergency shelters are suitable but are not necessarily immediately available, and they are not intended to meet legal standards or regulations. Currently, the community needs land and funding for emergency shelters. Once consensus is reached, using local knowledge to address disaster risk prevention might ensure that the risk prevention measures meet the community’s needs, as the official who participate in the workshop noted, “If these places encounter legal issues associated with building law or fire law, we must create an overall plan to address them, so that they become legal and safe emergency shelters! Above all, we all must unite to overcome this problem” (Participant C, 2018).

5. Discussion

Local disaster knowledge based on disaster experiences must be personally obtained and interpreted by individuals and the community. To reduce the impact of landslides, the community members should learn to reduce their exposure to the risks, which would be a direct and effective way to reduce disaster risk [4]. Geertz’s [6] concept of “involution” is based on his observations of farmers in Indonesia. When the colonial government in Java implemented a new agricultural system, the farmers accepted it and involuted their everyday farming habits, which somewhat preserved their traditional farming methods. The practice of transforming new foreign knowledge to fit a community’s understandings and needs is the outcome of involution of local knowledge [6].

In our study, the involution of local disaster knowledge meant that, when the government introduced disaster risk management measures to the Songhe, the Songhe residents accepted it but converted it by fitting their unique environmental and social context into it, thereby developing an involuted local disaster management mechanism in a form of complex measures that blend two streams of knowledge together. We propose that the involution of local disaster knowledge must be stimulated by external (top-down) disaster management measures that are mostly based on scientific knowledge. Very little attention was paid to the local social situation, which is concerned with local people’s everyday lives and their community [18]. Residents develop local disaster knowledge specific to their communities, and government-initiated disaster management might not fully understand people and their situations at the community level. Local disaster knowledge and governmental policies complement each other, and communities transform those policies into complex disaster responses suited to their conditions (Fig. 3). Fig. 3 shows that the run-in stage is a transition period during which the government controls and implements disaster risk management at the community level. Stakeholders and vested parties can interact, try to understand each other, shrink cultural gaps, and accommodate each other.

Taiwan has a community-based disaster prevention program. Although it claims to have implemented a community-based approach, the program is still not deeply rooted in the communities, and community residents do not understand the implications of the expert knowledge on disaster risk prevention.

In my view, the shelters and evacuation routes announced by the government are hasty decisions because the government does not communicate with us. Experts must seek advice from residents because we are the most familiar with the geographical and humanistic environments of Songhe! (Interviewee M6, 2018).

Compared to the residents, governments and their experts are not familiar with communities, so they might implement disaster management measures poorly suited to residents’ needs, sometimes even contrary to residents’ expectations. “Central agencies conduct field surveys in our tribe, but the local government, which is the closest to us, has never cared about us” (Interviewee M3, 2017). Moreover, the government manages communities’ needs mainly through regulations, plans, and applied scientific knowledge, seldom including local knowledge. When scientific knowledge is given dominant status, misunderstandings easily develop between it and local knowledge [18]. Only when the two streams of knowledge hold respect for and are willing to learn from each other can the process of knowledge involution be triggered. Local knowledge serves as the base from which external knowledge’s contributions can diversify viewpoints and practice to allow for the involuted knowledge to more flexibly face the changing world. We observed several pieces of evidence to demonstrate this phenomenon. For instance, local people used to depend on local information such as observations of the creeks’ water level, volume, color, and odor in addition to changes in cloud patterns and sky colors to determine whether they should prepare for hazards. However, currently, in addition to residents continuing such their disaster recognition practices, they also understand the notion of “rainfall threshold value for debris flow warning,” which was taught by external experts. Combining their knowledge with the usage of a simply styled rain gauge distributed by the Soil and Water Conservation Bureau of Taiwan, residents could merge the two streams of knowledge for more accurate decision making.

In sum, sustainable disaster risk governance is a process of ongoing communication and compromise [4,29]. Dialogue platforms based on local knowledge are needed to integrate community perspectives into the process. Active dialogues between local knowledge and scientific knowledge would minimize inequalities across the levels of government [10,30]. When governments formulate disaster governance policies, they should focus on community-level needs by engaging all interested parties (e.g., community residents and leaders, governments, scientists, non-governmental organizations, and schools) in discussions about DRR and should learn about communities’ particularities in social context. The goal would be to merge local knowledge with scientific knowledge and integrate all parties’ perspectives, thereby reaching consensus, developing trust in public policies, and ensuring the effectiveness of DRR strategies developed by governments. However, we argue that the involution is not expected to happen every time nor is involuted knowledge expected to continuously result in successful outputs. As shown in Fig. 5, external interventions (including disaster events and scientific knowledge) are critical triggers to kick off the process. In addition, as we mentioned above, respect for the other side and the willingness to communicate and learn are basic elements required to
participate in the fundamental steps of involution.

6. Conclusion

Local knowledge is of substantive significance to DRR [11,24,28]. To reduce humans' exposure to disaster risks, it is necessary to correctly apply local knowledge, develop early warning systems, improve emergency responses to disasters, and identify appropriate escape and evacuation plans. To mitigate human vulnerability and susceptibility to the effects of disasters, local knowledge should be applied to strengthen a community's disaster-monitoring capacities and relief distribution networks with a helpful and sharing attitude based on family and social networks. Self-sufficiency during disasters should be encouraged to improve disaster-related communications and organization, and people should learn about disasters from their elders' previous experiences.

Vulnerability to risk is linked to the natural and social environments of a given area. However, local knowledge could reduce disaster damages and improve disaster responses, thereby mitigating vulnerability. First, residents need to understand their environment, and we advise municipal governments to engage people in discussions of disaster risk reduction and empower them to express their views to improve their understanding of disaster risks. It is necessary to understand residents' perspectives and respect local knowledge so that governmental measures can meet communities' needs.

Second, disaster governance should be as inclusive as possible. To formulate disaster management strategies that fit into local contexts and have the capacity to solve community problems, it is necessary to integrate scientific-based knowledge through governmental policies and local knowledge of residents’ viewpoints during the entire process. Effective disaster management processes must meet the following three conditions: (1) emotional connections based on common culture, (2) cross-cultural transpositional thinking, and (3) appropriate places for communication with sufficient time provided to reflect. Local knowledge must be able to absorb scientific knowledge to meet community needs and to increase the flexibility of the community to cope with the changing environment. On the one hand, local knowledge must utter the interest of the peer party. On the other hand, to overcome the inequity in rights between local residents and governments, local knowledge must be used to facilitate an understanding of local disasters during the communication and coordination process; this would help in building an effective communication model that merges the benefits of top-down and bottom-up practices to satisfy local needs during the disaster governance process.

Lastly, we propose that involuted disaster knowledge is a new type of knowledge that integrates local knowledge with scientific knowledge. On the one hand, involuted disaster knowledge could help governmental measures to succeed at the community level. On the other hand, involuted disaster knowledge could merge with expert knowledge to develop new answers to disaster-related issues that improve prevention and reduction in a complementary system. It is necessary to understand the way that people in communities (1) think about disasters in their local contexts, (2) introduce ideas about disaster management based on local knowledge in areas with high disaster risks, and (3) rely on established social networks to preserve their wisdom about natural resources and
social relations. Doing so will help to develop a disaster risk governance model that effectively protects communities.

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Appendix A. Supplementary data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2019.101339.

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