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Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities

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ABSTRACT

The important role that local knowledge and practices can play in reducing risk and improving disaster preparedness is now acknowledged by disaster risk reduction specialists, especially since the 2004 Indian Ocean earthquake and tsunami. However, they have yet to be commonly used by communities, scientists, practitioners and policy-makers. We believe that local and indigenous knowledge needs to be integrated with science before it can be used in policies, education, and actions related to disaster risk reduction and climate change. This paper presents a process for integrating local and indigenous knowledge related to hydro-meteorological hazards and climate change with science, developed through a project implemented among coastal and small island communities in Indonesia, the Philippines and Timor-Leste. The process involves observation, documentation, validation, and categorization of local and indigenous knowledge, which can then be selected for integration with science. This process is unique in that it allows communities to (1) identify knowledge that can be integrated with science, which could then be further disseminated for use by scientists, practitioners and policy-makers, and (2) safeguard and valorize those that cannot be scientifically explained. By introducing a process that can be used in other communities and countries, we hope to promote the use of local and indigenous knowledge to enable communities to increase their resilience against the impacts of climate change and disasters.

1. Introduction

According to the World Risk Index, six out of the world's ten highest disaster risk countries are in Asia and the Pacific [8]. In the first decade of the 21st century, more than 200 million people were affected and more than 70,000 people were killed annually by disasters caused by

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natural hazards in the region, which represent 90% and 65% of the world's total, respectively [50]. Asian communities are thus extremely vulnerable to disasters, which are caused by natural hazards – such as earthquakes, tsunamis, cyclones, droughts, landslides, and floods – in combination with environmental degradation such as deforestation, desertification, biodiversity loss, pollution and soil erosion, as well as social factors such as poverty and inequality. Their vulnerability is also affected by political and economic conditions, and the structure and organization of their societies [40].

Coastal areas in Asia face "an increasing range of stresses and shocks", which are exacerbated by climate change. The projected sea-level rise would lead to increased frequency and intensity of tropical cyclones, heavier rainfall events, and droughts, and increased damage has already been reported in many parts of Asia ([15]:485). Island (or archipelagic) Southeast Asia – where many poor communities live in coastal areas – is thus extremely vulnerable to the impacts of hydro-meteorological hazards.

Efforts to mitigate the impacts of hazards and climate change tend to focus on infrastructure development such as building high sea walls, or on high-tech solutions such as sophisticated early warning systems based on scientific data and modeling. Although these technical and scientific solutions save lives when hazards strike, they need to be complemented by actions to address the risks surrounding the hazard and the underlying components of vulnerability – the interrelated human, social and cultural factors that influence risk – which can contribute to turning a hazard into a disaster [58]. An important factor that can increase the resilience of communities is their local knowledge, which, in combination with outside knowledge, has helped communities manage crises – be it natural hazards, economic problems, or political conflicts [18].

In the field of disaster risk reduction, evidence that local knowledge and practices can improve preparedness has grown since the 1970s [17]. Although it has been remarked that "indigenous knowledge has been slow to infiltrate the field of disaster management" ([31]:75), a substantial increase in studies on the topic can be noted particularly since mid-2000s, when, in the aftermath of the 2004 Indian Ocean earthquake and tsunami, knowledge that helped indigenous communities survive the disaster was widely publicized. Research that documents traditional knowledge related to geological disaster risk reduction includes those related to tsunamis among Solomon Islanders [19,30,31], among the Mokens on the islands off the coast of Myanmar and Thailand [44], and in Vanuatu, tsunamis [55] and volcanic eruptions [11]. Traditional knowledge related to hydro-meteorological hazards includes knowledge related to flash floods among herders in Pakistan [16], floods and landslides in Mexico [2], floods in Malaysia [10], Bangladesh [41], extreme weather events in Burkina Faso [43]. Shaw et al. [47,48] have published compilations of case studies on traditional knowledge and disaster risk reduction in Asia and the Pacific, and Dekens [17] has reviewed literature on the topic. Globally, the Hyogo Framework for Action (2005–2015) acknowledged "traditional and indigenous knowledge and cultural heritage" as one source of "knowledge, innovation and education to build a culture of safety and resilience at all levels" ([54]:9).

Similarly, in climate change research, social scientists have studied indigenous knowledge and its relevance for our understanding of climate change and adaptation strategies since the 1970s, but recent years have witnessed an explosion of research on the topic. While much of this research focuses on the Arctic [3,4,7,13,14,25,51,56] and the Pacific [1,9,24,26,28,32], other regions of the world are represented in a special issue of the *Global Environmental Change* journal [45], *Climatic Change* journal [21], a compilation of case studies by Galloway McLean [20] and a literature review in Nakashima et al. [38], demonstrating the increasing attention given to the topic.

As seen above, local and indigenous knowledge, observations, and practices related to disaster risk reduction and climate change adaptation have been well documented. It is, however, only in recent years that both scientists and practitioners have paid serious attention to actually using local and indigenous knowledge and practices to increase communities' resilience against the impacts of climate change and disasters, and to fully integrate such knowledge into scientific research, policy-making, and planning.

The resilience of communities facing disasters can increase when new and old techniques and knowledge are combined [18]. Furthermore, it is now generally recognized that integrating indigenous knowledge with scientific knowledge can lead to successful disaster preparedness strategies [35,36] and climate change adaptation strategies [4,23,24,49,57]. In combination with the latest technology and scientific assessment, local and indigenous knowledge can give communities and decision-makers a very good knowledge base to enable them to make decisions about the environmental issues they face. Walshe and Nunn [55] and Lauer [27] describe how indigenous knowledge about tsunami risks and responses, in combination with scientific and other knowledge, played an important role in helping villagers survive the 1999 tsunami in Vanuatu and in the Solomon Islands in 2007, respectively.

The 2004 Indian Ocean tsunami has been credited with sparking interest in integrating indigenous knowledge with science for disaster risk reduction [29], and many such efforts have been undertaken worldwide. In Vanuatu, participatory volcanic hazard awareness and education that incorporates traditional knowledge with volcanology has been developed for disaster-preparedness planning [11,12]. In Washington State, USA, Native American oral history has been incorporated into earthquake and tsunami hazard education [6]. Mercer et al. developed a framework for knowledge integration for a wide range of disasters, based on work in Papua New Guinea [34,36].

We present in this paper a process for integrating local and indigenous knowledge related to hydro-meteorological hazards with science and technology, because we believe this is necessary to promote the use of such knowledge to increase the resilience of communities against the impacts of hazards and to better adapt to climate change. The process was developed through a project led by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Jakarta Office and implemented in Indonesia, the Philippines, and Timor-Leste. In this project, local and indigenous