Indigenous Resilience to Disasters in Taiwan and Beyond

Fikret Berkes [1], Huei-Min Tsai [2,3], Mucahid Mustafa Bayrak [3,4] and Yih-Ren Lin [5,*]

1   Natural Resources Institute, University of Manitoba, Winnipeg, MB R3T 2N2, Canada;
    Fikret.Berkes@umanitoba.ca
2   Graduate Institute of Environmental Education, National Taiwan Normal University, Taipei 11677, Taiwan;
    hmtsai@ntnu.edu.tw
3   Center for Indigenous Research and Development, National Taiwan Normal University, Taipei 10610, Taiwan;
    mmbayrak@ntnu.edu.tw
4   Department of Geography, National Taiwan Normal University, Taipei 10610, Taiwan
5   Graduate Institute of Humanities in Medicine, Taipei Medical University, Taipei 11031, Taiwan
*   Correspondence: oyrlin@tmu.edu.tw; Tel.: +886-02-2736-1661 (ext. 8632)

1. Introduction

The world is undergoing rapid environmental change. Different perspectives must be used to understand change and to respond to environmental disasters brought about by climate change and other driving forces. Many national and international agencies have been exploring the use of Indigenous and local knowledge as a source of resilience and adaptation in the face of rapid change. This Special Issue is a follow-up to a conference organized in Taipei in December 2019 to explore two interrelated themes: "Climate Change and Food Security: Indigenous Knowledge-based Responses and Actions" and "Climate Change and Post-Disaster Resilience in Indigenous Communities–10 Years after Typhoon Morakot". This Special Issue includes selected papers from the Taipei December 2019 conference and contributed papers.

The overall goals of the Special Issue are to (1) discuss the international experience with Indigenous resilience and knowledge systems; (2) bring together what is known about Indigenous and local knowledge for adaptation to climate change and for disaster management, as relevant to Taiwan; and (3) generate a conversation among scholars, Indigenous peoples, and policy-making agencies to move the agenda forward.

This introductory paper starts with two sections on basic concepts and the logic behind them—the state of the art in the international literature. The next section discusses why Taiwan poses unique and interesting problems, and what special issues Taiwan is concerned with. The following section is a review of existing scholarship in Taiwan about these issues and gaps in knowledge. Taiwan is very experienced in disaster risk reduction, disaster management, and post-disaster recovery and re-settlement. Other areas, such as Indigenous resilience (the ways in which cultural factors such as knowledge and learning, along with the broader political ecology, determine how local and Indigenous people understand, deal with and adapt to environmental change), remain to be developed. The penultimate section deals with the policy implications of these findings and the way ahead. Specifically, we discuss the prospects toward adaptive governance using Indigenous knowledge and resilience. The final section introduces the papers in the Special Issue.

2. Climate Change, Disaster Risk Reduction, Indigenous Resilience

Recent discussions of climate change assume that there is a need for adaptation. This was not so until fairly recently. Under the 1992 UN Framework Convention on Climate Change and the 1997 Kyoto Protocol, the policy focus on climate change was mitigation, with the idea that climate change could be reduced in severity by such measures as reducing greenhouse gases. Adaptation was not widely discussed, and considered an undesirable policy focus in that it might undermine mitigation. Only after about 2010, after it became

clear that mitigation was not working, and the Kyoto Protocol formally expired in 2012, the concept of adaptation came into the foreground.

Thus, we are past the point of preventing climate change, so it is time to adapt. This requires being ready to respond to events that occur occasionally and unpredictably, such as typhoons. Unpredictable events, by their very nature, pose a difficult problem for governance. Some measures are possible, such as earthquake-proof building codes. However, it cannot be known beforehand when and where a typhoon might strike or its magnitude. Therefore, it is nearly impossible to typhoon-proof an entire island such as Taiwan.

We are in an unusual new era in which human activities have started to cause major changes in the earth's ecosystems and biogeochemical cycles—we are in the Anthropocene [1]. According to the last two IPCC reports, climate change very likely means a statistical increase in the frequency and strength of typhoons in the Pacific and hurricanes in the Atlantic [2]. However, typhoons are not the only consequence of climate change, and climate change is not the only kind of global environmental change. Rapid global environmental change requires governance for disaster risk reduction (DRR), and new and creative responses to maintain flexible policy options in the face of unpredictable disaster events.

With more frequent and more intense disasters, DRR evolved as an approach generally adopted by disaster risk management professionals to make "our communities safer and more resilient to disasters" (p. 1) [3]. DRR is generally aimed at identifying, assessing and reducing the causal and/or underlying risk factors of environmental disasters [4]. Indigenous communities hold a unique position in DRR discourse in that they are often thought to be more vulnerable than non-Indigenous groups. Yet they also hold local and traditional knowledge that enables an understanding of hazards and disasters, and confers adaptive capacity [5,6].

To explore what we can learn from local and traditional knowledge, we discuss the concept of resilience and its significance for environmental change in the context of risks and hazards. Resilience is the ability to deal with change successfully [7]. Since 2010 or so, resilience has become a central concept in sustainability science because it is probably the most commonly used theory of change in social-ecological systems, that is, the integrated system of people and environment considered together. Resilience may be formally defined as the "capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks" [8]. It is the capacity of a system (such as a community together with the land and resources on which it depends) to deal with disturbances, such as floods and typhoons, so as to retain its essential structures and functions. Resilient systems have the ability to absorb shocks and stresses, to self-organize, and to learn and adapt.

A resilient social-ecological system may have a high diversity of landscapes, native species, and crop species and varieties, as well as a diversity of economic opportunities and livelihood options for its inhabitants [9]. The knowledge and understanding behind such diversity and options provide a built-in ability to buffer change and/or to adapt to change [10]. Peoples' knowledge of their environment is an important consideration in buffering or adapting to change. For example, Indigenous knowledge can supplement science by providing grounded information and understanding of the actual impacts of climate change and adaptation possibilities [11].

Resilience is important for dealing with disaster-shocks for three reasons. First, resilience as a theory or organizing framework is interdisciplinary and avoids the artificial disciplinary divide between the study of people and the study of the biophysical environment. It helps evaluate hazards holistically when the integrated social-ecological system is used as the unit of analysis. For example, if a typhoon results in a landslide in an area used by an Indigenous community, the unit of analysis is the Indigenous community together with its land and resource base, including the area that has suffered the landslide. It is not only the people in the community, nor is it only the land.

Second, resilience puts the emphasis on the ability of the system to deal with a disaster-shock. There are multiple ways in which a response may occur. A relatively small disturbance typically triggers short-term or coping responses. However, if the coping capacity is exceeded, then there are incremental changes—an adaptive response. If both coping and adapting capacities are exceeded, the response is no longer incremental but transformative, such as in a resettlement situation following a typhoon. The system no longer retains its identity; in this case, it has been transformed from a rural to an urban social-ecological system. Absorptive capacity, adaptive capacity, and transformative capacity may be considered as the three components of social-ecological resilience [7].

Third, resilience is forward-looking and helps explore policy options for dealing with uncertainty and change. Because it deals with the dynamics of response, resilience helps explore policy options for dealing with future uncertainty and change. Resilience-building is an effective way to deal with social-ecological change characterized by future surprises and unknowable risks. It can be accomplished by actively developing and engaging the capacity to deal with change, for example, by improving social learning from past disaster-shocks and looking for "windows of opportunity" to affect policy change [9]. Resilience provides a way for thinking about policies for the future, an important consideration in a world characterized by rapid change.

The concept of resilience to disasters takes on special importance in an era of rapid change. One of the ideas explored in the Taipei December 2019 conference was the promising approach of building resilience based on Indigenous and local knowledge [12]. However, much of the IPCC literature makes little mention of Indigenous peoples, much less Indigenous knowledge. Salick and Ross [13] commented that the IPCC [14] treated Indigenous peoples only as helpless victims of environmental change that is beyond their control. This view of Indigenous peoples as passive victims is not consistent with the experience. For example, in the Canadian Arctic, the Inuit were adapting to climate change as early as the late 1990s [15]. Much has been documented since then throughout the world on local responses to climate change [11]. However, Indigenous and local knowledge seem to be still undervalued and largely unrecognized by the IPCC [16].

What is the source of Indigenous resilience, and how do Indigenous peoples do it? It is largely a question of survival. Left to their own devices, Indigenous and local rural peoples have developed the knowledge and experience to deal with disaster-shocks. We use this term to refer to unexpected and catastrophic impacts stemming from nature-triggered extreme environmental events, such as earthquakes, typhoons, hurricanes, cyclones, and floods. Disaster-shocks are typically extreme events that surpass the usual technological, socioeconomic and cultural thresholds [17,18]. Typically, they are events that oral cultures are well equipped to remember.

Thus, the use of social memory is one of the ways in which Indigenous peoples deal with these disaster-shocks. Indigenous and local rural peoples retain a memory of once-in-a-generation events and often develop protocols to deal with them. Some of these protocols were described as early as the 1930s in some Pacific islands by the anthropologist Raymond Firth [19]. Thus, a major mechanism to develop local responses to disasters seems to be social learning: the deliberation of individuals and groups to share experiences for collaborative problem-solving [20,21].

Building resilience based on Indigenous knowledge, social memory and social learning is still only a part of the story. Ford et al. [6] reviewed Indigenous resilience to environmental change, and emphasized the importance of the interconnected roles of place, agency, institutions, and collective action, in addition to Indigenous knowledge and learning. In this Special Issue, we explore Indigenous resilience: the ways in which local and cultural factors, along with the broader political ecology, determine how Indigenous people understand, cope with and adapt to climate change related events and other disaster-shocks.

3. Learning from Indigenous and Local Knowledge

After discussing disaster risk reduction, resilience and specifically Indigenous resilience, we focus on one of the major factors: how local and Indigenous knowledge can help build resilience. Indigenous knowledge is not only important for its own sake; it can also lead to mutual learning involving Indigenous peoples, researchers, and policy-makers. Such social learning involves networks of actors, including Indigenous knowledge-holders, and can facilitate adaptive governance to deal with rapid environmental change. This is a subject we return to in the next-to-last section of this paper.

Traditional ecological knowledge (TEK) has been defined as "a cumulative body of knowledge, practice and belief, evolving by adaptive processes, and handed down through generations by cultural transmission" [22]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) uses the same definition but calls it Indigenous and local knowledge (ILK) [23]. Indigenous knowledge (IK) may be more broadly defined as local knowledge held by Indigenous peoples or local knowledge unique to a given culture or society. These terms (TEK, ILK, IK) are often used interchangeably. Local knowledge usually refers to knowledge that is rooted in place but not time-tested through multiple generations [22].

Indigenous knowledge is time-tested wisdom. It is important for the knowledge-holders themselves and their communities, for cultural, educational, economic, and political reasons. However, it is also important as a part of the common heritage of humankind. Here, we discuss it in terms of dealing with hazards and disaster-shocks, but it has been used for a wide variety of purposes from conservation to development planning (Table 1). Indigenous and local knowledge can help build resilience in three ways: increasing the range of available knowledge; providing the basis for adaptations; and enabling social learning.

Table 1. Practical significance of Indigenous and local knowledge (traditional ecological knowledge (TEK)/Indigenous and local knowledge (ILK)/Indigenous knowledge (IK)) as common heritage of humankind. More details in Berkes [22].

> ➢ It is an important source of biological, pharmacological or medical knowledge
> ➢ It is an important source of ecological insights, for example, on species interactions and ecosystem dynamics
> ➢ It can inform natural resource management strategies
> ➢ It can be important for networks of protected areas by contributing community-conserved areas, such as sacred sites
> ➢ It provides scale-specific understandings (local knowledge) for biodiversity conservation
> ➢ It can be a source of input, including knowledge, preferences and values, for development planning
> ➢ It can be used in environmental monitoring and assessment
> ➢ It can inform climate change adaptation
> ➢ It is important for dealing with hazards and disaster-shocks
> ➢ It has been a source of wisdom that informs environmental ethics

First, Indigenous knowledge increases the range of knowledge available to solve problems. It is important for Indigenous and local peoples themselves, but it is also important to help address global problems. Many of these global issues require the use of different perspectives to understand the full range of their impacts, as in the case of climate change [11]. Indigenous knowledge is important for the co-production of knowledge, defined as the collaborative process of bringing a plurality of knowledge sources and types together to address a problem [24].

The multiple evidence base approach [25] brings together natural science, social science, transdisciplinary science, local knowledge, and Indigenous knowledge. The approach creates the potential for co-producing knowledge, enriching knowledge for insights and

for better understanding, and bridging knowledge systems to make links between multiple epistemologies. This approach has been used by IPBES [23] among others.

Second, Indigenous knowledge is a source of adaptive capacity, as it has the potential to provide the raw material for adaptations in the face of environmental change. Peoples' knowledge and practices are the basis for adaptions, and adaptive capacity is part of resilience. Knowledge provides options and flexibility for dealing with change. For example, the 9000 ha Potato Park in Peru holds some 1300 varieties and cultivars, and helps conserve crop genetic diversity for the world. It is a Biocultural Heritage site, located at the center of origin and diversity of potato in the Andean highlands. It is administered and managed by the local Quechua Indigenous people. The amazing diversity of varieties, adapted to different environmental variables in diverse habitats, is crucial as a source of genes needed for global food security in the face of climate change (summarized in Berkes [26]).

Another example comes from the Bolivian Andes, where Indigenous knowledge helps understand climate variability and change. Indigenous people maintain age-old adaptations for unpredictable environmental change. For example, they cultivate crops in discontinuous plots at different altitudes and different faces (aspects) of slopes. They diversify their holdings so that at least some of the fields produce successfully in a given year. Indigenous peoples note local and regional variations in climate change effects: violent rains, erosion and hail damage to crops in the highlands, but drought and unpredictable rain in the valleys. These differences in the local spatial scale do not show up in scientific climate change models [27].

Third, Indigenous knowledge can help build resilience, not only for Indigenous communities but society as a whole, when collaborative networks include researchers and policy-makers. For example, in Canada, regional and national policies have benefited from Indigenous knowledge and experience in two areas of environmental change: Arctic ecosystem contamination and climate change impacts and adaptations [28]. The co-production of knowledge and collaboration through mechanisms such as natural resource co-management lead to mutual learning at multiple levels of governance from local to national. The beginnings of co-management in Taiwan between the government and some Indigenous groups with regard to wildlife and forest management are very important in this regard.

Collaborative networks facilitate social learning, and social learning is key to learning-by-doing, also known as adaptive management and, more broadly, as adaptive governance. Many countries have typically practiced top-down management, with no history of user participation and community–government collaboration. In such cases, collaborative networks may take years before they become functional. Joint problem-solving and learning-as-participation are good ways to start collaboration to build trust among the parties.

Indigenous knowledge is essential for monitoring disaster-shocks and understanding environmental change because it provides on-the-ground information. However, Indigenous knowledge has to be used with caution because it has a cultural context—it is a body of knowledge, practice and belief. This is one of the reasons why scientists and governments sometimes dismiss Indigenous knowledge. Another reason is the politics of knowledge: there will always be power differences between Indigenous knowledge and government science. The key to knowledge co-production is to respect the integrity of each way of knowing, and in particular, not using Indigenous knowledge outside its cultural context. Knowledge systems can be used in parallel and can be "bridged" [25,29]. That is, they can be used together respectfully without mixing them or trying to test one against the other.

To summarize, lessons from the international literature indicate that Indigenous knowledge is useful in understanding environmental change. For example, local knowledge shows fine-scale differences in climate change impacts (e.g., valleys vs. highlands in Bolivia), whereas global and regional climate change models are simply too coarse to show this. Indigenous knowledge and local practice often indicate existing adaptations to

climate variability, and potential new adaptations made possible by experimentation and adaptation. In both the Peru and Bolivia examples, local knowledge drives adaptations that keep options open, hence providing resilience. These cases are not unique. Savo et al. [11] discovered and reviewed 1017 studies of local observations of climate change impacts and adaptations throughout the world. The surprisingly large number of cases indicates that local observations and knowledge are now part of the international effort to understand and deal with environmental change.

4. Taiwan: Unique Lessons and Considerations

Taiwan is a unique environment in which to explore Indigenous resilience to disasters. Consisting of the main island and some 121 others, Taiwan is a democratic regime in East Asia, rich in both biological and cultural diversity [30,31]. Taiwan's topography enables an unusual diversity of ecosystems from mountain tops to the seashore. Only 142 km wide, the main island contains over 200 peaks over 3000 m, the highest reaching nearly 4000 m. Set along the "Ring of Fire" and marking the border between two tectonic plates, Taiwan is often plagued by quakes and landslides.

Due to its location in the Pacific Rim and its mountainous topography, Taiwan is increasingly affected by typhoons and related disasters, such as floods, landslides and debris flows. High and steep mountains are erosion-prone; rivers can turn into torrents running the short distance from the upper slopes to the sea. That makes mountain communities and infrastructure such as roads difficult to maintain. The rapid flow of water from the mountains is hard to control, and necessitates building reservoirs to meet water needs.

Taiwan has a complex colonial history. Since the 17th century, the Spanish, Dutch, Chinese, Japanese and others have come to trade with or colonize Taiwan. The multiple colonial history has meant ever-changing governing policies of the colonists impacting the population and the environment in various ways. To put this into the framework of nature–culture interactions, Taiwan is relatively small but very complex. One spectacular advantage of this is that one can visit very different social-ecological systems on a one-day trip!

Taiwan and its offshore islands are home to 16 officially recognized Indigenous groups ("yuan-chu-min-zu"; 原住民族) as well as other local or unofficially recognized groups (Figure 1). Taiwan is a settler society like the United States, Canada and Australia. The Indigenous peoples are Austronesian in general, and they were living on Taiwan long before the mass immigration of Han Chinese from southern China began in the 17th century. The plains and fertile lands have been occupied by the Han Chinese. In the process of modernization, most of the plains area has become urbanized. Indigenous communities occupy the mountainous interior and the rugged eastern coast. Indigenous peoples in Taiwan accounted for 573,086 people in 2020 (2.4% of the island's total population), of whom 287,789 lived in Indigenous tribal communities [32].
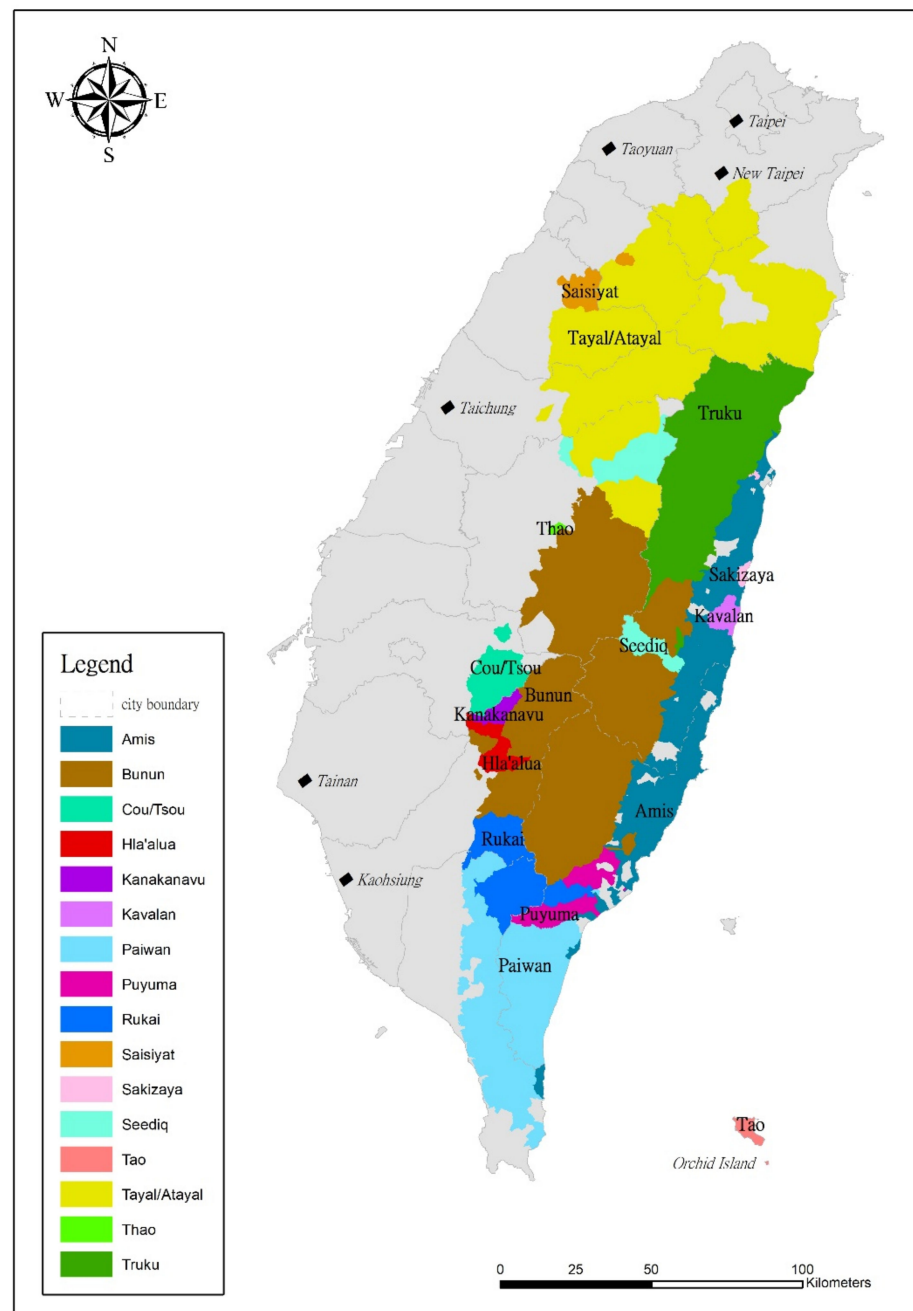
Figure 1. Map of Indigenous territories in Taiwan (prepared by Hsu, Y.Y. and Bayrak, M.M., National Taiwan Normal University, based on Dept. of Household Registration [33]).

The 16 official Indigenous groups all have their distinctive languages and cultures. The land and biodiversity of Taiwan are understood and used in the traditional ways of these groups, such as through naming, material practices, social institutions and worldviews. Assuming that each tribe has a unique understanding of Taiwan's biodiversity, Taiwan has at least 16 different sets of biodiversity through the lens of its Indigenous languages. This constitutes a very rich treasure of biocultural diversity, not just biological diversity or cultural diversity per se [26,34]. The most diverse and rich ecosystems of the island are maintained as national reserves, many of them home to Indigenous peoples who have knowledge and understandings of these areas better than others. Indigenous cultures have wisdom accumulated from interacting with their lands and changing environments. However, at the same time, Indigenous peoples have been treated as a threat to national

reserves and biodiversity. These are important issues for resilience studies, and Taiwan has a lot to offer.

Partly due to geography, but also due to colonial legacy and political economy, Taiwan's Indigenous peoples are disproportionately affected by climate change and other disasters. Bayrak et al. (in this Special Issue) found that of all recorded instances of extreme climate-related events between 2006 and 2020 (which are related to, but not necessarily caused, by climate change), 43% occurred or directly impacted Indigenous communities [35]. Typhoon Morakot in 2009 had perhaps the most profound impact on Indigenous and rural communities in Taiwan in recent history. Typhoon Morakot caused 699 deaths, destroyed 1766 houses and displaced 4500 residents [36]. The responses from the government, civil society organizations and Indigenous communities themselves during and after Morakot included disaster relief, resettlement, and recovery, and became a focus of studies after 2009 [37].

Politically, Taiwan's Indigenous peoples have been gaining political legitimacy, recognition, and the ability to revive their customs and languages. However, centuries of colonization, assimilation, and modernization have left deep and profoundly negative impacts. There are many land use and nature conservation-related conflicts between Indigenous peoples and government agencies, private stakeholders, and even among Indigenous communities themselves [38–42].

The recognition of Indigenous knowledge and the consideration of Indigenous resilience in Taiwan are closely intertwined with democratization processes in this young and independent political regime. Particularly important for Indigenous peoples is the name rectification in the constitutional amendment of 1991. Since then, "yuan-chu-min" (原住民, Indigenous people) has become the formal title to replace "mountain people", or even worse, the discriminatory and offensive title, "fan-jen" (蕃人, barbarian).

Changes have not come easy. Waves of social movements, including those on Indigenous peoples' rights, made a great effort to promote Indigenous peoples and discourses related to their oppressed situation, consistent with international norms. Article 26 (2) of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) contemplates the rights of Indigenous peoples to own, use, develop and control their lands, territories and resources.

In 2000, another major leap for Indigenous people's rights was achieved through the "New Partnership Policy" adopted by the then new President of Taiwan. The President promised to respect traditional customary law and facilitate the co-management of natural resources and the recognition of land rights [43]. Subsequently, the "Indigenous Basic Law" was enacted in 2005. Indigenous peoples' issues have become significant in the political agenda and in election campaigns. In 2016, the transitional justice issue that closely embodies Taiwan's democratic process appeared on the agenda. This then led to the formal Presidential apology to Indigenous peoples in the same year.

Overall, the role of Indigenous peoples has been promoted in Taiwan's civil society at significant speed since about 1990. The democratization of Taiwan has brought forth Indigenous voices. The social dimension of resilience studies pays particular attention to democratic participation, mutual learning, networking and local knowledge. It seems interesting that the struggle history of Indigenous peoples and decolonizing processes parallel the growth of democratic processes in Taiwan.

In this context, multiple hazards and environmental threats have created new opportunities for society to reorganize disaster management to include Indigenous concerns. This led to a new collaborative learning environment involving science, government, and local community. The new partnerships were made possible through legislative support, institutional transitioning and multilevel disaster governance [37,44,45], providing the context for making sense of Taiwan's experience with disasters.

5. Dealing with Disaster-Shocks: The Taiwan Experience

Since the devastating effects of Typhoon Herb in 1996, Typhoon Mindulle in 2004 and Typhoon Morakot in 2009, Taiwanese academia assumed a leadership role in disaster management, DRR and post-disaster recovery among Indigenous communities. We arrived at this conclusion after having analyzed 111 peer-reviewed studies on Indigenous peoples, climate change and resilience since Typhoon Morakot (see also Bayrak et al. in this Special Issue). We found that 76 of these (68.5%) have dealt with one of the four stages of disaster management or DRR, ranging from risk perception to post-disaster recovery. Most of these studies were written in the context of Typhoon Morakot (Table 2).

Table 2. Number of publications in Taiwan since 2009 on climate change, resilience, disaster resilience and indigenous peoples, in peer-reviewed publications indexed in Scopus or Airiti Library.

Subject/Purpose	International (Mostly English)	Domestic (Mostly Chinese)	Total
Disaster management	26	50	76
Indigenous culture	17	22	39
Indigenous knowledge and wisdom	11	16	27
Community development	20	6	26
Housing and architecture	5	12	17
Indigenous health	8	7	15
Indigenous tourism	7	4	11
Traditional agriculture	6	2	8
Climate justice	4	4	8
Adaptive governance	4	0	4
Indigenous education	0	1	1

There are many lessons to be learned from Taiwan. The Taiwanese government shifted a significant amount of funding towards research projects on Indigenous peoples and DRR, resulting in a substantial number of studies, encompassing a variety of views and perspectives. For example, Wang et al. [46] employed a community resilience model to discover the drivers of successful post-disaster recovery. These drivers were: effective use and coordination of community resources, private-public sector partnership building, and positive values among community members (such as a sense of mutual help, sharing of social and economic assets, and autonomy). Other studies on Taiwan's post-disaster response [47–49] showed that some cases of DRR have been culturally inappropriate.

For example, after Typhoon Morakot, several historically rival Indigenous groups were resettled in the same villages. Reconstructed villages were often planned without the necessary input from the new residents [47,50]. Additionally, insufficient attention was given to the farming and livelihood practices of the resettled groups. Indigenous households were unable to resell their homes or return to their old farming and hunting grounds [48,50]. Based on these criticisms, Taiban et al. [49] concluded that post-disaster policies for Indigenous communities should be land-based and culturally appropriate in order to enhance community resilience in a post-disaster setting.

Studies on Taiwan have adopted various resilience or vulnerability approaches, such as community resilience [46,49], social and cultural vulnerability [36] and livelihood vulnerability [51]. However, these approaches have not always been embedded in a particular Indigenous context. Power relations are part of that context. One of the more promising approaches in the literature has been procedural vulnerability. Procedural vulnerability arises "from people's (and peoples') relationships to power rather than environment, and the ways that power is exercised" (p. 309) [52]. Historical vulnerabilities and power relations have shaped contemporary disaster management among Taiwan's Indigenous peoples, and therefore also their resilience to environmental change.

Indigenous knowledge and wisdom (including TEK, ILK and IK) has been another important theme or approach in the literature (24%). Some studies have linked knowledge to DRR or climate change adaptation. Examples include studies on traditional farming

methods [53,54], Indigenous ecological knowledge and disaster management [55], and traditional knowledge and risk perceptions [56]. Lin and Chang [57] argue that local knowledge plays a substantive role in disaster risk management. They introduce a new type of knowledge, which they define as involuted disaster knowledge, which integrates Indigenous knowledge with scientific knowledge. Significantly, many studies on Indigenous knowledge and wisdom have been written, either as first author or co-author, by Taiwanese Indigenous peoples themselves (i.e., [54–56,58–60]).

Among the analyzed publications, four studies addressed themes of adaptive governance and management [57,61–63]. Tai developed a framework on adaptive governance aimed to be deliberative, multi-layered, just, networked and participatory [61]. Lin and Chang [57] called for an inclusive form of disaster governance that fits "into local contexts and have the capacity to solve community problems" (p. 8). As Taiwanese Indigenous peoples are actively asserting their political rights to restore their customary territories, new modes of adaptive governance are needed to govern and manage these territories. Studies on adaptive governance in the context of land and resources, as well as in disaster management, are therefore crucial.

Social learning is widely acknowledged in the analyzed studies as being important for strengthening social-ecological resilience, community resilience [46], post-disaster recovery [49], knowledge creation [57], and adaptive governance [61]. A study of Yen and Chen [53] involved a series of workshops, which served as social learning platforms for local Tayal farmers to exchange knowledge on sustainable agriculture and agricultural adaptation. As pointed out by Gerlak et al. [64], many studies, in Taiwan and internationally, lack a clear conceptualization and operationalization of (social) learning. Empirically, it has also not been clear how social learning has shaped Indigenous resilience and adaptive governance in Taiwan.

Typhoon Morakot was a "focusing event", defined as "a sudden, exceptional experience that, because of how it leads to harm or exposes the prospect for great devastation, is perceived as the impetus for policy change" (p. 983) [65]. The disastrous consequences of Morakot led to policy change, which enabled a substantial amount of government funding to be channeled towards Indigenous community resettlement, post-disaster recovery, academic research, and DRR [36,49]. As the impact of Morakot was disproportionally severe for Taiwan's Indigenous communities [36], many studies consequently shifted attention to Indigenous-related issues.

While this shift is important, future studies could more explicitly focus on the role of social learning in shaping Indigenous resilience and adaptive governance. This could be carried out at multiple levels from local to national, as well as over time, i.e., longitudinal or ex-post approaches. The scholarship in Taiwan on Indigenous peoples, climate change impacts, and disaster risk reduction is strong. While there is an increasing amount of studies on Indigenous knowledge [55,66–71] and community resilience, more work is warranted on social learning and adaptive governance in the context of environmental change.

6. Towards Adaptive Governance with Indigenous Resilience

Acknowledging the right of Indigenous peoples as self-determining entities that can define their own means of shaping the future, how do we foster Indigenous aspirations for dealing with disasters? This is a question of governance. Indigenous knowledge helps people to understand environmental change and respond to it. It is a major factor in building Indigenous resilience and in facilitating adaptive governance. Although Indigenous knowledge and participation have contributed to the response to disaster-shocks in Taiwan, the concept of Indigenous resilience [6] remains to be developed, as indicated by the literature review in the previous section. The present section deals with the policy implications of these findings and the way ahead. Specifically, we discuss the prospects toward adaptive governance using Indigenous knowledge and learning.

Perhaps the major lesson from the literature is the importance of building capacity for learning and adapting (i.e., the resilience approach) for adaptive governance. Approaching

disaster risk reduction through social learning can build resilience in the face of rapid change and unpredictable events. This, we argue, is a key requirement for disaster preparedness, given the context of global change, uncertainty and the suddenness of most disaster-shocks. Learning-based adaptive governance has a better record in dealing with surprises than conventional management, which embodies assumptions of predictability and controllability [6,12,72].

Dealing with unpredictable events, such as extreme weather events, is a very difficult task for governments. Using Indigenous knowledge to build resilience and adopting a learning approach can help deal with unpredictability. The term adaptive governance captures this flexible, integrated, holistic form of governance. Governance is considered the broader arena in which institutions operate; it is used here as a more inclusive term than management. Adaptive governance is governance that incorporates social learning to improve outcomes in an iterative way; in our case, from one disaster-risk reduction and recovery case to the next [57].

Adaptive governance is a research framework for analyzing social, institutional, economic and ecological aspects of governance for building resilience. It is an outgrowth of the search for modes of managing uncertainty and complexity [73]. Adaptive governance is based on learning-by-doing, and builds on social learning and experience. In contrast to individual learning, social learning is learning at the level of groups, including institutions. Adaptive governance is an ongoing process. As Pahl-Wostl and Hare [74] put it, it "is not a search for the optimal solution to one problem but an ongoing learning and negotiation process where a high priority is given to questions of communication, perspective sharing, and the development of adaptive group strategies for problem solving" (p. 193).

The key to adaptive governance is social learning and the co-production of knowledge: the art of combining different kinds of knowledge to solve problems [24]. Local and Indigenous knowledge can create opportunities for problem-solving through local collective action and self-organization, assisted by government science. Intermediary organizations, such as universities and non-governmental organizations, help perceive and assess disaster-shocks, and respond and adapt to them. Learning-by-doing can be made more effective by (1) co-management, the sharing of power and responsibility for making decisions; (2) participatory research involving local people and scientists/managers working together; and (3) capacity development (capacity-building) to improve the ability to deal with problems.

Co-management is important for setting the stage. Participatory research is effective for social learning and also results in trust-building, especially important in situations in which there is no previous experience of working together. Capacity development helps cooperation and communication, for example, by sharing technical vocabulary and concepts. It also helps to tackle problems at increasingly greater scales, starting with small problems and moving onto larger ones. Essential ingredients of adaptive governance include linkages at multiple levels, allowing two-way communication from local to national. Co-management and participatory research can give rise to problem-solving networks, sometime called learning communities, which are informal groups of people who collaboratively apply their knowledge. These measures have the potential to facilitate knowledge co-production for mutual learning.

To recap, resilience-building, social learning with Indigenous knowledge and science, and adaptive governance are significant for the ability to respond to risks and hazards. They help the ability to respond to climate change impacts and other disaster-shocks. Funding and encouragement of disaster-response studies in Taiwan are extremely important in this regard. Indigenous resilience shows promise to be effective in dealing with unpredictable events. Useful Indigenous knowledge exists, for example, in the area of water management in Taiwan [62]. Intermediary organizations such as universities have an important role to play as partners in bridging different kinds of knowledge; developing capacity; assisting with communication; supporting local institutions; and fostering social learning.

Emphasis on social learning, with ongoing adjustments in governance, makes adaptive governance dynamic. This calls for a willingness to experiment with innovative policies and practice in the face of uncertainty [72]. The active engagement of local people, including Indigenous peoples, through democratic participation is crucially important. Multiple voices are needed to generate innovative practices and governance options [75]. Indigenous resilience, driven and controlled by local communities, and characterized by place-based knowledge, social learning, collective action and empowerment, is an essential part of the way ahead in dealing with disaster-shocks.

7. Introduction to the Papers of the Special Issue

This Special Issue brings together several papers on Taiwan and international case studies on local and Indigenous resilience to environmental change (see Appendix A for the full list of papers). We identify five (overlapping) themes: (1) Indigenous resilience and knowledge systems; (2) Social learning and adaptive governance; (3) DRR and disaster management; (4) International case studies; and (5) Academic and policy dialogues towards a new policy agenda on Indigenous resilience.

In terms of Indigenous resilience and knowledge systems, authors have focused on local marine-area management among coastal Amis communities (Futuru C.L. **Tsai**), seeing Indigenous resilience through a foodscape lens in the face of global climate change among Tayal communities (Yih-Ren **Lin** et al.), and building Indigenous resilience after Typhoon Soudelor (Su-Hsin **Lee** and Yin-Jen **Chen**). Studies in this Special Issue show how Indigenous resilience should be better situated within broader livelihood strategies, social-ecological dynamics, and Indigenous worldviews and knowledge systems. Authors such as Yih-Ren **Lin** et al. and Yayut Yishiuan **Chen** highlight the importance of decolonizing knowledge and Indigenous counter-stories of resilience and sustainability. This would serve to understand how Taiwan's Indigenous peoples cope with, adapt to, and transform negative impacts of climatic and other environmental stressors and shocks. More than "giving voice" to Indigenous people, it is imperative to understand and listen to Indigenous narratives and knowledges towards creating resilient social-ecological systems which can cope with broader social, environmental and climate-related challenges.

The second theme is social learning and adaptive capacity. Futuru C.L. **Tsai**, Yayut Yishiuan **Chen** and Yih-Ren **Lin** et al. show in great detail how Indigenous communities engage in social learning, and how this is linked to community-building, agriculture and food systems, local ecosystem management, traditional institutions, and worldviews and belief systems. Yayut Yishiuan **Chen** understands resilience from Tayal's "ontological understandings of their place in the world" (p. 2), which requires a completely new paradigm and mindset towards Indigenous resilience. The paper by Joyce Hsiu-yen **Yeh** et al. further shows how the transformation and innovation of Indigenous cultural heritage provide Taiwanese Indigenous peoples additional possibilities to create culturally appropriate development interventions, which can help them to cope better with the challenges of contemporary society and environmental change.

Futuru C.L. **Tsai** and Hsing-Sheng **Tai** discuss the adaptive governance of Indigenous communities. Both studies highlight in detail the struggles that communities face with top-down government planning. While participatory governance regimes are starting to emerge (such as community-based natural-resource management), Hsing-Sheng **Tai** concludes that social-ecological resilience in Taiwan has "focused on ecological resilience and the well-being of Han society" (p. 16). If so, this is problematic as there is a growing awareness among many policy-makers and scholars in Taiwan that Indigenous communities are disproportionally affected by typhoons and other disaster shocks (Mucahid Mustafa **Bayrak** et al.) and their needs require attention too.

Regarding the third theme, DRR and disaster management, Mucahid Mustafa **Bayrak** et al. have effectively shown in their bibliometric analysis and literature review that Taiwan has assumed a leadership position in this field. Two papers stand out which deal with this theme: the papers of Pei-Shan Sonia **Lin** and Wei-Cheng **Lin,** and Su-Hsin **Lee** and

Yin-Jen **Chen**. The former focusses on post-disaster recovery among Tsou communities after Typhoon Morakot, whereas the latter highlights the coping strategies during and after typhoon Soudelor among Tayal communities. The cultural dimensions related to how Indigenous peoples cope with climate disasters should play a more prominent position in DRR and post-disaster recovery efforts according to both studies. Pei-Shan Sonia **Lin** and Wei-Cheng **Lin** state: "shared culture positively influences cohesion within an ethnic group, allowing communities affected by disasters to jointly strengthen, preserve, and sustain their identity" (p. 13).

The fourth theme of this Special Issue is related to international cases. The study of Gerard A. **Persoon** and Tessa **Minter** shows how four Indigenous communities in Indonesia and the Philippines have reacted to external development interventions and how climate change impacted their ways of life. This study is particularly valuable as many parallels could be drawn between Taiwan's Indigenous peoples and the Indigenous peoples of insular Southeast Asia. The papers by Ephias **Mugari** et al. and Muhamad Khoiru **Zaki** et al. both employ quantitative methods. The former identified the underlying drivers influencing Indigenous climate change response in Botswana, whereas the latter focused on how local and Indigenous knowledge systems helped communities cope with changing weather events and droughts in Indonesia. Two additional papers focus on Pacific Island states. Jan **van der Ploeg** et al. include a discourse analysis on the "sinking islands" narrative, and argue that this narrative detracts attention and resources from more urgent environmental and development problems. The paper by Janne **von Seggern** employed a meta-ethnographic approach in order to analyze studies focusing on local and Indigenous climate change adaptation and mitigation strategies in selected South Pacific Island States.

The fifth and last theme is about generating a conversation among scholars, Indigenous peoples, and policy-makers to move the agenda forward. All papers have policy implications, but the two papers by Gregory A. **Cajete** and Richard **Howitt**, both keynote addresses at the December 2019 conference, provide particularly important policy considerations towards a new agenda on Indigenous resilience to environmental change.

Richard **Howitt** argues that Indigenous vulnerability and resilience need to be understood in the messy contexts of lived experience: "policy, science and practice all need to develop a much more sophisticated literacy in the scale politics of responding to the risk landscapes that Indigenous groups negotiate" (p. 2). Researchers need to engage with the knowledges, ontologies and experiences of Indigenous peoples meaningfully, considering their specific histories, geographies and impacts of colonialization: "Climate risks render Indigenous groups more vulnerable, not because of their indigeneity, but because their lives are so often marked by intergenerational legacies and the newly created scars of colonialism" (p. 11). Hence, decolonizing people and places is part of the approach to nurture Indigenous self-determination in rethinking the geopolitics of Indigenous resilience.

Gregory A. **Cajete**, an Indigenous scholar himself, articulates some foundational considerations toward a framework for thinking about Indigenous community-building and development, as illustrated with Taiwan examples by Joyce Hsiu-yen **Yeh** et al. Directly addressing Indigenous peoples, he argues that Indigenous science is not subordinate to western science: "we have ancient systems of extended family, clan, and tribal relationships that we can mobilize in positive ways to implement sustainable changes in our economies" (p. 10). These Indigenous ways of sustainability could be translated into the present through Indigenous community-building and science curricula development toward culturally responsive models—models that strengthen Indigenous societies and develop capacity for new forms of economic development, self-determination, and ways of dealing with adversity, including disasters.

The engaged scholarship of this Special Issue encourages the readers of Sustainability and other scholars to critically reflect upon the various insights and lessons learnt on Indigenous resilience in the context of Taiwan and beyond. The recognition of Indigenous issues in Taiwan is closely intertwined with democratization processes. The emergence of

Indigenous voices, Indigenous knowledge, and the consideration of Indigenous resilience to environmental change are not apolitical processes, but rather related to democratization by direct participation. The engagement of more scholars and practitioners with comprehensive studies and applications of Indigenous resilience is needed. In doing so, we hope that Taiwan's Indigenous peoples, as well as all other Indigenous peoples, are at the forefront of this new paradigm shift.

Appendix A

Table A1. List of papers belonging to the Special Issue (ordered according to Section 7's themes).

No.	Full Bibliography
1	Tsai, F. Shuttling between Land and Sea: Contemporary Practices among Amis Spearfishing Men as a Foundation for Local Marine-Area Management. *Sustainability* **2020**, *12(18)*, 7770; https://doi.org/10.3390/su12187770
2	Lin, Y.; Tomi, P.; Huang, H.; Lin, C.; Chen, Y. Situating Indigenous Resilience: Climate Change and Tayal's "Millet Ark" Action in Taiwan. *Sustainability* **2020**, *12(24)*, 10676; https://doi.org/10.3390/su122410676
3	Lee, S.; Chen, Y. Indigenous Knowledge and Endogenous Actions for Building Tribal Resilience after Typhoon Soudelor in Northern Taiwan. *Sustainability* **2021**, *13(2)*, 506; https://doi.org/10.3390/su13020506
4	Chen, Y. Decolonizing Methodologies, Situated Resilience, and Country: Insights from Tayal Country, Taiwan. *Sustainability* **2020**, *12(22)*, 9751; https://doi.org/10.3390/su12229751
5	Yeh, J.H.-y.; Lin, S.-c.; Lai, S.-c.; Huang, Y.-h.; Yi-fong, C.; Lee, Y.-t.; Berkes, F. Taiwanese Indigenous Cultural Heritage and Revitalization: Community Practices and Local Development. *Sustainability* **2021**, *13(4)*, 1799; https://doi.org/10.3390/su13041799
6	Tai, H. Resilience for Whom? A Case Study of Taiwan Indigenous People's Struggle in the Pursuit of Social-Ecological Resilience. *Sustainability* **2020**, *12(18)*, 7472; https://doi.org/10.3390/su12187472
7	Bayrak, M.; Hsu, Y.; Hung, L.; Tsai, H.; 'e vayayana, t. Global Climate Change and Indigenous Peoples in Taiwan: A Critical Bibliometric Analysis and Review. *Sustainability* **2021**, *13(1)*, 29; https://doi.org/10.3390/su13010029
8	Lin, P.; Lin, W. Rebuilding Relocated Tribal Communities Better via Culture: Livelihood and Social Resilience for Disaster Risk Reduction. *Sustainability* **2020**, *12(11)*, 4538; https://doi.org/10.3390/su12114538

Table A1. *Cont.*

No.	Full Bibliography
9	Persoon, G.; Minter, T. Knowledge and Practices of Indigenous Peoples in the Context of Resource Management in Relation to Climate Change in Southeast Asia. *Sustainability* **2020**, *12(19)*, 7983; https://doi.org/10.3390/su12197983
10	Mugari, E.; Masundire, H.; Bolaane, M. Adapting to Climate Change in Semi-Arid Rural Areas: A Case of the Limpopo Basin Part of Botswana. *Sustainability* **2020**, *12(20)*, 8292; https://doi.org/10.3390/su12208292
11	Zaki, M.; Noda, K.; Ito, K.; Komariah, K.; Sumani, S.; Senge, M. Adaptation to Extreme Hydrological Events by Javanese Society through Local Knowledge. *Sustainability* **2020**, *12(24)*, 10373; https://doi.org/10.3390/su122410373
12	van der Ploeg, J.; Sukulu, M.; Govan, H.; Minter, T.; Eriksson, H. Sinking Islands, Drowned Logic; Climate Change and Community-Based Adaptation Discourses in Solomon Islands. *Sustainability* **2020**, *12(17)*, 7225; https://doi.org/10.3390/su12177225
13	von Seggern, J. Understandings, Practices and Human-Environment Relationships—A Meta-Ethnographic Analysis of Local and Indigenous Climate Change Adaptation and Mitigation Strategies in Selected Pacific Island States. *Sustainability* **2021**, *13(1)*, 11; https://doi.org/10.3390/su13010011
14	Howitt, R. Decolonizing People, Place and Country: Nurturing Resilience across Time and Space. *Sustainability* **2020**, *12(15)*, 5882; https://doi.org/10.3390/su12155882
15	Cajete, G. Indigenous Science, Climate Change, and Indigenous Community Building: A Framework of Foundational Perspectives for Indigenous Community Resilience and Revitalization. *Sustainability* **2020**, *12(22)*, 9569; https://doi.org/10.3390/su12229569

References

1. Steffen, W.; Broadgate, W.; Deutsch, L.; Gaffney, O.; Ludwig, C. The trajectory of the Anthropocene: The Great Acceleration. *Anthr. Rev.* **2014**, *2*, 81–98. [CrossRef]
2. IPCC. *Climate Change 2014: Summary for Policymakers*; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2014.
3. UNDRR. What Is the Sendai Framework? 2020. Available online: https://www.undrr.org/implementing-sendai-framework/what-sendai-framework (accessed on 9 November 2020).
4. Alexander, D.; Davis, I. Disaster risk reduction: An alternative viewpoint. *Int. J. Disaster Risk Reduct.* **2012**, *2*, 1–5. [CrossRef]
5. Lambert, S.J.; Scott, J.C. International Disaster Risk Reduction Strategies and Indigenous Peoples. *Int. Indig. Policy J.* **2019**, *10*, 1–21. [CrossRef]
6. Ford, J.D.; King, N.; Galappaththi, E.K.; Pearce, T.; McDowell, G.; Harper, S.L. The Resilience of Indigenous Peoples to Environmental Change. *One Earth* **2020**, *2*, 532–543. [CrossRef]
7. Brown, K. *Resilience, Development and Global Change*, 1st ed.; Routledge: New York, NY, USA; London, UK, 2015; ISBN 978-0-415-66347-2.
8. Walker, B.; Holling, C.S.; Carpenter, S.R.; Kinzig, A.P. Resilience, Adaptability and Transformability in Social-ecological Systems. *Ecol. Soc.* **2004**, *9*, 9. [CrossRef]
9. Berkes, F.; Ross, H. Community Resilience: Toward an Integrated Approach. *Soc. Nat. Resour.* **2013**, *26*, 5–20. [CrossRef]
10. Gómez-Baggethun, E.; Corbera, E.; Reyes-García, V. Traditional Ecological Knowledge and Global Environmental Change: Research findings and policy implications. *Ecol. Soc.* **2013**, *18*. [CrossRef]
11. Savo, V.; Lepofsky, D.; Benner, J.P.; Kohfeld, K.E.; Bailey, J.; Lertzman, K. Observations of climate change among subsistence-oriented communities around the world. *Nat. Clim. Chang.* **2016**, *6*, 462–473. [CrossRef]
12. Berkes, F. Environmental Governance for the Anthropocene? Social-Ecological Systems, Resilience, and Collaborative Learning. *Sustainability* **2017**, *9*, 1232. [CrossRef]
13. Salick, J.; Ross, N. Traditional peoples and climate change. *Glob. Environ. Chang.* **2009**, *19*, 137–139. [CrossRef]
14. IPCC. *Climate Change 2007: Synthesis Report*; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2007.
15. Berkes, F.; Jolly, D. Adapting to Climate Change: Social-Ecological Resilience in a Canadian Western Arctic Community. *Conserv. Ecol.* **2002**, *5*. [CrossRef]
16. Ford, J.D.; Cameron, L.; Rubis, J.; Maillet, M.; Nakashima, D.; Willox, A.C.; Pearce, T. Including indigenous knowledge and experience in IPCC assessment reports. *Nat. Clim. Chang.* **2016**, *6*, 349–353. [CrossRef]
17. Haque, C.E.; Etkin, D. *Disaster Risk and Vulnerability: Mitigation through Mobilizing Communities and Partnerships*; Illustrated Edition; McGill-Queen's University Press: Montreal, QC, Canada, 2012; ISBN 978-0-7735-3992-1.
18. Clarvis, M.H.; Bohensky, E.; Yarime, M. Can Resilience Thinking Inform Resilience Investments? Learning from Resilience Principles for Disaster Risk Reduction. *Sustainability* **2015**, *7*, 9048–9066. [CrossRef]

19. Berkes, F.; Folke, C. Back to the Future: Ecosystem Dynamics and Local Knowledge. In *Panarchy: Understanding Transformations in Human and Natural Systems*; Gunderson, L.H., Holling, C.S., Eds.; Island Press: Washington, DC, USA, 2002; pp. 121–146; ISBN 978-1-55963-857-9.

20. Berkes, F. Indigenous ways of knowing and the study of environmental change. *J. R. Soc. New Zealand* **2009**, *39*, 151–156. [CrossRef]

21. Murti, R.; Mathez-Stiefel, S.-L. Social learning approaches for ecosystem-based disaster risk reduction. *Int. J. Disaster Risk Reduct.* **2019**, *33*, 433–440. [CrossRef]

22. Berkes, F. *Sacred Ecology*, 4th ed.; Routledge: New York, NY, USA; London, UK, 2018; ISBN 978-1-351-62830-3.

23. Díaz, S.; Pascual, U.; Stenseke, M.; Martín-López, B.; Watson, R.T.; Molnár, Z.; Hill, R.; Chan, K.M.A.; Baste, I.A.; Brauman, K.A.; et al. Assessing nature's contributions to people. *Science* **2018**, *359*, 270–272. [CrossRef]

24. Armitage, D.; Berkes, F.; Dale, A.; Kocho-Schellenberg, E.; Patton, E. Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Glob. Environ. Chang.* **2011**, *21*, 995–1004. [CrossRef]

25. Tengö, M.; Brondizio, E.S.; Elmqvist, T.; Malmer, P.; Spierenburg, M. Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. *Ambio* **2014**, *43*, 579–591. [CrossRef]

26. Berkes, F. *Advanced Introduction to Community-Based Conservation*; Edward Elgar: Cheltenham, UK; Northampton, MA, USA, 2021; ISBN 978-1-83910-224-0.

27. Boillat, S.; Berkes, F. Perception and Interpretation of Climate Change among Quechua Farmers of Bolivia: Indigenous Knowledge as a Resource for Adaptive Capacity. *Ecol. Soc.* **2013**, *18*, 18. [CrossRef]

28. Berkes, F.; Armitage, D. Co-management institutions, knowledge, and learning: Adapting to change in the Arctic. *Études/Inuit/Studies* **2010**, *34*, 109–131. [CrossRef]

29. Berkes, F.; Reid, W.V.; Wilbanks, T.J.; Capistrano, D. *Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment*; Reid, W.V., Berkes, F., Wilbanks, T., Capistrano, D., Eds.; Illustrated edition; Millennium Ecosystem Assessment and Island Press: Washington, DC, USA, 2006; ISBN 978-1-59726-037-4.

30. Simpson, S.; Tsai, H.-M.; Chen, C.-J. *Island of Diversity: Nature Conservation in Taiwan, R.O.C.*; Ministry of Interior and Council of Agriculture: Taipei, Taiwan, 1992; ISBN 978-957-00-0892-0.

31. Baldacchino, G.; Tsai, H.-M. Contested enclave metageographies: The offshore islands of Taiwan. *Politi Geogr.* **2014**, *40*, 13–24. [CrossRef]

32. Council of Indigenous Peoples Confirmed Tribe Area. Available online: https://www.cip.gov.tw/portal/docList.html?CID=7CDD0E527E32B424 (accessed on 1 December 2020).

33. Department of Household Registration, Ministry of the Interior, Taiwan Demographic Database. Available online: https://www.ris.gov.tw/app/portal/346 (accessed on 1 December 2020).

34. Frainer, A.; Mustonen, T.; Hugu, S.; Andreeva, T.; Arttijeff, E.-M.; Arttijeff, I.-S.; Brizoela, F.; Coelho-De-Souza, G.; Printes, R.B.; Prokhorova, E.; et al. Opinion: Cultural and linguistic diversities are underappreciated pillars of biodiversity. *Proc. Natl. Acad. Sci. USA* **2020**, *117*, 26539–26543. [CrossRef]

35. Soil and Water Conservation Bureau, COA Extreme Disaster Event. Available online: https://246.swcb.gov.tw/?lang=en (accessed on 1 December 2020).

36. Lin, J.-J.; Lin, W.-I. Cultural issues in post-disaster reconstruction: The case of Typhoon Morakot in Taiwan. *Disasters* **2016**, *40*, 668–692. [CrossRef] [PubMed]

37. Liu, T.-J. Impact of Recent Climate Disasters on Taiwan Aborigines and their Adjustment. In *Proceedings of Climate Change Adaptation and Responses Policies in Taiwan and the Pacific Austronesian Peoples*; Research Center for Environmental Change, Ed.; Academia Sinica: Taipei, Taiwan, 2014; pp. 20–57.

38. Simon, S. Negotiating power: Elections and the constitution of indigenous Taiwan. *Am. Ethnol.* **2010**, *37*, 726–740. [CrossRef]

39. Simon, S. Yearning for Recognition: Indigenous Formosans and the Limits of Indigeneity. *Int. J. Taiwan Stud.* **2020**, *3*, 191–216. [CrossRef]

40. Li, P.J.-K. *The Ethnic Groups, Languages and Migration of the Formosan Natives*, 1st ed.; National Academy for Educational Research and Bookman Books: Taipei, Taiwan, 2013; ISBN 978-957-445-495-2.

41. Van Bekhoven, J. Identity crisis: Taiwan's laws and regulations on the status of indigenous peoples. *Asia Pac. Law Rev.* **2016**, *24*, 202–232. [CrossRef]

42. Berg, K.J.; Icyeh, L.; Lin, Y.-R.; Janz, A.; Newmaster, S.G. Multiple-factor classification of a human-modified forest landscape in the Hsuehshan Mountain Range, Taiwan. *Ambio* **2016**, *45*, 919–932. [CrossRef] [PubMed]

43. Lin, Y.-R. Politicizing Nature: The Maqaw National Park Controversy in Taiwan. *Capital. Nat. Social.* **2011**, *22*, 88–103. [CrossRef]

44. Tsai, H.-M. Sustainability of Small Islands in Taiwan. In *Sustainable Development for Island Societies: Taiwan and the World*; Hsiao, H.-H.M., Liu, C.-H., Tsai, H.-M., Eds.; Asia-Pacific Research Program of Academia Sinica and SARCS Secretariat at National Central University: Taipei, Taiwan, 2002; pp. 395–408; ISBN 978-957-671-947-9.

45. Lin, K.-H.E.; Tsai, H.-M.; Chang, C.-Y.D. Science and vulnerability reduction in Taiwan after the 1999 Chi-Chi Earthquake. In *Integrating Science and Policy: Vulnerability and Resilience in Global Environmental Change*; Kasperson, R.E., Berberian, M., Eds.; Routledge, Earthscan: London, UK; Washington, DC, USA, 2011; pp. 233–268; ISBN 978-1-84407-606-2.

46. Wang, L.-R.; Chen, S.; Chen, J. Community Resilience after Disaster in Taiwan: A Case Study of Jialan Village with the Strengths Perspective. *J. Soc. Work. Disabil. Rehabil.* **2013**, *12*, 84–101. [CrossRef]

47. Hsu, M.; Howitt, R.; Chi, C.-C. The idea of 'Country': Reframing post-disaster recovery in Indigenous Taiwan settings. *Asia Pac. Viewp.* **2014**, *55*, 370–380. [CrossRef]

48. Huang, S.-M. Heritage and Postdisaster Recovery: Indigenous Community Resilience. *Nat. Hazards Rev.* **2018**, *19*, 05018008. [CrossRef]

49. Taiban, S.; Lin, H.-N.; Ko, C.-C. Disaster, relocation, and resilience: Recovery and adaptation of Karamemedesane in Lily Tribal Community after Typhoon Morakot, Taiwan. *Environ. Hazards* **2020**, *19*, 209–222. [CrossRef]

50. Shieh, C.S.; Fu, T.-S.; Chen, J.-S.; Lin, W.-I. A Road Far Away from the Aboriginal Hometown?-Rethinking the Post-disaster Relocation Policy of Typhoon Morakot. *Ntu Soc. Work Rev.* **2012**, 41–86. [CrossRef]

51. Lin, K.-H.E.; Polsky, C. Indexing livelihood vulnerability to the effects of typhoons in indigenous communities in Taiwan. *Geogr. J.* **2016**, *182*, 135–152. [CrossRef]

52. Hsu, M.; Howitt, R.; Miller, F. Procedural Vulnerability and Institutional Capacity Deficits in Post-Disaster Recovery and Reconstruction: Insights from Wutai Rukai Experiences of Typhoon Morakot. *Hum. Organ.* **2015**, *74*, 308–318. [CrossRef]

53. Yen, A.-C.; Chen, Y.-A. Agroforestry as Sustainable Agriculture: An Observation of Tayal Indigenous People's Collective Action in Taiwan. *Int. J. Environ. Sustain.* **2016**, *13*, 1–16.

54. Ba, Q.-X.; Lu, D.-J.; Kuo, W.H.-J.; Lai, P.-H. Traditional Farming and Sustainable Development of an Indigenous Community in the Mountain Area—A Case Study of Wutai Village in Taiwan. *Sustainability* **2018**, *10*, 3370. [CrossRef]

55. Guan, D.-W. Indigenous Ecological Knowledge and Contemporary Disaster Management A Case Study on the Tayal Communities' Experience in the Watershed of Shih-Men Reservoir. *J. Geogr. Sci.* **2015**, *76*, 97–132. [CrossRef]

56. Roder, G.; Ruljigaljig, T.; Lin, C.-W.; Tarolli, P. Natural hazards knowledge and risk perception of Wujie indigenous community in Taiwan. *Nat. Hazards* **2015**, *81*, 641–662. [CrossRef]

57. Lin, P.-S.S.; Chang, K.-M. Metamorphosis from local knowledge to involuted disaster knowledge for disaster governance in a landslide-prone tribal community in Taiwan. *Int. J. Disaster Risk Reduct.* **2020**, *42*, 101339. [CrossRef]

58. Taiban, S.; Pei, K.; Lu, T.; Ke, W.; Lai, C. Conservation, Development and Relocation: Implementing the Forest Guard System Among the Western Rukai. *J. Taiwan Indig. Stud. Assoc.* **2011**, *1*, 145–174. [CrossRef]

59. Lamuran, S. tibusungu, 'e.v. Tao Traditional Ecological Knowledge and its Value for Sustainability. *J. Geogr. Res.* **2016**, *65*, 143–167. [CrossRef]

60. Lamuran, S.; Hsiao, S.-H.; Tsai, H.-M. Tao People's Response to Modern Environmental Governance and the Development of the Sustainable Environmental Governance. *J. Taiwan Indig. Stud. Assoc.* **2015**, *5*, 1–44.

61. Tai, H.-S. Cross-Scale and Cross-Level Dynamics: Governance and Capacity for Resilience in a Social-Ecological System in Taiwan. *Sustainability* **2015**, *7*, 2045–2065. [CrossRef]

62. Chen, Y.-S.; Suchet-Pearson, S.; Howitt, R. Reframing Indigenous water rights in 'modern' Taiwan: Reflecting on Tayal experience of colonized common property. *Int. J. Commons* **2018**, *12*, 378–401. [CrossRef]

63. Shie, Y.-J. Indigenous legacy for building resilience: A case study of Taiwanese mountain river ecotourism. *Tour. Manag. Perspect.* **2020**, *33*, 100612. [CrossRef]

64. Gerlak, A.K.; Heikkila, T.; Smolinski, S.L.; Huitema, D.; Armitage, D. Learning our way out of environmental policy problems: A review of the scholarship. *Policy Sci.* **2018**, *51*, 335–371. [CrossRef]

65. Michaels, S.; Goucher, N.P.; McCarthy, D. Policy Windows, Policy Change, and Organizational Learning: Watersheds in the Evolution of Watershed Management. *Environ. Manag.* **2006**, *38*, 983–992. [CrossRef] [PubMed]

66. Lin, Y.-R.; Icyeh, L.; Kuan, D.-W. Indigenous language-informed participatory policy in Taiwan: A socio-political perspective. In *Documenting and Revitalizing Austronesian Languages*; Rau, D.V., Florey, M.J., Eds.; LD&C Special Publication No. 1; University of Hawai'i Press: Honolulu, HI, USA, 2007; pp. 134–161; ISBN 978-0-8248-3309-1.

67. Tung, S.-Y. *Time and Rituals: Indigenous Knowledge of Tao People*; Taiwan Archives Commission: Taichung, Taiwan, 1997.

68. Syaman, R. *The Original Affluent Island: Tao Peoples Ocean Knowledge and Culture*; Department of Anthropology, National Tsing Hua University: Hsinchu, Taiwan, 2003.

69. Tsai, H.-M. Rebuilding Social-Ecological Systems for a Resilient Island Future: A Case Study on Pongso-No-Tau (Orchid Island), Taiwan. In Proceedings of the IGU Regional Conference, Changes, Challenges, Responsibility, International Geographical Union, Krakow, Poland, 18 August 2014.

70. vayayana, T.E. kuba-hosa-hupa: A Preliminary Exploration of Taiwan Indigenous Cou Cosmology and Pedagogy. In *Indigenous Knowledge in Taiwan and Beyond*; Shih, S., Tsai, L., Eds.; Sinophone and Taiwan Studies; Springer: Singapore, Singapore, 2021; pp. 35–54; ISBN 9789811541780.

71. Shih, S.; Tsai, L. (Eds.) *Indigenous Knowledge in Taiwan and Beyond*, 1st ed.; Springer: Singapore, 2021; ISBN 9789811541773.

72. Young, O.R. Beyond Regulation: Innovative Strategies for Governing Large Complex Systems. *Sustainability* **2017**, *9*, 938. [CrossRef]

73. Dietz, T.; Ostrom, E.; Stern, P.C. The Struggle to Govern the Commons. *Science* **2003**, *302*, 1907–1912. [CrossRef] [PubMed]

74. Pahl-Wostl, C.; Hare, M. Processes of social learning in integrated resources management. *J. Community Appl. Soc. Psychol.* **2004**, *14*, 193–206. [CrossRef]

75. Charles, A.; Loucks, L.; Berkes, F.; Armitage, D. Community science: A typology and its implications for governance of social-ecological systems. *Environ. Sci. Policy* **2020**, *106*, 77–86. [CrossRef]