The effect of cultural practices and perceptions on global climate change response among Indigenous peoples: a case study on the Tayal people in northern Taiwan

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Keywords: Indigenous peoples, climate change adaptation, Taiwan, Tayal/Atayal people, cultural practices, perceptions on climate change

Supplementary material for this article is available online

Abstract
Many Indigenous peoples are disproportionately affected by global climate change. Current research is focused on how Indigenous adaptation and mitigation strategies can be integrated into mainstream climate change adaptation and mitigation strategies. Through a mixed-methods approach, this study explored the effects of culture and local perceptions on coping strategies and adaptations to climate change among Indigenous communities, of which knowledge is inadequate, with a specific focus on two Indigenous Tayal communities in northern Taiwan (N = 101). From our findings, we developed a typology based on a polychoric factor analysis, which includes four key aspects: commercialized response; experience and anticipation; culture, preparedness and recovery; and external support and institutions. The typology shows that cultural practices and perceptions profoundly shape how Indigenous households respond to climate-related disasters and should therefore be incorporated more comprehensively into climate change adaptation and mitigation policy. Our findings reflect a nuanced understanding of Indigenous peoples' complicated relationship with global climate change. The proposed typology could be used as a theoretical and/or policy-oriented framework to advance an agenda for strengthening Indigenous livelihood resilience to global climate change.

1. Introduction
Until recently, Indigenous and other traditional peoples were rarely considered in public debates on climate change and climate change adaptation (Nyong et al 2007, Salick and Ross 2009). This is problematic because Indigenous peoples are often regarded as being among the groups most vulnerable to the negative effects of climate change (Salick and Ross 2009, IPCC 2014, Makondo and Thomas 2018, Lam et al 2019). However, scientific discourse exhibits a trend of striving to integrate the concerns, livelihood strategies and knowledge systems of Indigenous peoples into climate change adaptation and mitigation strategies (David-Chavez and Gavin 2018, Ford et al 2020). Additionally, the importance of Indigenous peoples and their knowledge systems in climate change adaptation is increasingly acknowledged in Intergovernmental Panel on Climate Change (IPCC) assessment and special reports (IPCC 2014, 2018, 2019) as well as other international policy reports (i.e. UNDESA 2020).

Indigenous peoples occupy 40% of the world’s protected areas (Garnett et al 2018), which contain at least 17% of the total carbon stores across more than 60 countries (Rights and Resources Initiative 2018). According to a global review by Savo et al (2016), Indigenous peoples’ observations of changing temperature patterns are consistent with those of scientific models and provide crucial information on climate change impacts on coupled human–environmental systems and processes.

Current research on Indigenous peoples and climate change focuses on four interrelated dimensions: (a) integration of traditional ecological knowledge (TEK) and culture into climate change adaptation (Nyong et al 2007, Paneque-Gálvez et al 2018, van Gevelt et al 2019), (b) land tenure and conservation (Vergara-Asenjo and Potvin 2014, Ceddia et al 2015, Blackman et al 2017, Poudyal et al 2020),
(c) Indigenous rights and climate justice (Wallbott 2014, Dehm 2016, Ford et al 2016), and (d) perceptions of Indigenous peoples of (global) climate change (Pyhälä et al 2016, Savo et al 2016, Kent and Hannay 2020). Although all four dimensions are important, knowledge regarding the cultural and perceptual dimensions of integrating Indigenous peoples into climate change adaptation planning is particularly inadequate (Boillat and Berkes 2013, Adger et al 2013, Reyes-García et al 2016, Kent and Hannay 2020). This could lead to further exclusion of Indigenous peoples and a lack of understanding of how they experience, perceive and respond to global climate change (Green and Raygorodetsky 2010).

This study used a mixed-methods and inductive approach to understand the importance of local perceptions and cultural dimensions on global climate change among rural Indigenous communities in Taiwan. We examined the roles that culture and perceptions play in coping and adaptation strategies for changing weather patterns and extreme weather events. This was accomplished by looking at the individual perceptions of climatic change, perceived climate change impacts, coping strategies, and livelihood adaptations of smallholders in two Indigenous jurisdictions in northern Taiwan. Indigenous and local smallholders employ several coping or adaptation strategies to global climate change, including adapted farming practices, livelihood diversification, environmental management, and migration (Burnham and Ma 2016, Meuwissen et al 2019). The concept of TEK (or Indigenous knowledge) contributes critically to this discussion because it comprises three forms: beliefs and perceptions, biological knowledge of land and species, and exploitation practices (Berkes 2018). TEK encompasses not only biological knowledge but also land and resource management systems, social institutions, spiritual and cultural beliefs, and worldviews (Berkes et al 2000, Berkes 2018, Paneque-Gálvez et al 2018, Makondo and Thomas 2018, Son et al 2019). To set an agenda to incorporate Indigenous peoples into mainstream climate change adaptation policymaking and strengthen their climate resilience, thorough investigation of the cultural aspects of TEK (including social institutions) and local perceptions is essential (Ford et al 2016, David-Chavez and Gavin 2018, Son et al 2019).

In this study, we developed a typology of climate change adaptation in an Indigenous context, which could advance this aim. This typology explores how culture and local perceptions influence Indigenous coping and adaptation strategies to climate change. To our best knowledge, such typology does not exist yet. While some studies provide important insights into the relationship of Indigenous knowledge, perceptions and climate change (Nyong et al 2007, Son et al 2019, van Gevelt et al 2019), this study takes a different approach by introducing a new typology which can be applied to other cultural and social contexts. This study investigated two rural Tayal (or Atayal) communities in Taiwan. The Tayal, numbering 92,306 people in 2020, are Taiwan’s second-largest Indigenous group of the 16 officially recognized Indigenous peoples’ groups (Ministry of the Interior 2020). They have traditionally been dependent on hunting and swidden agriculture and maintained a cosmology of ‘Gaga’ (an ancestral belief system) and ‘Utux’ (supernatural beings). With the introduction of Christianity, modernization, and colonization, many of the Tayal’s TEK systems and traditional livelihoods have become extinct (Yen and Kuan 2004, Chen et al 2018). However, TEK continues to play a crucial role in the agricultural and agroforestry practices (Yen and Chen 2016, Lin and Polsky 2016), hunting (Fang et al 2016), water governance (Chen et al 2018), legal systems (Sheu and Huang 2014), and institutions of the Tayal (Yen and Kuan 2004, Tang and Tang 2010). In terms of climate change adaptation of the Tayal people, studies have focused on how TEK plays a role in disaster risk management (Kuan 2015), agricultural adaptation to climate change (Wang 2013), and disaster risk reduction (Lin and Chang 2020). Many disasters are climate-related—which include typhoons, torrential rains, rainfall-induced debris flow and landslides, and floods—and have negatively impacted the livelihoods, natural environment, residential dwellings and infrastructure of the Tayal people over the past few decades (Lin and Chang 2020). These studies, which have primarily adopted qualitative and ethnographic research methods, show in great detail that TEK—including roles of traditional leaders, holistic views on human–environment relations and cultural practices—profoundly influence and shape the climate change adaptation strategies of the Tayal people. However, due to lack of quantitative data, we argue that evidence remains somewhat descriptive and context-bound. Quantitative data, complemented by qualitative findings, enable comparability and transferability of results to other Indigenous contexts (Pyhälä et al 2016).

Because its Indigenous peoples and local farmers are becoming increasingly vulnerable to climate change (Lin and Polsky 2016), Taiwan was selected as the setting of our investigation of the influence of culture and local perceptions on climate change adaptation among Indigenous peoples. Here, we adopt the United Nations Department of Economic and Social Affairs (UNDESA) definition of Indigenous peoples (see UNDESA ND). The lessons learned from Taiwan, a newly developed country, can be helpful to both developed (e.g. New Zealand and Australia) and developing nations (e.g. Vietnam, Cambodia, Laos) that are home to Indigenous peoples. Taiwan is one of the few nations in Asia that explicitly acknowledges the rights of Indigenous peoples (Van Benhoven 2016). This could trigger new debates on how we could develop endogenous or alternatives modes of development, including Indigenous adaptations to
global climate change, in the Asia-Pacific context. The academic contribution of this study is to introduce a new typology on Indigenous adaptation to climate change, which takes its perceptual and cultural dimensions more comprehensively into account (see Adger et al. 2013). Here, we aim to contribute to the overarching theme on how community-based adaptation to climate change can be ‘up-scaled’ to other geographical contexts and spatial scales (see Forsyth 2013).

2. Materials and methods

2.1. Analytical framework
In order to understand what roles cultural dimensions and perceptions play in coping and adaptation strategies of Indigenous people, we developed an analytical framework consisting of four main dimensions: perceptions on climate change and impacts, coping strategies, livelihood resilience, and TEK and culture. We employed an inductive approach (Berrang-Ford et al. 2015) to understand how these four main components are connected with each other in an Indigenous context.

The first dimension, perceptions on climate change and impacts, was measured by asking respondents about their experiences of changing weather/climate patterns, perceived climate change impacts, and future expectations of climate change (Hiwasaki et al. 2015, Pyhälä et al. 2016, Son et al. 2019). The second dimension, coping strategies, refers to households’ ability to cope with climate-related disasters (drought, intensified rainfall, more frequent typhoons, more intense typhoons, floods, rainfall-induced landslides, etc.). We also inquired whether households received external support from other households and formal institutions, such as government agencies and community organizations, to cope with climate-related disasters (Mcnaught et al. 2014, Monirul Alam et al. 2017). Information sources on climate change (Mcnaught et al. 2014, Pyhälä et al. 2016) as well as one’s conviction to take action to combat global climate change (Hung and Bayrak 2019) also influence households’ coping strategies. The third dimension deals with livelihood resilience. Livelihood resilience could be subdivided into three capacities: absorptive, adaptive and transformative capacity (Pelling 2011, Agrawal et al. 2019, Meuwissen et al. 2019). Smallholders can employ several adaptation strategies to cope with climate change (see Burnham and Ma 2016), this could range from making small adjustments to one’s farming practices (absorptive capacity) and adopting new agricultural methods (adaptive capacity) to abandoning agriculture altogether in favor of non-farming livelihood activities (Pelling 2011, Burnham and Ma 2016). Coping with or adapting to climate change correspond to absorptive and adaptive capacity respectively (Béné et al. 2012). Additionally, respondents were questioned about their perceived preparedness to climate change as well as recovery from climate-related disasters (see Tanner et al. 2015).

The three aforementioned dimensions mutually influence each other (Tanner et al. 2015), but the role of the cultural dimension (TEK and culture) in climate change adaptation remains unclear (Adger et al. 2013). In order to measure the fourth dimension, we questioned respondents on the roles of traditional leaders, the church, cultural practices, and natural conservation in climate change adaptation (Yen and Kuan 2004, Boillat and Berkes 2013, Chen et al. 2018, Berkes 2018). We used these four components as proxies for TEK as a means to measure the cultural dimension of climate change adaptation.

2.2. Methods and data analysis
We conducted face-to-face in-depth interviews and questionnaire surveys with members of rural households at two Indigenous study sites—Fuxing District in Taoyuan City and Nan’ao Township in Yilan County. In March 2020, 101 individuals aged over 20 years claiming to represent their respective households were interviewed. The respondents used 5-point Likert scales to respond to survey statements regarding global climate change impacts, coping and adaptation strategies, TEK systems, and local perceptions. We analyzed the data using descriptive analysis, individual t-tests, and a polychoric factor analysis. Statistical differences between the two study sites—Nan’ao, which is coastal and mountainous, and Fuxing, which is mountainous—and between Tayal and non-Tayal residents were assessed. The polychoric factor analysis included data from all respondents because we wished to gain the perspectives of non-Indigenous peoples as well (see Savo et al. 2016). Polychoric analysis was used because the evaluated variables were ordinal (Aletras et al. 2010). Our findings were supplemented with data from in-depth interviews conducted in February and March 2020. These interviews were conducted with ten households in order to contextualize the findings of the quantitative data. A variety of respondents was chosen, including village elderly, community leaders, hunting households, and young households. Details regarding the methods (including sampling methods), ethics, sample characteristics, operationalization, questionnaire development, topic lists, and data analysis are presented in the supplementary information in appendix A (available online at https://stacks.iop.org/ERL/15/124074/mmedia).

2.3. Study area and research context
Fuxing District in Taoyuan City and Nan’ao Township in Yilan County are both located in northern Taiwan (figure 1). In January 2020, Fuxing and Nan’ao consisted of 12 222 people and 5964 people respectively, of which the Tayal people accounted for 67.5% of the total population in the former and
83.7% in the latter study site (Fuxing District Household Registration Office 2020, Nan’ao Township Household Registration Office 2020). The respondents of this study primarily engaged in smallholder agriculture (both organic and non-organic), but they also engaged in forest-based (such as hunting) and other non-farm livelihoods activities (such as tourism, mining, and other business and services). Farmers in Fuxing mainly grew peach, persimmon and leafy vegetables, whereas farmers in Nan’ao grew leafy vegetables, rice and mushroom. Both study sites were affected by climate-related disasters, of which Fuxing was more severely affected than Nan’ao. These disasters mainly included rainfall-induced landslides and debris flows, typhoon damage, torrential rain, and flooding (source: in-depth interviews).

In terms of TEK, the villages in both study sites had traditional leaders, and there was an internal push to restore traditional Tayal farming methods, which included organic farming and the cultivation of traditional species, such as millet. Our in-depth interviews with hunting households furthermore revealed that they employed TEK in hunting and catching animals. Additionally, Tayal village elderly recognized taboo forest areas (or sacred forests), in which the hunting of animals was prohibited. However, TEK systems, like any other knowledge system, change throughout time (Berkes 2018), and this was also the case for the Tayal respondents in this study. Nan’ao, for example, was relocated towards the coast by Japanese colonial forces in the beginning of the 20th century, in which many Tayal households lost a connection with their traditional lands. A Tayal respondent stated: ‘Because they [the Japanese] forced us to leave, we lost sense of our sacred places’ (28 March 2020). Many traditional agricultural methods of the Tayal, including the cultivation of a variety of millet species, have also vanished over time (source: in-depth interviews).

3. Results

3.1. Climatic impacts

Households in both study sites indicated that they had experienced problems related to climatic change over the past 10 years (2009–2019); in particular, they reported more frequent drought and greater variability in weather patterns (table 1). Drought has especially been perceived as problematic: 45.1% and 70.0% of households in Nan’ao and Fuxing respectively reported a more frequent occurrence of drought over the past 10 years. No significant differences were found in the average amount of financial loss each household reported for the most recently experienced damage caused by a climate-related disaster event (\( t = -1.541, p = 0.127 \)); the average was NT$177 572 (approximately US$6 004) and NT$334 640 TWD (approximately US$11 315) in Nan’ao and Fuxing, respectively.

3.2. Differences in household statements between Fuxing and Nan’ao and between Tayal and non-Tayal residents

Households in Fuxing experienced significantly more changing weather or climate patterns over the past 10 years than did those in Nan’ao (statement 1; mean scores for Fuxing (SF) and Nan’ao (SN): 4.50 and 4.02, respectively; \( p < 0.01 \)) as well as more damage to their crops (statement 3; SF: 4.34, SN: 3.82).
Table 1. Statements on impacts and perceptions of and coping strategies for climate change between 2009 and 2019 (Likert scale 1 = completely disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = completely agree).

| Category                        | Item                                                                 | Statement                                                                                           | N  | Mean | SD  | Skewness | Kurtosis |
|---------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----|------|------|----------|----------|
| Perceptions on climate change   | 1                                                                   | I observe more changing weather/climate patterns over the past 10 years                              | 101 | 4.26 | 0.93 | −1.59    | 2.56     |
|                                 | 2                                                                   | Over the past 10 years, climate change-related disasters (e.g. typhoon, flooding, drought) have worsened | 100 | 4.23 | 0.89 | −1.63    | 3.23     |
|                                 | 3                                                                   | Me and my household experienced damage to our crops because of climate-related disasters (e.g. typhoon, flooding, drought) over the past 10 years | 101 | 3.89 | 1.34 | −1.07    | −0.22    |
|                                 | 4                                                                   | Me and my household experienced physical damage (e.g. to your house or property) because of climate-related disasters (e.g. typhoon, flooding, drought) over the past 10 years | 101 | 2.47 | 1.38 | 0.52     | −1.16    |
|                                 | 5                                                                   | I expect climate change-related disasters to become worse in the near future                         | 95  | 4.24 | 0.91 | −1.11    | 0.47     |
| Coping strategies               | 6                                                                   | My household knows how to cope with climate-related disasters independently                           | 101 | 2.89 | 1.46 | 0.11     | −1.48    |
|                                 | 7                                                                   | Other households in the village help me and my household to cope with climate-related disasters       | 101 | 2.91 | 1.36 | −0.33    | −1.50    |
|                                 | 8                                                                   | The government helps me and my household to cope with climate-related disasters                       | 100 | 2.97 | 1.37 | −0.36    | −1.42    |
|                                 | 9                                                                   | The community association helps me and my household to cope with climate-related disasters           | 99  | 2.70 | 1.42 | 0.07     | −1.54    |
|                                 | 10                                                                  | I receive information about climate change from the media/TV/newspapers                              | 100 | 4.42 | 0.50 | 0.33     | −1.93    |
|                                 | 11                                                                  | I receive information about climate change from the government/schools                               | 100 | 3.18 | 1.28 | −0.61    | −1.11    |
|                                 | 12                                                                  | I believe we should take action to combat climate change in order to reduce climate-related disasters | 97  | 4.30 | 0.99 | −1.55    | 1.93     |
| Livelihood resilience           | 13                                                                  | Over the past 10 years, I borrowed more money (from the bank or relatives) because of climate-related disasters | 101 | 2.12 | 1.44 | 0.93     | −0.71    |
|                                 | 14                                                                  | Over the past 10 years, I adapted my farming strategies to climate change-related disasters            | 99  | 2.98 | 1.50 | −0.04    | −1.56    |
Table 1. (Continued).

| Category                  | Item                              | Statement                                                                 | N   | Mean | SD  | Skewness | Kurtosis |
|---------------------------|-----------------------------------|----------------------------------------------------------------------------|-----|------|-----|----------|----------|
| 15                        | Over the past 10 years, I        | shifted to a new job (for example tourism) as a means to deal with climate-related disasters | 101 | 2.45 | 1.50| 0.49     | -1.36    |
| 16                        | Over the past 10 years, I        | changed my livelihood activities to non-farming activities because of climate-related disasters | 101 | 2.33 | 1.44| 0.67     | -1.09    |
| 17                        | Over the past 10 years, my       | household has prepared to deal with climate-related disasters             | 100 | 3.72 | 1.20| -1.02    | 0.09     |
| 18                        | Over the past 10 years, my       | household has been fully recovered from climate-related disasters that have affected us | 101 | 3.70 | 1.11| -1.00    | 0.29     |
| TEK and culture           | 19                                 | Our traditional leaders support us to cope with climate-related disasters | 100 | 3.02 | 1.32| -0.28    | -1.31    |
|                           | 20                                 | Our church supports us to cope with climate-related disasters             | 98  | 2.99 | 1.47| -0.18    | -1.53    |
|                           | 21                                 | Our cultural practices can help us cope with climate-related disasters   | 101 | 3.70 | 1.14| -1.10    | 0.45     |
|                           | 22                                 | I believe that nature conservation is important to combat global climate change | 100 | 4.42 | 0.92| -2.04    | 4.11     |

3.45; \( p < 0.01 \); see appendix B). Households in Fuxing, which are primarily engaged in peach farming, lost almost their entire 2019 harvest because of unusually warm weather conditions that February. A Tayal peach farmer proclaimed: 'Because of changing weather conditions last year, we lost our peaches. It is very strange, we do not know how this happened. It is like a disaster. The weather is becoming more unpredictable each year!' (19 March 2020). Households in Nan’ao are comparatively less dependent on monoculture and were therefore less affected by changing weather conditions (source: in-depth interviews).

In terms of statistically significant differences between Tayal and non-Tayal residents of the two study sites, these were evident in responses to five statements (see appendix C). Tayal residents claimed that they received more support from other households to cope with climate-related disasters than did non-Tayal residents (statement 7; mean scores for Tayal (SA) and non-Tayal (SNa): 3.12 and 2.36, respectively; \( p < 0.01 \)). Non-Tayal residents were more likely to shift to new jobs such as those in tourism as a means to deal with climate-related disasters (statement 15; SA: 2.23, SNa: 3.00; \( p < 0.05 \)). Tayal residents more strongly asserted that they had recovered from climate-related disasters (statement 18; SA: 3.82, SNa: 3.39; \( p < 0.05 \)) over the past 10 years than did non-Tayal residents. Regarding TEK and culture, Tayal residents claimed to receive more support from their traditional leaders than did non-Tayal residents (statement 19; SA: 3.19, SNa: 2.57; \( p < 0.05 \)) and to have more salient cultural practices to cope with climate-related disasters (statement 21; SA: 3.90, SNa: 3.18; \( p < 0.05 \)).

3.3. Polychoric factor analysis

Table 2 shows the results of the polychoric factor analysis. Four factors were identified as accounting for 60.85% of the explained variance and having a Kaiser–Meyer–Olkin (KMO) test value of 0.6 in the analysis. Factor 1 (statements 11, 13, 15, 16), factor 2 (statements 1–5, 14), factor 3 (statements 10, 12, 17, 18, 21), and factor 4 (statements 6–9, 19, 20) accounted for 23.19%, 16.05%, 12.86%, and 8.59% of the explained variance, respectively. Statement 22 was excluded from the factor analysis because its inclusion rendered the KMO test value unacceptable (KMO < 0.5). Based on the highest factor loadings for each statement, we labeled the four identified factors as follows: (a) commercialized
Table 2. Polychoric factor analysis of the 21 statements.

| Item | 1st Commercialized response | 2nd Experience and anticipation | 3rd Culture, preparedness and recovery | 4th External support and institutions |
|------|-----------------------------|---------------------------------|----------------------------------------|--------------------------------------|
| 1    | -0.087                      | 0.86                            | 0.002                                  | 0.005                                |
| 2    | -0.094                      | 0.812                           | 0.265                                  | -0.022                               |
| 3    | 0.085                       | 0.844                           | -0.183                                 | 0.023                                |
| 4    | -0.186                      | 0.526                           | -0.347                                 | 0.476                                |
| 5    | 0.058                       | 0.566                           | 0.458                                  | -0.212                               |
| 6    | -0.47                       | 0.053                           | 0.26                                   | 0.495                                |
| 7    | 0.308                       | -0.068                          | -0.201                                 | 0.67                                 |
| 8    | 0.36                        | -0.103                          | 0.061                                  | 0.657                                |
| 9    | 0.188                       | -0.008                          | 0.083                                  | 0.755                                |
| 10   | -0.13                       | 0.221                           | 0.621                                  | 0.07                                 |
| 11   | **0.359**                   | 0.067                           | 0.351                                  | 0.147                                |
| 12   | 0.279                       | -0.07                           | **0.811**                              | 0.058                                |
| 13   | **0.492**                   | 0.437                           | -0.228                                 | 0.113                                |
| 14   | 0.399                       | **0.595**                       | 0.152                                  | -0.145                               |
| 15   | **0.8**                     | 0.02                            | 0.098                                  | 0.107                                |
| 16   | **0.779**                   | -0.072                          | 0.07                                   | 0.147                                |
| 17   | -0.171                      | 0.077                           | **0.582**                              | 0.005                                |
| 18   | 0.109                       | 0                              | **0.754**                              | -0.056                               |
| 19   | 0.006                       | -0.028                          | 0.062                                  | **0.849**                            |
| 20   | -0.064                      | 0.068                           | -0.01                                  | **0.809**                            |
| 21   | -0.169                      | -0.143                          | **0.498**                              | 0.471                                |
| Proportion of explained variance | 23.19%                        | 16.05%                          | 12.86%                                 | 8.59%                                |
| Cumulative proportion of explained variance | 0.23188                      | 0.39235                          | 0.52099                                | 0.60685                              |

Notes: Factors were extracted by applying principal component analysis with Promax rotation to polychoric correlations; Cronbach’s alpha = 0.623; Bartlett’s statistic: chi-square = 907.6 (degrees of freedom = 231; p = 0.000010); Kaiser–Meyer–Olkin (KMO) test = 0.60204 (mediocre); numbers in bold constituted the highest factor loadings. Statement 22 was excluded from the analysis as it rendered the KMO test value unacceptable.

response; (b) experience and anticipation; (c) culture, preparedness, and recovery; and (d) external support and institutions. Factors 1 and 4 were more related to responses to climate-related disasters and factors 2 and 3 were more associated with experience, recovery, and preparedness as well as cultural practices.

4. Discussion

Households at both study sites were affected by climate-related disasters to varying degrees. We determined that cultural aspects play a key role in coping with global climate change. Traditional leadership and cultural practices (as part of TEK) were considered to be more important by Tayal respondents than by non-Tayal respondents, which is fully in line with findings of other studies on the Tayal people (Fang et al 2016, Yen and Chen 2016, Chen et al 2018) as well as with other case studies of Indigenous communities around the globe (Nyang et al 2007, Hiwasiaki et al 2015, Pyhälä et al 2016, Makondo and Thomas 2018, Son et al 2019). The Tayal respondents also claimed to receive more support from other households to cope with climate change, which highlights the importance of social capital and community support (Boillat and Berkes 2013, Monirul Alam et al 2017, Dapilah et al 2020). The reason non-Tayal respondents were more likely to change jobs (to nonagricultural positions) as a coping strategy is that many Indigenous peoples in Taiwan, including the Tayal, are less involved in the market economy than their Han majority counterparts (Simon 2010). Tayal respondents’ belief that they had recovered more fully from climate-related disasters is attributed to many Tayal people’s perception that climate-related disasters are not necessarily ‘disasters’ but rather natural phenomena or a normal part of life (source: in-depth interviews). A Tayal farmer elucidated this as follows: ‘Typhoons are inevitable and in the past our elderly did not think typhoons were a big deal. They are just nature. If typhoons do not hit the mountains, more bees will attack people. We therefore need typhoons.’ (28 March 2020). This is consistent with the cosmologies and worldviews of many Indigenous peoples with respect to nature (Savo et al 2016, Berkes 2018).

From the factor analysis, we developed a new typology of the experienced effects, coping and adaptation strategies, cultural dimensions, and perceptions of global climate change of Indigenous communities (appendix D) consisting of four
dimensions. Commercialized response refers to households’ employment of nonagricultural (or market-based/commercial) strategies (e.g. borrowing money and changing jobs to nonagricultural activities) to cope with and adapt to climate-related disasters. This appears to be associated with the information households receive from the government or schools (i.e. formal institutions) concerning climate change (statement 11). Many Indigenous villages in Taiwan face high outmigration rates as younger households abandon agricultural activities in favor of finding jobs in cities (Lin and Polsky 2016). The negative factor loading for statement 6—‘my household knows how to cope with climate-related disasters independently’ (−0.47)—is notable because it suggests a link between households’ lack of coping strategies and the shift to nonagricultural jobs. The existence of a relationship between climate change and outmigration among Taiwanese Indigenous peoples warrants further investigation. Experience and anticipation concerns whether households have experienced actual damage to their crops and property because of climate-related disasters, their observations of changing weather patterns, and their judgment on whether climate-related disasters have worsened over the past 10 years. This dimension influences not only their risk perception (statement 5) but also whether they have adapted their farming strategies to climate-related disasters (statement 14) (see Kinsey et al 1998). The dimension of culture, preparedness, and recovery highlights the importance of the media, cultural practices, and motivation to take action against climate-related disasters and is used to assess whether households are recovered from and prepared to deal with climate-related disasters. Taiwanese are highly connected to the Internet; as of 2019, 88.8% of Taiwanese use the Internet and 97.9% own a mobile phone (Taiwan Network Information Center 2020). Thus, in addition to local observations and cultural practices, Taiwan’s Indigenous communities increasingly depend upon the media as a source of climate change information. A positive relationship was observed between media use, cultural practices, and motivation to take action against global climate change. This result somewhat discordant with those of a study by Fernández-Llamazares et al (2015), but this discrepancy may be ascribed to differences in study settings (a newly developed country as opposed to a country in the Global South). The findings regarding the final dimension, external support and institutions, accord with those of other studies (e.g. Son et al 2019) that beyond formal organizations (e.g. the government and community associations), customary institutions (e.g. traditional leaders), religious organizations (e.g. churches), and other community members all play important roles in climate change adaptation and coping strategies. Hence, receipt of external support was positively associated with households’ ability to independently cope with climate-related disasters (see Son et al 2019, Dapilah et al 2020).

Our findings suggest that the culture and perceptions of Indigenous peoples profoundly shape their coping and adaptation strategies to climate change. Further investigations are necessary to confirm this relationship, including cross-country analyses, ethnographic research, and comparative research between, for example, the Indigenous peoples of developed and developing nations. A limitation of our study is the relatively small sample size, which was primarily due to the high outmigration rates of Tayal villages. For this reason, we lack the perspectives of Indigenous migrants on climate change. Therefore, and in view of the variation in global climate change experiences between different Indigenous communities in Taiwan, future meta-level analyses are warranted. For instance, Indigenous communities in southern Taiwan were severely negatively affected by Typhoon Morakot in 2009 as well as by consequence government relocation programs (Hsu et al 2015, Taiban et al 2020). Exploring how these extreme weather events shape Indigenous peoples’ perceptions of and cultural responses to global climate change is vital (Howe et al 2019). Lastly, and most importantly, even though the proposed typology of this study is in line with findings from other studies, we argue that further research needs to be conducted which can confirm the transferability of our typology to other Indigenous contexts.

5. Conclusion

This study investigated the relationship between Indigenous peoples and global climate change through a cultural and perceptual lens. We selected Tayal villages in northern Taiwan for our study sites and developed a typology of this relationship. This typology consists of four dimensions: commercialized response; experience and anticipation; culture, preparedness, and recovery; and external support and institutions. Our study supports the argument that Indigenous peoples should not be presented as victims of climate change; nor should their TEK systems be seen as the ‘solution’ to climate change (Green and Raygorodetsky 2010). We therefore agree with the conclusion of Ford et al (2016) that culture and relevant adaptations should be developed for Indigenous peoples through critical engagement with their TEK systems and their past experiences with climate change, relationships with the State and mainstream society, natural resource management, and (post-)colonial relations (Howitt 2020). In addition to further investigations of Indigenous narratives and experiences of global climate change, culture and local perceptions should be incorporated into climate change adaptation policy. This can be done through
stabilizing a meaningful dialogue, from the international to local level, between Indigenous peoples and other stakeholders on how Indigenous strategies could be effectively integrated into mainstream climate change adaptation.

**Data availability statement**

The data are available from the corresponding author upon reasonable request.

**Acknowledgments**

This study was supported by the Ministry of Science and Technology (MOST) of Taiwan (MOST 109-2636-H-003-007 and MOST 108-2410-H-003-140). We thank all respondents, Global View Survey and Research Center, and Wallace Academic Editing.

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