

**Public engagement with flood risk management
in Bangkok:
A case of Thai public visitors
to a large science museum in Thailand**

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Declaration:

I, **Supa Tanprasertkun** confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Due to the increasing flood risks in Thailand, the education sector has been called on to promote public engagement in flood risk management (FRM). Still, there is limited support in terms of how the sector, especially non-formal education, can achieve this task effectively. To address this gap of support, this thesis qualitatively explored the scenario of public engagement in FRM in Thailand from the perspectives of fifty-six Thai public visitors to a large science museum (eighteen children and thirty-eight adults) and ten FRM key actors in Thailand.

By accepting that laypeople have the potential and are important to act in both the private and public spheres to reduce their own and collective flood risks, the study provides empirical evidence that, through their lived experiences, the Thai public visitors possess several sorts of capital that are essential for improving FRM (i.e. flood experiences, a strong/moderate belief that severe flood will occur in the future, and knowledge of personal flood impacts). This affirms that the public is a potential contributor to dealing with flooding issues in Thai society. The study further revealed that the Thai public visitors' engagement with FRM remained limited to taking no action or taking private actions to lessen personal or household flood risks. By analysing the empirical data through a holistic lens, the study underlines that the limited engagement was a result of several personal and situational constraints. Based on these constraints, the study suggests two significant roles that museums and other similar non-formal education organisations in Thailand can adopt to support the promotion of public engagement in FRM: (1) being a source of reliable and updated knowledge about flooding issues and FRM for the public to access, and (2) being a safe space for the public to exercise their participation in conversations, deliberations, and collective actions toward improving FRM. Possibilities and challenges in integrating these roles into science museum practices in Thailand are discussed.

Impact statement

This study explored the scenario of public engagement in flood risk management (FRM) from the perspectives of the public and FRM key actors in Thailand. The findings of this study have crucial impacts both inside and outside academia.

In the fields of Disaster Risk Reduction (DRR) and Environmental Citizenship (EC), as one of a few empirical studies that examined the public's engagement practices toward tackling flooding issues in the context of Thailand, it broadens the knowledge and geographical reach of previous works in the field. It provides insights into how the Thai public engages with flooding issues, their potential to address the issues, and personal and situational constraints that limit their ability to advance their engagement.

In addition, regarding the fact that disaster risk management and solving environmental problems are inevitably related, the research also benefits the two fields by providing insights into a possible pathway to understanding people's practice regarding addressing environmental risks from the two fields' perspectives. While most DRR research focuses on people's responses and adaptation measures to mitigate risks, the theoretical framework developed in this study incorporates the perspective of EC, in which people have the potential to be proactive in reducing the causes of collective environmental risks.

As this investigation is directly aimed at impacting educational settings outside academia, I am especially keen to bridge the gap between theories and practices of public engagement in addressing environmental issues. By investigating laypeople's actual engagement practice toward addressing flooding issues through a holistic theoretical framework constructed from theories in public engagement in FRM, social capital, and EC, the study provides a theory-driven pedagogical guideline for public education to enhance engagement in environmental risk mitigation, particularly flooding issues in Thailand. While the pedagogical knowledge produced in this study directly informs science museums' practices in promoting public engagement in mitigating flooding issues, the knowledge could also inform other (educational) institutions that aim to achieve a similar goal (i.e. promoting public engagement in FRM).

Furthermore, this present study can directly benefit the development of sustainable FRM plans and policies in Thailand. As the findings are derived from actual circumstances of laypeople's engagement practice in FRM in Thailand, the research provides insights into personal and situational constraints that limit such engagement that is specific to the national context. Thus, practitioners and policymakers in Thailand can use the knowledge produced in this research to inform the development of their practices.

Beyond presenting the research through oral and poster presentations in academic conferences both inside and outside the academy (including the European Science Education Research Association (ESERA) Conference in 2019, the Teacher Education for Equity and Sustainability (TEESNet) Conference in 2020, and the European Network for Environmental Citizenship (ENEC) Training School in 2021), it is intended to be published in academic and professional journals to disseminate the findings and implications of this present study to a wider audience. It is also intended to be used to inform the development of public flood education programmes in Thailand, the primary goal of conducting this study.

Dedication

To my amazing mum and dad,
who always encourage and support me to pursue my dreams.

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The metamorphosis of this thesis from mere possibility into flourishing reality could not happen without support from many extraordinary people, whom I shall name and thank below.

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Chapter 1: Introduction

Flooding is one of the significant environmental problems that affect livelihoods in Thailand. According to Singkran (2017), from 1985 to 2016 (a 32-year period), sixty-nine major flood events in Thailand were recorded. Fifteen of these events, in 1995, 1996, 2000, 2002-2007, 2010, 2011, and 2016, lasted for a month or more. The 2011 flood was the most devastating one: floodwater had beaten the flood protection systems that were put in place to protect Bangkok, the metropolis of Thailand. About 30% of the Thai population was impacted (Gale & Saunders, 2013; Ministry of Finance and World Bank, 2012). Apart from severe flood events, Bangkok nowadays has also been suffering from the increasing risk of annual pluvial floods due to the rising sea level, the likelihood of extreme precipitation and land subsidence caused by the continuous over-pumping of groundwater for the industrial sector (Dhakal & Shrestha, 2016; Lebel Sinh et al., 2009; Marome et al., 2017; Marome, 2016; Shrestha et al. 2015).

The damage caused by previous flood events in 2011 is evidence of the ineffectiveness of flood risk management (FRM) in Thailand. Enhancing public engagement in FRM is argued to be a key to a sustainable flood solution for the nation ('building societal flood resilience¹') (Lebel et al., 2009; Marome et al., 2017; Marome, 2016; Phanthuwongpakdee, 2016; Saito, 2014; Singkran, 2017; Tingsanchali, 2012). Since then, shared responsibility in mitigating disaster risks among all sectors (i.e. citizens, the private sector, and the government) has been emphasised as a core strategy of the national disaster risk management plan (DDPM, 2015). The education sector in Thailand has been requested to enable the public to become proactive in flood risk mitigation (DDPM, 2015; Tanwattana & Toyoda, 2018; Thanvisitthpon et al., 2018). According to the recent national disaster risk management plan (*National Disaster Risk Management Plan 2015*), the attempt to promote citizen engagement in FRM appears to be limited to school students (DDPM, 2015; Thai Safe Schools, 2018), but not the general public.

As science museums have potential—in terms of professionals and resources for public education and connections with the public—to respond more

¹ Capacity to act, prepare, recover, and adapt to reduce flood risk (Marome et al., 2017; Marome, 2016).

to the needs of people and societies in their services (International Council of Museums, 2007; Lane et al., 2007; Newman et al., 2005; Nieroba, 2018), I envisage that science museums in Thailand can help promote public engagement in FRM. The fact that effective interventions to promote public engagement in mitigating flooding issues require bottom-up development—they need to be developed based on insights into the scenario of public engagement in FRM from the context where the intervention will be applied ('context specific') (Baggini, 2019; Dufty, 2008)—underlines the issue of the limited availability of knowledge about the scenario of public engagement in FRM in the context of Thailand. Recently, there have been only a few research studies exploring community flood preparation and adaptation in Thailand (Phanthuwongpakdee, 2016; Tanwattana & Toyoda, 2018). Thus, even though science museums want to support building flood resilience in Thai society, the scarcity of this supporting knowledge appears to be a main barrier for the museums to achieve their objective². It is this gap in supporting knowledge that I aim to address throughout this study.

To inform promotion of public engagement in FRM—particularly for science museums' target audience in Thailand—, in this research project, I qualitatively explore the reality of Thai public engagement in FRM from two perspectives: Thai public visitors to a large science museum (18 child visitors and 38 adult visitors) and FRM key actors (4 researchers in disaster risk management, 4 volunteer educators, and 2 state authorities) in Thailand. The generated data (via draw-and-explain, personal meaning mapping, and interview approaches) were analysed under a qualitative-interpretive approach to identify possibilities for and barriers to promoting public engagement in FRM in both personal and situational dimensions. The main findings and the subsequent suggestions on how to promote public engagement in FRM in Thailand are presented and analysed throughout this thesis.

² The scarce knowledge of their audience and society is a main barrier to museums to better respond to the needs of people and society in their practices (Nieroba, 2018).

1.1 Motivation for the research

My motivation to conduct this study emerged from my own environmental concerns and my future career path as a science museum educator. Since I was completing my undergraduate studies in environmental science about a decade ago, encouraging people to take action for a better environmental situation has become my personal interest. Among several socio-environmental problems in Thailand (my home country), flooding issues receive most of my attention due to my direct experience with the terrible flood in 2011 (both as an affected person and a volunteer rescuer). During that time, the university campus where I was pursuing my post-graduate degree was severely flooded.

Although I fortunately evacuated just a few days before the flood hit, the extensive damage caused by the flood to my campus meant I had to relocate for several months (from Bangkok to another province) to study on a temporary campus. During the post-flood recovery period, I also witnessed firsthand flood impacts on others when I went to deliver living supplies to a few flood-affected communities. Being personally affected by the flood and witnessing its effects on others prompted me to question what laypeople like myself can do to mitigate the issues.

In 2015, I gained the Royal Thai Government PhD scholarship with a contract to work as an educator at the National Science Museum (NSM) in Thailand. A few of NSM's museum buildings (including the Science Museum, where I recruited Thai public visitors for this study) are in the 2011 flood-affected area, and the buildings were converted into an emergency evacuation centre during the flood event. Prior to beginning my PhD studies, I had the opportunity to speak with two NSM programme developers to gain information about their development objectives and challenges. One of the noteworthy points I acquired from the discussion was that the NSM has already sought to support the promotion of sustainable movements in Thai society, especially to foster public engagement in environmental problem mitigation. Still, similar to several practitioners in the field of Education for Sustainability (EfS) (Wade, 2008), achieving the goal remains a significant challenge.

Combining my concern about flooding issues with the opportunity to work with a science museum that is working to support sustainability in Thailand, I

decided to use this PhD research opportunity to gain insights into the Thai public's engagement with FRM in order to support the promotion of such engagement.

1.2 Context of the research

This study was a cross-sectional study of the scenario of public engagement in FRM in the context of Thailand derived from the perspectives of two groups of FRM stakeholders: the Thai public who visited the Science Museum—a large science museum in Thailand operated by the NSM—and FRM key actors in the national context. The research participants' data were collected in 2018 (September - December), approximately seven years after the devastating 2011 flood event in Thailand.

This study investigated the scenario of public engagement in FRM within a 'flawed democratic' political context³ (The Economist Intelligence Unit, 2016). Despite that Thailand is a democratic country where citizens should be encouraged to influence the development of their national and local policies (and plans), political opposition and critics are still suppressed by the government (e.g. through restricting media freedom). Politics has been deemed inappropriate and unwelcome to discuss even in educational and family settings, (Fry, 2002; Sasipornkarn, 2020). The national democratic process was worsened by the military coup d'état in 2014 as since then national politics has been dominated by the Thai military in an authoritarian manner. There is no attempt to enhance citizens' ability to participate in democratic activities appears in the latest national education scheme (2017–2036). The government has also been attempting to silence critics by enacting the *Computer Crimes Act*⁴ in 2021 (Bugher, 2021; Ganjanakhundee, 2020). Since state governance affects all aspects of national development, I cannot ignore the influence of these political issues in the participant contexts, which will be discussed further when relevant in this thesis.

³ Classified based on Democracy Index 2015 (The Economist Intelligence Unit, 2016).

⁴ The act is argued by the government as a tool to protect the public from fake news on social media platforms (Bugher, 2021)

1.3 Definition of terms

In this section I explain some terminologies that I often use in this thesis. As the terms below have different meanings in different contexts, it is my intention to let the readers know how I am using them in this study context.

Capital: When I use this term I refer to accumulated legitimate, valuable and exchangeable resources that can generate forms of social advantage within a specific field (in this study, flood risk reduction) for those actors (i.e. individuals, organisations, and communities) who possess it (Bourdieu, 1986, 1984). Actors who possess more capital tend to be more successful in achieving their goals.

Flood risk: Within this thesis *flood risk* refers to the potential impact caused by flood events on the subjects of interest (e.g. individuals and communities). Flood risk is determined by the interaction of four interdependent variables: the probability of unwanted flood events, the subjects' exposure to floods, the subjects' vulnerability toward floods, and the subjects' responses toward floods (Mitchell, 1999; Mustafa, 2009).

FRM key actors: I use this term to refer to people who have official roles and (or) experience working (either officially or voluntary) to improve FRM.

Public engagement: When I use this term I refer to public involvement—taking part or action—in a particular issue based on their willingness and desire (Samaranayake, 1996). The term *public engagement* is not used interchangeably with public participation due to the difference in the degree of individuals' psychological investment (Newmann, 1992); that is, individuals can participate in the FRM policy decision-making process without really engaging in addressing flooding issues. In this sense, public participation in a national or local development decision-making process is therefore a way, but not the only way, that citizens can engage with issues of their interest.

Science communication: Within this thesis, *science communication* refers to an emergent field of study (Trench & Bucchi, 2015) and to the theory that originated within the field. Models of science communication are commonly referred to in the literature as *deficit*, *dialogue* and *participation* (Bucchi, 2008).

Science museums: I use the expression as an umbrella term to refer to, according to the definition of museums defined by the International Council of Museums (ICOM) (2007), a permanent institution in the service of society which

acquires, conserves, researches, communicates about science and technology for the purposes of public education, study and enjoyment. In this sense, *science museums* in this thesis encompass contemporary science centres.

Thai public visitors: In this thesis, the expression refers to the Thai public who visits science museums.

1.4 Structure of the thesis

Following this introductory first chapter, in chapter 2 I review the theoretical perspectives informing my empirical investigation. I focus on looking for connections between the public, FRM, education, factors influencing citizen engagement in FRM, and science museums. Based on the review, I also propose a holistic framework for evaluating public engagement in FRM to guide this research design.

Chapter 3 describes the design of this empirical research. I focus on introducing my research aims and questions; outlining the investigations of two distinct participant groups (Thai public visitors and FRM key actors); and presenting the philosophical, value, and ethical aspects involved in these investigations. Chapter 4 will then provide detailed information about the settings and participants involved, along with a description and critical appraisal of the chosen methods and instruments of data generation and analysis (mainly of qualitative nature).

In chapters 5 and 6 I present the main findings from the investigation of participant Thai public visitors. Chapter 5 focuses on reporting the flood experiences of participant Thai public visitors, as well as their perceptions of flooding issues, their understanding of flood causes, their perceptions of future severe floods, and their perceptions of the relationship between flooding and climate change issues. Chapter 6 reports the participant Thai public visitors' perceptions of their roles in flooding issues; their actions to mitigate flooding issues; their questions about flooding and climate change issues; and their desire to inform others about the issues. At the end of both chapters, I also discuss how the findings inform the promotion of public engagement in FRM in Thailand, focusing on identifying possibilities and limiting factors in both personal and situational dimensions that must be addressed.

In chapter 7 I present the main results from the investigation of participant FRM key actors, focusing on their perceptions of challenges in improving FRM in Thailand; their expectations of support from the public; their views on challenges in and strategies for promoting public engagement in FRM; and their expectations of support from science museums. Similar to chapters 5 and 6, I then discuss how the findings from the investigation of participant FRM key actors inform the promotion of public engagement in FRM in the nation.

Chapter 8 presents the results of the cross-investigation analysis. I provide a reinterpretation of the findings from the two investigations (i.e. participant Thai public visitors and participant FRM key actors) to provide better insight into possibilities and limiting factors that must be addressed to promote public engagement in FRM in Thailand. I then present ideas generated from my research about how to promote such engagement. The chapter also includes a reflection on the limitations of this study regarding its methodological design, including sampling, methods of data generation, and scalability.

In chapter 9 I offer the research implications for science museum practitioners, focusing on how science museums can support the improvement of FRM in Thailand, and for practitioners and researchers in a wider context. Lastly, chapter 10 is dedicated to the thesis conclusion and recommendations for future research.

Chapter 2: Literature review

In this chapter I will present relevant research that explains my access to the potential roles of science museums to promote public engagement in flood risk management (FRM) in Thailand. My literature review focuses on exploring some of the connections between the public, FRM, education, factors influencing citizen engagement in FRM, and science museums.

In section 2.1 I will explore the need for FRM in Thailand. Section 2.2 will focus on exploring the importance of public engagement in FRM and the types of action that the public can adopt to mitigate flooding issues. In section 2.3 I will present and discuss factors that influence citizen engagement in FRM. A holistic framework for evaluating public engagement in FRM will also be proposed. In section 2.4 I will explore the relationship between education and FRM. In this section, I will also discuss models of science communication that have been developed to enhance citizen engagement in addressing socio-scientific issues. Lastly, in section 2.5 I will discuss the potential roles and some challenges for science museums to promote public engagement in addressing socio-environmental issues.

2.1 Looking for engagement: Thailand and flood risk management

2.1.1 Increasing flood risk in Thailand

The increase in flood risk is a significant socio-environmental issue that Thailand encounters, particularly in the Bangkok Metropolitan Region (BMR). Figure 2.1 illustrates the geographical information of the BMR. Severe floods occurred in Bangkok in 1942, 1983, 1995, and 2011. The 2011 flood was the most devastating one (see the affected area in Figure 2.2). In terms of economic loss, the damage cost about USD45.7 billion (14% of the national gross domestic product (GDP)) (Ghaderi et al., 2015; Impact Forecasting LLC, 2011). There were 813 deaths and 165,000 individuals were displaced (Guha-Sapir et al., 2012).

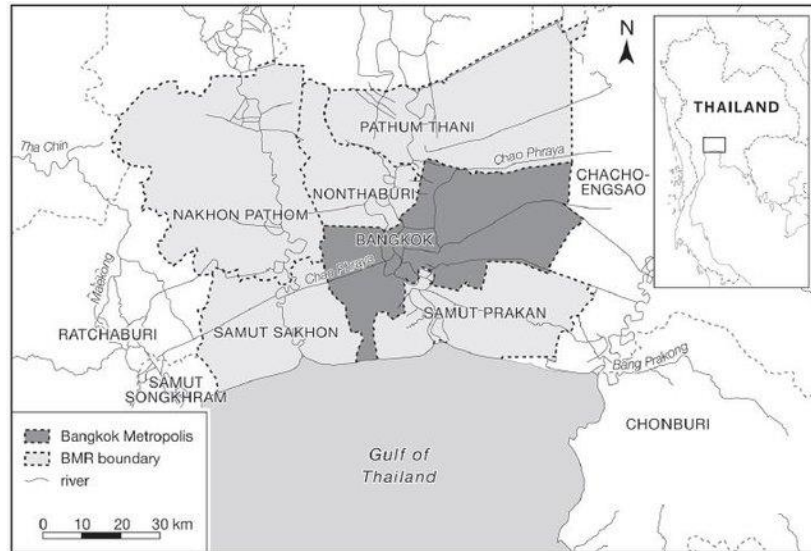


Figure 2.1 Bangkok Metropolitan Region (BMR)

The BMR is a government-designated ‘political definition’ of the urban area encompassing Bangkok, the metropolis of Thailand, and its five surrounding provinces. The region covers 7,761.50 km² in the flood-prone coastal area, the flat deltaic plain of the River Chao Phraya basin adjacent to the Gulf of Thailand, which has an average elevation of just 1.5 metres above mean sea level. Due to the concentration of economic and development activities (i.e. education, modernisation, industrialisation, internationalisation, and politics) (OECD, 2015), the region has the highest population density when compared to other regions in the country. About 15% of the country’s population, approximately 14.5 million people (the number includes those who are not registered), live in the region (NSO, 2010).



Figure 2.2 Thailand’s 2011 flood-affected area (ReliefWeb in Wake, 2011)

Despite being protected by a strong structural flood protection system (as it is the centre of national development, in terms of education, modernisation, industrialisation, internationalisation, politics, and economics), 42 out of 50 districts in Bangkok were underwater for weeks, which cost about USD9 billion in the city alone (OECD, 2015). The city has also been suffering from pluvial floods during the wet season every year (Shrestha et al., 2015). Flood risk in the BMR has been increasing due to the interaction of several factors: its topographic characteristics, rapid urbanisation, high population density, over-pumping of groundwater for the industrial sector, and climate change (Dhakal & Shrestha, 2016; Kulp & Strauss, 2019; Marome, 2016; Shrestha et al., 2015). As shown in Figure 2.1 above, the BMR is located in low-lying topography, in which much of the region's area is prone to inundation due to the influence of "three waters" (i.e. runoff, rain, and sea rise) (Marome, 2016).

Having the metropolis region in a flood-prone coastal area makes Thailand one of the top eight countries that are affected by the rise in sea levels (an impact of climate change) (Kulp & Strauss, 2019). According to the OECD (2007), over five million people in Thailand are predicted to be exposed to coastal flooding by 2070. Figure 2.3 demonstrates Thailand's projected inundated area due to sea level rises in 2050.

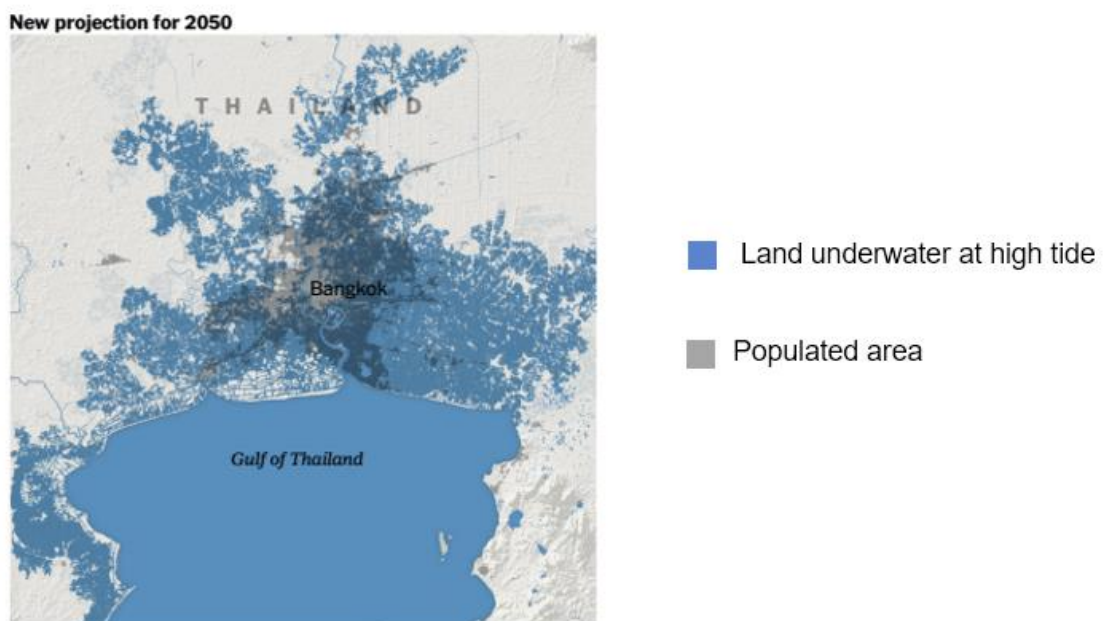


Figure 2.3 Thailand's projected inundated area due to sea level rises in 2050
(Lu & Flavelle, 2019)

The increase in flood risk stresses the urgency and necessity of investing in FRM strategies in the nation (Kulp & Strauss, 2019; Marome et al., 2017; Marome, 2016; Shrestha et al., 2015).

2.1.2 (Poor) flood risk management in Thailand

For Thailand, dealing with flooding issues is not new; from 1985 to 2016, 69 major flood events in Thailand were recorded (Singkran, 2017). As evident in the Eighth National Economic and Social Development Plan (1997-2001), the country has been attempting to deal with the risk of flooding since the 1990s (Hungspreug et al., 2000). The Royal Irrigation Department (RID) has been assigned to protect agricultural areas in the BMR. An extensive system of levees along the River Chao Phraya (the main river in the area) was installed (Hungspreug et al., 2000).

In 2002, the Department of Disaster Prevention and Mitigation (DDPM) was established to take responsibility for the development of disaster risk management policies and plans (Tanwattana & Murayama, 2014). Despite the implementation of the National Disaster Prevention and Mitigation (NDPM) Plan (2010-2014), Thailand experienced severe damage caused by the 2011 floods and persistent pluvial floods in the BMR. Regarding this matter, several researchers (Lebel et al., 2009; Marks, 2015; Marome, 2016; Phanthuwongpakdee, 2016; Pratuangkrai, 2012; Saito, 2014; Singkran, 2017; Tingsanchali, 2012) argue that FRM in Thailand is ineffective and underline the urgency of improving it.

Researchers argue that FRM in Thailand must be improved on three main issues. First, even though flooding is a major concern in the nation, unlike most nations, Thailand has not yet had a clear law governing the management of water resources (Marks, 2015). The authority to administer water resources is embedded in over 50 laws and more than 30 organisations. None of them prioritises FRM specifically. Thus, there are overlapping authorities and difficulties in implementing FRM strategies that require collaboration between these organisations. Saito (2014) argues that numerous development projects in Thailand are implemented without considering FRM. In other words, despite

evidence of the increase in flood risk in Thailand, FRM has not yet been taken seriously in relation to urban planning.

Second, climate change impacts have not yet been taken into account in the development of FRM in Thailand (Marome, 2016; Saito, 2014). It is not effective enough to cope with the uncertainty caused by climate change (e.g. intense precipitation). Lastly, several researchers (Lebel et al., 2009; Phanthuwongpakdee, 2016; Pratuangkrai, 2012; Saito, 2014; Singkran, 2017; Tingsanchali, 2012) argue that FRM in Thailand is primarily based on structural measures (e.g. floodwalls), which are unsustainable. The authors argue that structural measures cannot always prevent flooding from happening, and their failure often causes greater risk (e.g. failure of floodwalls). In many cases, these structural measures are ineffective because there is a lack of engagement from the end users (the public) to help design the interventions (Lebel et al., 2009; Phanthuwongpakdee, 2016; Pratuangkrai, 2012; Singkran, 2017; Tingsanchali, 2012).

Regarding these matters, many researchers (Marome et al., 2017; Marome, 2016; Phanthuwongpakdee, 2016; Singkran, 2017) suggest Thailand move from prioritising the flood protection paradigm to building flood risk resilience (an 'integrated method'), strengthening Thai society's capacity to act, prepare, recover, and adapt to reduce flood risk. In doing so, public engagement in FRM in Thailand needs to be promoted.

Indeed, the promotion of citizen engagement in building Thai society's resilience toward disasters has been incorporated as a core strategy in the nation's latest disaster risk management plan (*the National Disaster Risk Management Plan 2015*) (DDPM, 2015):

“a shared responsibility among citizens, the private sector, and government [...] to further carry out their disaster risk management responsibilities cooperatively [...]; investing in disaster risk reduction or resilience and building natural disaster immunity; and enhancing disaster preparedness for effective response, ‘Building Back Better’ and safer recovery, rehabilitation, and reconstruction” (p.43).

Regarding the plan, the education sector has been assigned to help promote such engagement, which I will discuss below.

2.1.3 Calling for support from the education sector

In Thailand's latest disaster risk management plan (DDPM, 2015), the education sector (the Ministry of Education) is assigned to (p.43):

- “- develop educational curricula at all levels to include disaster-related subjects, from primary to higher educational institutions,*
- encourage educational agencies to take an active role in disaster risk management efforts,*
- educate students across all educational levels, including the general public, to inspire them to participate in disaster risk management,*
- promote and encourage educational personnel, including boy and girl scouts, to support the work of National Disaster Command Headquarters and their local Disaster Management Centres, and*
- conduct surveys and create an educational facility database to designate temporary shelters in the event of disasters.”*

However, the implementation of these strategies is limited. Recently, there is only one disaster risk reduction and climate change adaptation curriculum developed by the Ministry of Education (and their partners) for Thai schools to help teachers and students understand the risks of disasters and how to respond to them (Thai Safe Schools, 2018), and there is still no follow-up research on the effectiveness of such curriculum. In relation to flooding issues, this reflects several researchers' arguments, as mentioned earlier, that promoting public engagement in FRM in Thailand remains limited (Lebel et al., 2009; Phanthuwongpakdee, 2016; Pratuangkrai, 2012; Singkran, 2017; Tingsanchali, 2012).

In summary, in this section, I explored the scenario of FRM in Thailand. The review highlights the need for promoting public engagement in FRM to strengthen the nation's ability to cope with increasing flood risks. While the education sector in the nation has already been assigned to help with the task, the development of educational practice to promote such engagement, especially among the general public, is still limited. From the review, I noticed the absence of guidelines to support non-formal education settings in Thailand (e.g. science museums) to help promote public engagement in FRM. Therefore, from a science museum educator's perspective, I see how difficult it is for these settings to help promote public engagement in FRM effectively without supportive guidelines. It was this gap in practice that I aimed to address.

In doing so, there were a number of questions that I thought I needed to explore further. *Why is public engagement important in FRM? What are the public's potential actions in FRM? What are the challenges of adopting such actions? What are the factors influencing citizen engagement in FRM? How can education promote public engagement in FRM? What are science museums, their roles in supporting sustainability, their types of educational practice, and the challenges of incorporating controversial socio-scientific issues in their practice?* I will explore the answers to these questions in the following sections.

2.2 Looking for engagement: The public and flood risk management

Promoting public engagement is not a new concept in FRM. It has been integrated into the core of FRM development in many nations at risks of flood hazards, such as the nations in the European Union (EU) and the UK (Commission of the European Communities, 2007; Speller, 2015; The Netherlands Embassy, 2020). In the following sub-section I will describe the importance of public engagement in FRM from the perspectives of two fields: disaster risk reduction (DRR) and Environmental Citizenship⁵ (EC).

2.2.1 Importance of public engagement in flood risk management

The public, according to DRR and EC, is key in reducing their own and others' flood risk. From the DRR perspective, environmental risk (or environmental hazard in some research literature) is defined as the potential impacts caused by environmental circumstances on the subjects of interest (e.g. individuals and communities) (Hall et al., 2003; Slovic, 1987; Slovic et al., 1980). According to Mitchell (1999, 1990) and Mustafa (2009), environmental risk is determined by the interaction of four main interdependent variables:

- 1) the probability of unwanted environmental circumstances (e.g. floods),
- 2) the subject's exposure to the circumstances (e.g. topographic characteristics of the subject's living area, and types of flood),
- 3) the subject's vulnerability toward the circumstances (i.e. the extent of

⁵ The field focuses on promoting citizen engagement in tackling socio-environmental problems and injustice (Hadjichambis & Reis, 2020; Ockwell et al., 2009; Stern, 2011).

the subject's inability to anticipate, struggle against, cope with, and recover from the circumstances), and

4) the subject's responses toward the circumstances (i.e. actions and strategies taken by the subjects to mitigate, cope with, adjust, and adapt to the circumstances).

Likewise, Wisner et al. (2004) argue, as illustrated in their Pressure and Release (PAR) model (Appendix 1), that there are a number of interdependent factors determining individuals' or communities' risks of extreme environmental events. They classified these factors into three interdependent layers: unsafe conditions (e.g. living in flood-risk locations), dynamic pressures (e.g. rapid population growth and climate change), and root causes (e.g. social inequality). This notion of environmental risk highlights people's power to, at least partly, reduce their risk of experiencing extreme environmental events (e.g. floods).

In this light, and together with the limitations of technological flood protection systems (i.e. cannot always cope with increasing flood likelihood, can result in greater damage if they fail, and can cause dramatic social and ecological changes in the long term), enhancing the public's capacity to reduce their own flood risk has been widely accepted among researchers and practitioners in DRR as a key to sustainable FRM (Chapman, 2004; Federal Emergency Management Agency, 2020; Grothmann & Reusswig, 2006; Mustafa, 2013, 2009; Phanthuwongpakdee, 2016; Ravetz, 2005; Shaw, 2014; Singkran, 2017; Speller, 2015). Grothmann and Reusswig (2006) argue that self-protective behaviours taken by residents in urban areas could mitigate monetary flood damage by 80%, which results in a lower requirement for investing in flood protection systems in their communities.

Wisner et al. (2004) raise a significant point in the field. They argue that every flood victim cannot make themselves less vulnerable to floods because of the inequal distribution of resources and power (e.g. financial resources and the degree of significance in influencing FRM policies and plans) among different groups of people (e.g. industrial owners vs. marginalised people). People who have limited access to those resources and power are always more vulnerable.

The inability to influence policies and plans that affect them does not just create greater vulnerability among people in material terms. It also disempowers people psychologically. Wisner et al. (2004) point out that, because of their limited

power to influence change, marginalised people often forgo safety culture and lose confidence in their abilities to reduce their vulnerability toward hazards (e.g. avoid getting involved with their local or national DRR plans). The authors argue that unless this limited access to resources and power is addressed, vulnerable people will remain vulnerable. To enhance their safety from extreme environmental events, vulnerable people need to be supported to fight for their rights to use the state's resources, opportunities, power, and social services to secure a livelihood (Wisner et al., 2004). Wisner et al.'s (2004) claim reflects a point raised in the EC field.

From the EC perspective, the importance of public engagement in mitigating flood issues is not limited to those members of the public who are at risk of flooding. EC also argues that everyone, even if they are not impacted, has the responsibility to address socio-environmental issues. From the Anthropocene⁶ perspective, Dobson (2003), a significant contributor to the concept of EC, underlines that we are living in an ecologically interdependent world. People's unsustainable production and consumption patterns in one place can affect people who live in other corners of the world (Dobson, 2003). In other words, humans partly create environmental risks through their contribution to global and local environmental degradation, such as climate change, deforestation, and rapid urban development (DellaSala & Goldstein, 2018; Li, 2017). These issues are a major cause of the increase in frequency and intensity of environmental disasters (Shamsuddoha & Chowdhury, 2007), including floods in Thailand and many countries (as discussed earlier in section 2.1).

In accordance with the notion of Anthropocene, Dobson (2003) argues that the obligation of citizens to address environmental problems therefore is asymmetrical and non-reciprocal. Instead, it depends on citizens' ecological footprints, the degree of environmental impacts that each individual has on ecological systems. Citizens who occupy more unsustainable amounts of ecological space or impose upon the ecological space of others have a greater obligation to minimise their ecological footprint. In turn, those who consume less have fewer obligations. In this sense, a number of DRR and EC researchers argue that everyone, particularly those who cause global and local ecological

⁶ Anthropocene is "*the concept that refers to global, catastrophic, ecosystem changes that are caused or remediable by human activity and that adversely affect the biosphere in a manner that will profoundly adversely disrupt human habitation*" (Miles & Craddock, 2018, p. 21).

degradations, bears responsibility for mitigating the risks of extreme environmental events for others (e.g. Dobson, 2003; Hadjichambis & Reis, 2020; Li, 2017; Shamsuddoha & Chowdhury, 2007; Wisner et al., 2004).

It is not a simple task to convince those who occupy unsustainable amounts of ecological space to change their practices. As argued by Wisner et al. (2004) above, people who are vulnerable to environmental risks have limited access to resources and the power to change their circumstances. Dobson (2003) therefore argues that to tackle environmental issues and injustice effectively, citizens need to be more than solely concerned with reducing their ecological footprint. They must also take action to tackle the unsustainable production and consumption patterns of other people to create a more equitable division of ecological space. Dobson (2003) refers to this type of citizenship as ‘ecological citizenship.’

In other words, ecological citizenship is not only about preserving their environmental rights but also seeking to bring justice to those who lack a voice in policymaking processes, including marginalised groups of people and other living species. Dobson’s (2003) ecological citizenship informs the development of the recent concept of environmental citizenship (defined by the European Network for Environmental Citizenship (ENEC) (2018) and accepted by more than 120 researchers and scholars from 37 countries):

“the responsible pro-environmental behaviours of citizens who act and participate in society as agents of change in the private and public sphere on a local, national and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability and developing a healthy relationship with nature” (Hadjichambis et al., 2020, p.8).

In this respect, the public (citizens) is not only important in reducing their own flood risks but also the risks of others.

In summary, the discourse regarding public (citizen) engagement in mitigating environmental risks (from the DRR perspective) and addressing socio-environmental problems and injustice (from the EC perspective) highlights that the public, depending on one’s circumstances, is key in reducing both their own and others’ flood risks. From this theoretical argument, in the next sub-section I will explore a range of actions that the public can adopt to mitigate flooding issues. I will also search for the challenges and limitations of the actions.

2.2.2 Public's potential actions in flood risk management and challenges

To support the promotion of public engagement in addressing socio-environmental issues, Stern (2000) proposes three distinct types of action that citizens can adopt to mitigate the issues: *Private-Sphere Environmentalism*, *Non-activist Actions in the Public Sphere*, and *Environmental Activism*. I will discuss each type of action and its challenges or limitations as follows.

Private-Sphere Environmentalism

According to Stern (2000), private-sphere environmentalism actions are aimed at directly reducing the actor's environmental impacts. The actions can directly mitigate personal impacts on the environment, but their effect is small. The actions will generate a significant impact only when many people independently do the same things. Reduced energy consumption, purchasing goods and services with lower environmental impacts ('green consumption'), and recycling are examples of private-sector environmentalism actions.

Scholars have recently highlighted the limited effectiveness of private-sector environmentalism actions (Levinson et al., 2020; Sörqvist & Langeborg, 2019). That is, the actions are not enough to compensate for unsustainable environmental circumstances because they do not affect social and political structures (e.g. policies and social norms), which determine the majority of people's practices. Sörqvist and Langeborg (2019) contend that not acknowledging the limitations of private-sphere environmentalism actions often prevents individuals from engaging in addressing environmental circumstances in the public sphere because they believe that they have done enough for the environment.

Non-activist Actions in the Public Sphere

According to Stern (2000), non-activist actions in the public sphere focus on supporting the development of public policies, regulations, and interventions to address environmental problems in their communities, regions, nations, and

global contexts. Willingly participating and voting in the decision-making of environmental management policies and willingly providing financial support to environmental organisations are examples of non-activist actions in the public sphere.

By adopting non-activist actions in the public sphere, the public becomes a supporter of the environmental movement. Thus, in a context where the existing environmental movement is limited, the actions appear to have a minor impact (Stern, 2000). They have limited capacity to initiate new policies, regulations, or interventions to address environmental issues.

Environmental Activism

Environmental activism actions impel the development of public policies, regulations, and norms to address environmental issues. Examples of the actions include joining environmental organisations and organising demonstrations to request a better policy for addressing environmental circumstances (e.g. writing open letters to the government and organising protests) and initiating interventions to address issues in their communities (e.g. cleaning campaigns). The effects of actions, if successful, are large because public policies, regulations, and social norms can alter the behaviours of many people and organisations at once.

The main limitation of environmental activism actions is that despite the most opportunity they offer to citizens to express voices and ideas about addressing environmental issues (especially in terms of improving social structure), the actions barely affect governance. The case of young Swedish activist Greta Thunberg (BBC News, 2020) can be an example. Greta has been pursuing serious global actions on climate change issues since 2018 (when she was 15 years old). Her actions include writing essays about climate change in local newspapers, carrying out school strikes to protest alone in front of the Swedish parliament building every Friday to request the Swedish government to cut down the national carbon emissions seriously, and giving speeches on international stages (e.g. the UN Climate Change Conference in 2019) criticising national leaders' lack of concern about addressing climate change issues. Her actions have raised awareness of the issues among millions of students

worldwide, which has resulted in more student protests about climate change in other countries. Still, there is no clear evidence that Greta's and other students' protests have caused changes in global or national policies about climate change.

By considering that flooding is a socio-environmental issue, Stern's (2000) types of action to address environmental issues provide me with a better picture of potential actions that the public can adopt to mitigate flooding issues. It assists me in categorising different types of public engagement in FRM, as shown in Table 2.1. Given that flooding issues are complex in terms of their causes and impacts (discussed earlier in sections 2.1.1 and 2.2.1), I argue that to improve FRM effectively, the public should be encouraged to act in both the private and public spheres. This could be explained by Bourdieu's (1986, 1984) concept of capital.

Bourdieu (1986, 1984) defines the term "*capital*" as accumulated legitimate, valuable, and exchangeable resources that can generate forms of social advantage within a specific field (in this study, flood risk reduction) for those actors who possess it (e.g. individuals, organisations, and communities). Bourdieu (1986) claims that there are three forms of capital: economic (e.g. financial resources), cultural (e.g. knowledge and power in decision-making), and social capital (e.g. social connections), which influence each other and are convertible. For instance, financial resources can be used to gain more knowledge. Thus, actors who possess more capital tend to be more successful in achieving their goals.

Table 2.1 Types of public engagement in flood risk management

(Adapted from Stern's (2000) types of action to address socio-environmental issues)

Type of public engagement in FRM	Characteristics of action	Examples of actions	Limitations
Actions in the private sphere	The actions are meant to directly lower personal and household flood risk and minimise personal contributions to the causes of flooding issues.	<ul style="list-style-type: none"> - Adopting flood adaptation and preparation approaches (e.g. buying flood insurance) - Adopting pro-environmental behaviours (e.g. reducing energy consumption, purchasing environmentally-friendly goods and services, and properly managing waste and wastewater) <p>(See e.g. Federal Emergency Management Agency, 2020; Grothmann & Reusswig, 2006; Phanthuwongpakdee, 2016; Shaw, 2014; Speller, 2015; Tanwattana & Toyoda, 2018)</p>	Their effect is small because they do not affect social and political structures (e.g. policies and social norms), which determine the majority of people's practices.
Non-activist Actions in the Public Sphere	The actions are meant to support the implementation of policies, regulations, and interventions to mitigate flooding issues in their communities, regions, nations, and international contexts.	<ul style="list-style-type: none"> - Cooperating with environmental regulations and FRM initiatives (e.g. volunteering to assist in flood evacuation, relief, and recovery; and providing knowledge and opinions for designing national and local FRM strategies) - Willingly paying higher taxes for environmental protection and FRM - Supporting environmental organisations financially <p>See e.g. (Cheung & Feldman, 2019; McEwen & Jones, 2012; Mitchell et al., 2008; Speller, 2015; Tanwattana & Toyoda, 2018)</p>	They have limited capacity to initiate new policies, regulations, or interventions to address environmental issues.

Type of public engagement in FRM	Characteristics of action	Examples of actions	Limitations
Activism (social/political leadership actions)	The actions are meant to impel social and political change to mitigate flooding issues in their communities, regions, nations, and international contexts.	<ul style="list-style-type: none"> - Actively taking part in environmental organisations and demonstrations to request a better structure for FRM (e.g. writing open letters to the government and organising protests for better FRM plans and implementations) - initiating interventions to address flooding issues (e.g. community clean-up campaigns) (See e.g. Da-Silva-Rosa et al., 2015; Mitchell et al., 2008)	Although activism offers the most opportunity for the public to express their voice, it rarely affects policies and plans.

Focusing on FRM, the complexity of flooding issues underscores the fact that flood risks cannot be sustainably mitigated by a single actor (e.g. an individual or an organisation). It requires collaboration and the accumulation of capital from all sectors of society. Research evidence shows that parts of the capital for FRM only exist among the public. For example, Dufty (2008) and McEwen & Jones (2012) argue that as FRM is context-specific, expert knowledge alone cannot effectively develop FRM policies and practices. It also needs to be informed by local knowledge (i.e. local flood characteristics) and the experiences of those who encounter flooding issues. This underlines how important it is to encourage citizens to act in the public sphere to promote collaboration and build up capital for FRM in society.

Although public engagement in FRM has been promoted for the public's own benefit, previous research (e.g. Evers, 2012; Jenkins, 2000; Speller, 2015; Speller & Ravenscroft, 2005) shows that encouraging the public to get involved with their local, national, and global issues is not an easy task due to the complex interplay between several factors (e.g. individuals' knowledge and awareness of flooding issues and social and political context). Given this, several researchers (e.g. Dufty, 2008; Evers, 2012; Jenkins, 2000; Speller, 2015; Speller & Ravenscroft, 2005; Stern, 2000) suggest that an understanding of the complex factors that influence public engagement in socio-environmental issues, particularly FRM, is essential for encouraging the public to engage with addressing the issues effectively. What are the factors? How do they influence public engagement in addressing flooding issues? I will explore the answers to these questions in the following section.

2.3 Looking for engagement: Factors influencing citizen engagement in flood risk management

According to my review, a framework or model to inform about all factors that influence public engagement in FRM has yet to be developed in the research literature. I therefore begin with exploring existing models that represent the complexity of factors affecting pro-environmental behaviours in general, which I will describe below.

2.3.1 Models of pro-environmental behaviours

For decades, an understanding of the complexity of factors that influence people's decisions about whether and how to address environmental issues has been developed. From a simple 'knowledge-attitudes-action model' (Ramsey & Rickson, 1976), several researchers proposed new models that represent the complexity of factors that influence individuals' environmental actions (Hawthorne & Alabaster, 1999; Hines et al., 1987; Hungerford & Volk, 1990; McKinley & Fletcher, 2012; Monte & Reis, 2021; Takahashi et al., 2017). Some of these models were developed to use in their specific areas of interest, such as addressing marine issues (McKinley & Fletcher, 2012).

In this sub-section, it is not my aim to describe all of these models. Instead, I aim to present some of them to highlight key issues in the complexity of factors that influence individuals' engagement with addressing environmental issues. In doing so, I will describe two significant models that are distinct in their features and discuss their advantages and limitations if the models were used as a framework to search for variables that influence citizen engagement in FRM.

(1) Hines et al.'s (1987) model of responsible environmental behaviour

Hines et al. (1987) proposed this responsible environmental behaviour model (Figure 2.4) based on the analysis of 128 studies on variables influencing responsible environmental behaviour. Hines et al. (1987) argue that two main factors determine responsible environmental behaviours: "*intention to act*" and "*situational factors*." As shown in Figure 2.4, the intention to act is influenced by a number of factors. Situational factors (e.g. economic constraints, social pressures, and opportunities to choose different actions) "*serve to either counteract or strengthen*" individuals' actions (Hines et al., 1987, p. 7).

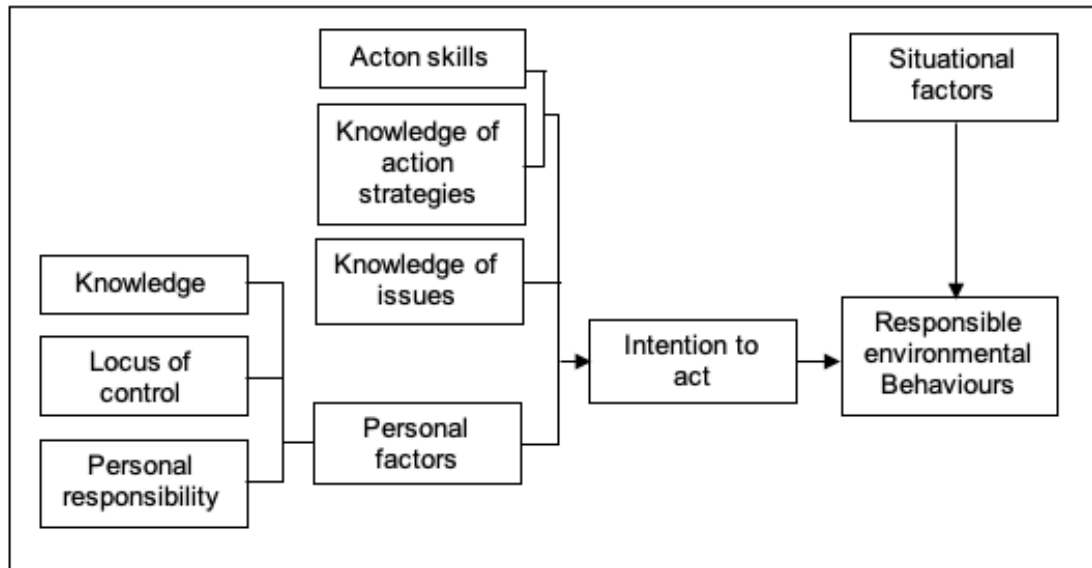


Figure 2.4 Hines et al.'s (1987) model of responsible environmental behaviour

Note: Locus of control = expectancy of reinforcement, the higher the locus of control an individual possesses, the more intention they have to act to achieve their goals.

The significant advantage of this model is that it demonstrates the significance of both personal (psychological) and situational aspects of the variables that determine an individual's engagement with addressing environmental issues. This significance of both personal (psychological) and situational factors is also advocated later by several researchers (e.g. Bryman, 2012; Hawthorne & Alabaster, 1999; Stern, 2000). For example, Bryman (2012) argues that people's behaviours cannot be understood unless the specific environment in which they function and operate is explored. Situational factors (i.e. social and economic conditions) affect individuals' ability to act.

However, this model is not without its limitations. The model does not cover affective factors (e.g. empathy for nature and other beings), which have been found to significantly influence people's intention to address socio-environmental issues (Brown et al., 2019; Collado et al., 2020; Monte & Reis, 2021). Thus, using this model as a framework to explore factors that influence public engagement in FRM could lead me to overlook the importance of affective factors.

(2) Hungerford & Volk's (1990) model of environmental citizenship behaviour

Unlike Hines et al.'s (1987) model, Hungerford & Volk's (1990) model (Figure 2.5) focuses solely on variables in the personal domain in detail. As illustrated in Figure 2.5 below, the model classifies personal variables into three categories: entry-level, ownership, and empowerment. Within each category, the factors are classified, in accordance with the level of their influence, into two different levels: major and minor. Factors at the minor level appear to be sub-factors that influence factors at the major level.

When compared to Hines et al.'s (1987) model, Hungerford and Volk's (1990) model offers two advantages. Firstly, the model covers affective variables ("environmental sensitivity," which is defined by the authors as an empathetic perspective toward the environment). Second, their systematic classification of the variables provides a better comprehension of how personal factors operate. Despite these advantages, using Hungerford and Volk's model as a framework to study people's pro-environmental actions may lead researchers to overlook the influence of situational factors.

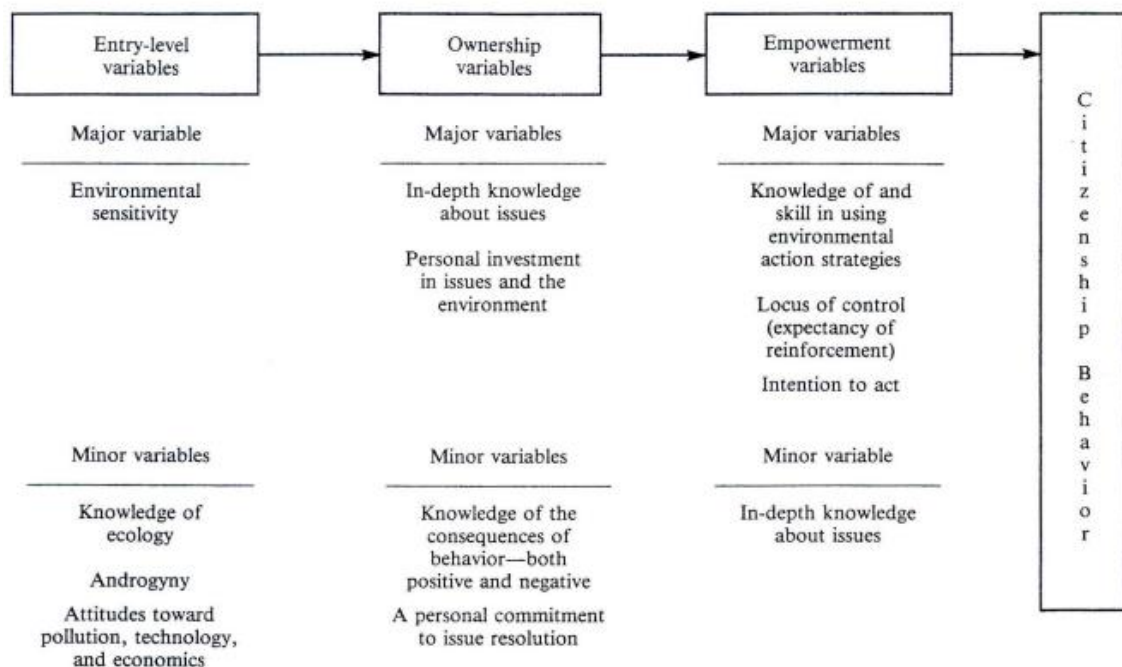


Figure 2.5 Hungerford & Volk's (1990) model of environmental citizenship behaviour

Note: The term *androgyny* is defined by the authors as psychological characteristics associated with individuals who are active in helping resolve environmental issues, such as being sympathetic and assertive.

In summary, the key information that I acquired from exploring some models of pro-environmental behaviours, as described above, is the fact that there are a number of factors in both personal and situational dimensions that influence citizen engagement in addressing socio-environmental issues. It informs my search for factors that influence public engagement in flood risk management (FRM) in particular. That is, I searched for the factors in both dimensions, which I will describe and discuss in the following sub-section.

2.3.2 Factors influencing public engagement in flood risk management

In the research literature, factors influencing public engagement in FRM in both personal ('psychological') and situational ('structural') dimensions are evident. However, the factors in these dimensions have usually been studied separately. On one hand, psychological research focuses on personal factors. The research seeks to identify cognitive and affective factors that influence people's flood risk mitigation behaviour (Burton et al., 1978; Kates, 1971). On the other hand, socio-political research aims to identify structural elements (i.e. political, cultural, economic, and social conditions) that affect people's actions to address disaster risk management (Cannon, 1994; Hewitt, 1983; Torry, 1979; Waddell, 1977). I will discuss the factors in each dimension below.

Factors in the personal dimension

(1) Flood risk perception

Risk perception generally refers to the perception of the potential negative consequences of hazards (e.g. extreme environmental events) (Becker et al., 2014; Bubeck et al., 2012; Grothmann & Reusswig, 2006). Slovic (1987) defines risk perception as the judgement of intuitive risk expressed by lay citizens to evaluate hazards. Raaijmakers et al. (2008) argue that risk perception is a combination of three specific factors: awareness, worry, and preparedness. It typically encompasses an individual's beliefs, attitudes, judgments, and feelings (e.g., fear and insecurity) towards a particular event (Bubeck et al., 2012; Kellens et al., 2013).

Several researchers argue that flood risk perception has a significant relationship with risk prevention awareness and response behaviours (Birkholz & Jeffrey, 2013; Grothmann & Reusswig, 2006; Ho et al., 2008; Ludy & Kondolf, 2012; McEwen et al., 2017; Nash et al., 2019; Peacock et al., 2005). If a hazard is perceived as serious enough, it could motivate individuals to take action to reduce their risk of the hazard. Grothmann and Patt (2005) claim that it is likely that individuals who perceive a higher level of risk tend to undertake risk reduction strategies more than those who perceive a lower risk. Likewise, based on an online survey of 300 respondents in South Virginia (USA), Knocke and Kolivras (2007) claim that perceived risk plays a key role in shaping the way an individual approaches flash floods; people who had a lower level of concern expressed less response to flood risk prevention measures (e.g. tracking flash flood events).

Most studies on disaster risk reduction (DRR) agree that risk perception is socioculturally constructed (Cardona, 2004). It is influenced by numerous factors, including, but not limited to, an individual's physical location, flood characteristics, residence characteristics, size of consequences, range of impact, direct experience, socio-economic and demographic profiles, related knowledge, indirect experiences, cultural-historical context, religious context, and political context (Douglas, 1966; Joffe, 2003; Lechowska, 2018; López-Marrero, 2010; Slovic, 2000; Slovic, Flynn & Layman, 1991). It should be noted that these factors function together in a sophisticated way. It therefore would be inaccurate to accept that one factor can predict the level of risk perception.

Davis & Hall (1999) and Tucker et al. (2010), for example, show that people in communities that are frequently exposed to environmental hazards do not always consider such hazards to be dangerous, risky, or problematic. Instead, they became accustomed to the hazards and developed strategies to deal with them. Cardona (2004) argues that everyday social risks (short-term personal threats) (e.g. insecure job) can overshadow people's perception of longer-term issues (e.g. flooding issues). These studies highlight the role of situational factors in individuals' perception of flood risk.

(2) Perceived self-efficacy in action-taking

Perceived self-efficacy in action-taking refers to the extent to which individuals believe in the effectiveness of their actions to influence situational

outcomes. People who possess a higher perceived self-efficacy tend to take more actions to alter circumstances. Honneth (1992), translated and referred to by Van Oenen (2002, p. 119), claims that:

“a lack of recognition of their ability to influence the change of situations, which results in inadequately developed forms of self-confidence, self-respect, or self-esteem, leads to insufficient opportunities to manifest and express oneself as a citizen.”

Regarding its definition, perceived self-efficacy in action-taking appears to be similar to “*locus of control*” in Hines et al.’s (1987) and Hungerford & Volk’s (1990) models of pro-environmental behaviours, as discussed earlier in the above subsection.

Newman et al. (2005) argue that a lack of belief in their ability to change their living conditions is a significant factor that prevents socially excluded people from being active citizens. Their study shows that the research respondents who reflected a feeling of powerlessness over their living conditions illustrated no interest in taking political action, though they acknowledged that those political decisions are related to their well-being. Likewise, Evers (2012) found that in European countries, citizens’ feelings of insignificance (powerlessness and hopelessness) in affecting flood risk management (FRM) policies and plans are another significant factor that prevents citizens from taking part in the FRM decision-making process.

Several researchers argue that perceived self-efficacy is influenced by several other factors in both personal and situational dimensions. The personal factors include, but are not limited to, individuals’ sense of belonging to their community, attachment to place, coping style, sense of collective efficacy, self-confidence, self-respect, self-esteem, ability to express themselves, experiences of participating in the democratic participation process, and resources (e.g. time and budget) (Cottrell, 2006; Evers, 2012; Hooge, 2001; Newman et al., 2005; Paton et al., 2001). The situational factors include, but are not limited to, opportunities to take action and support (e.g. channels to communicate their ideas and needs) (Evers, 2012; Hooge, 2001).

(3) Empathy with flood victims

Eisenberg and Miller (1987) define empathy as an individual's ability to feel what someone else feels and to understand what someone else thinks. Several researchers argue that empathy with those who are impacted by extreme environmental events is a significant motivator that encourages people to take action to address environmental issues (Brown et al., 2019; Hungerford & Volk, 1990; Keller, 2016; Marjanovic et al., 2012; Zhou et al., 2003). Given that decision-makers in disaster risk management policies and plans are usually not the people who are impacted by such policies and plans, Keller (2016) contends that empathy among the decision-makers is essential to good decision-making in disaster risk management.

The positive relationship between empathy and supportive behaviours is evident in numerous psychological studies. For instance, Harmon-Jones et al. (2003) found that when compared to those who expressed lower empathy, the participants who expressed higher empathy volunteered more of their time and money to help a family in distress. However, empathy is not without its detractors. According to Brown et al. (2019), there are two main criticisms of the relationship between empathy and supportive behaviours: the term is defined and measured differently across disciplines, and empathy with others does not necessarily lead to pro-social or pro-environmental behaviour.

For instance, Eisenberg and Miller (1987) found a low-to-moderate association between empathy and prosocial behaviours. Zhou et al. (2003) argue that this variation in research findings may be a result of how empathy was measured and the differences in the sorts of prosocial behaviours that each researcher considered in their studies. Bekkers's (2006) study demonstrates how selecting different types of action to measure the effect of empathy shapes research results. The author found that affective empathy promotes charitable giving more than other types of prosocial responses (e.g. blood and organ donation). This highlights that empathy is not the only factor that influences citizens' pro-social or pro-environmental behaviour. According to Brown et al. (2019) and Stueber (2019), there is no perfect way to measure empathy. Most researchers in the field have focused on investigating the variables associated with empathy, such as individuals' expression of sympathy for others and awareness of the impact of a particular circumstance (e.g. disasters) on others.

(4) Judgement of human responsibility

Judgement of human responsibility (perceived responsibility) refers to the extent to which an individual perceives environmental disasters as a result of human action, making them foreseeable and, to some extent, preventable (Marjanovic et al., 2012). According to Hines et al. (1987), Hungerford & Volk (1990), and Stern (2000), a judgement of human responsibility is one of the critical factors that promote citizen engagement in addressing socio-environmental issues. Hungerford and Volk (1990) argue that before individuals can engage in responsible citizenship behaviour, they must understand the implications of human actions on the environment and other beings. When individuals have a judgement of human responsibility, they appear to be more likely to help mitigate those issues (Hungerford & Volk, 1990).

Marjanovic et al.'s (2012) studied how Canadian people responded to Hurricane Katrina victims. The authors found that the participants who believed that the hurricane was a consequence of human impact on the environment tended to help the victims more than those who considered that the hurricane was caused by uncontrollable factors (e.g. nature and supernatural forces). Based on their findings, the authors argue that people who see themselves as a cause of disasters tend to feel more responsible for helping the victims who are affected by the consequences of their actions. Thus, these researchers (Hines et al., 1987; Hungerford and Volk, 1990; Marjanovic et al., 2012; Stern, 2000) argue that developing people's judgments of human responsibility is critical to increasing citizen engagement in addressing socio-environmental issues.

(5) Flood experience

Researchers (Bickerstaff, 2004; Hulme, 2012) argue that life experiences are a vital way for people to build their understanding of the environment (i.e. its conditions and changes). Past disaster experiences play a significant role in motivating people to take risk mitigation action by increasing people's risk perception of environmental hazards, which consequently influences their risk mitigation behaviours (Baldassare & Katz, 1992; Burton et al., 1993; Ge et al., 2021; Grothmann & Reusswig, 2006; Laska, 1990; Trenberth et al., 2015; Weinstein, 1989).

Empirical studies provide evidence that individuals who have experienced severe losses from flood events tend to be more likely to take action to mitigate their flood risk. Based on their study of people's willingness to take action on global warming, Fortner et al. (2000) found that experiencing the impacts of climate change appears to motivate people to seek out information to help them mitigate such impacts. Likewise, according to the data collected from 66 households that were hit by the severe flood in 1997 in Poland, Zaleskiewicz et al. (2002) found that past flood experience was a significant motive for people to buy flood insurance.

In turn, based on their survey of 702 residents in Nanjing, China, Ge et al. (2021) found that, even though the area is prone to flooding, flood risk was neglected by most of the respondents because they had never experienced floods in the area before (flood likelihood in the area has been reduced by flood protection systems). Therefore, they did not relate themselves to the impacts of flooding. Siegrist and Gutscher (2008) found similar results from their investigation of 201 people, including those who were affected by a severe flood and those who were not. The participants who had never experienced floods often underestimated the negative impacts of floods, which resulted in them having a limited intention to mitigate their flood risk. Based on the findings, the authors argue that to enhance public engagement in FRM, people need to be supported to visualise the actual impacts of flood disasters

Several scholars also advise that when compared to indirect experience, direct experience has a more substantial effect on peoples' intentions to mitigate their risk of flooding; people with direct flood experiences are more likely to accept that flooding poses a serious risk (de Man & Simpson-Housley, 1988; Hansson, Noulles & Bellovich, 1982; Payne & Pigram, 1981). Constantly experiencing environmental hazards can enable people to develop adaptive measures to cope with the hazards; as time passes, these measures can accumulate into traditional knowledge and culture. In contrast, second-hand sources of information (e.g. mass media) tend to have a limited influence on individuals' flood risk perception (Gunter & Wober, 1983).

Based on exploring the link between flood experiences, climate change risk perceptions, and pro-environmental behaviours of local communities in the UK, Whitmarsh (2008) found no significant correlation between flood experience and taking action to tackle climate change. The author argues that this tends to be

because those respondents who have experienced floods had a limited perception that climate change is a cause of flood incidents. The findings highlight that although disaster experiences might make people aware of disaster risks, the experiences appear to be insufficient to inform people how to mitigate the causes of disaster risks. For example, if people do not know that climate change can lead to flooding problems, how will they perceive addressing climate change as a way to lower the risk of flooding? Thus, as argued by many researchers (Hines et al., 1987; Hungerford and Volk, 1990; Smederevac-Lalic et al., 2020), in-depth knowledge about the causes of flooding issues is essential knowledge for people to address FRM.

Factors in the situational dimension

(1) Political factors

As environmental risk management takes place in the political landscape (Levinson et al., 2020; Wisner et al., 2004), as discussed in section 2.2, many researchers agree that public engagement in disaster risk reduction policy and plan decision-making will lead to more effective FRM (McEwen & Jones, 2012; Phanthuwongpakdee, 2016; Speller, 2015; Stern, 2000; Wisner et al., 2004). Ideally, in democratic nations, encouraging citizen engagement in the development of local, national, and international policies and strategies to mitigate disaster risks should be a common practice of the state. However, in reality, the socio-political operation in democratic nations does not always support such levels of citizen engagement (Arnstein, 1969; Levinson, 2010).

Based on the investigation of numerous public participation projects in the USA, Arnstein (1969) claims that traditional powerholders' political views are a significant roadblock that prevents distributing decision-making powers on policies and plans to citizens:

“These roadblocks lie on both sides of the simplistic fence. On the powerholders' side, they include racism, paternalism, and resistance to power redistribution. On the have-nots' side, they include inadequacies of the poor community's political socioeconomic infrastructure and knowledgebase, plus difficulties of organizing a representative and accountable citizens' group in the face of futility, alienation, and distrust” (p. 217).

Evers (2012) and Wehn et al. (2015) argue that their negative perception of public engagement is a main reason for powerholders' and key actors' (e.g. policymakers and state authorities) to avoid supporting citizens to engage with the development of FRM policy and plan. Wehn et al. (2015) investigated national authorities' perceptions of the development of mechanisms for engaging citizens in FRM in three national contexts (16 participants in total): Doncaster (UK), Delfland (the Netherlands), and Vicenza (Italy). They found that the perceptions of citizen participation in FRM (i.e. citizens' roles and degrees of their influence) varied among the authorities, which resulted in differences in how they designed mechanisms to foster citizen engagement in the development of FRM policy and plan.

In relation to the management of socioscientific issues, powerholders and experts may avoid engaging the public in the management decision-making processes because of their fear that the engagement will hinder their implementation of scientific solutions for the issues (Arnstein, 1969; Evers, 2012; Levinson, 2010). For example, based on the author's experience in promoting citizen engagement in FRM in the EU context, Evers (2012) argues that politicians' fear of being restricted by the public is a significant reason for them to avoid promoting such engagement.

In this sense, in a setting where powerholders do not prioritise distributing decision-making power to the public, there tends to be a lack of support systems, in terms of knowledge bases and infrastructure, created to enable the public to actively participate in democratic processes. Da-Silva-Rosa et al. (2015) found that although (after participating in disaster risk reduction education) young citizens in Brazil wanted to provide their ideas to inform their communities' FRM plans, acting out their intentions was limited by a lack of opportunity and platform for them to do so. This highlights the need for the public to take activism action (as discussed earlier in section 2.2.2).

(2) Cultural factors

Culture is argued to play a significant role in citizen engagement in FRM, especially in the context of flood adaptation strategies and pro-environmental behaviours (Bickerstaff, 2004; Boholm, 2003; Hulme, 2012). Several studies found that local knowledge and cultural values influence the capacity of a

community to adapt and cope with environmental hazards (Da-Silva-Rosa et al., 2015; Egeru, 2012; Manyena, 2006; Mitchell et al., 2008; Mustafa, 2013). While some cultural practices hinder community resilience toward environmental hazards (Da-Silva-Rosa et al., 2015), others promote such resilience (Berkes, 2007, 2000; Fletcher et al., 2013; Floke, 2004; Maldonado, 2014; Takeuchi & Shaw, 2008).

For example, Da-Silva-Rosa et al. (2015) found that although they were informed that littering causes greater flood risks to their community, perceiving dumping litter into watercourses as their common disposal management approach (a part of their living culture) prevented locals in Brazil from adopting pro-environmental behaviours. Texier (2008) found the same constraint in two kampung communities, traditional villages of indigenous people or urban slum areas, in Jakarta, Indonesia.

On the other hand, many research studies found that some cultural practices and local (or indigenous) knowledge of communities, which accumulated through trial and error, assisted the communities in coping with extreme environmental events (Berkes, 2004; Colding et al., 2003; Delgado-Serrano et al., 2017; Kellert et al., 2000; Phanthuwongpakdee, 2016). For instance, in Thailand, the traditional stilt house (Figure 2.6) is how Thai communities in the past used to live harmoniously with floods during the wet season. It appears that if all houses were elevated this way, there would be less property and asset damage.

Arunotai (2008) and Phanthuwongpakdee (2016) argue that these useful traditional cultures and knowledge for coping with floods are usually overlooked and forgotten in FRM policies and strategies and are seldom passed on to new generations because they are perceived as outdated and ineffective. For example, at present, this type of house no longer appears in urban areas of Thailand, even in flood-prone areas. This example shows how changes in cultural values from the traditional to the modern way of living influence changes in people's practice toward flood circumstances, which result in the community becoming more vulnerable to floods.

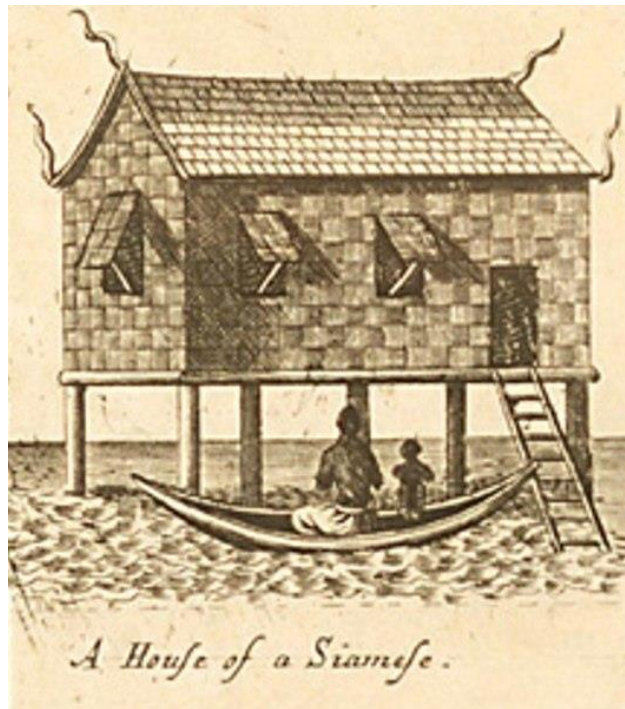


Figure 2.6 Thai traditional (Siamese) house

The picture is depicted by Simon de la Loubere during his mission to Siam (previous name of Thailand) between 1687-88 AD (La Loubère, 1693, p. 24)

Some researchers also found a correlation between traits, religious or spiritual beliefs, and resilience to disasters. Jang and Wang (2009) found that the traits unique to the Hakka people (a group of Chinese with a relatively distinct culture in Taiwan), including being determined, persistent, hard-working, flexible, and having positive thinking, played a crucial role in the community's being resilient to the 921 Earthquake in 1999. Nathanson (2003) claims that spiritual beliefs assist victims to develop their inner strengths to recover from disaster impacts. Likewise, Canda and Furman (2010) and Siddiqi (2014) indicate that some religious beliefs inspire people to help disaster victims by advancing their empathy.

Regarding the positive effects of some cultures and traditional knowledge on disaster risk management, researchers (e.g. Berkes, 2000; Jang and Wang, 2009; Phanthuwongpakdee, 2016) argue that preserving and promoting these cultures and knowledge is a key way to building social resilience to environmental risks.

(3) Economic factors

Economic conditions are evident in the research literature as another significant factor that influences public engagement in environmental risk management. In the context of the great disparity in accessing resources between rich and poor people, economic reasons constrain poor individuals from taking efforts to reduce their own and collective disaster risks in two significant ways.

First, low and insecure income is one of the immediate risks that people face on a day-to-day basis, which often impedes their perceptions of disaster risk (long-term risk) (Cardona, 2004). López-Marrero and Yarnal (2010) found that residents in two flood-prone communities in Puerto Rico considered flood risk as “a” risk, but not the most important. When compared to disasters, they perceived that other competing risks (i.e. health conditions, family financial situations and well-being, and land tenure) were more urgent for them to deal with.

Second, Wisner et al. (2004) argue that poverty also limits people’s choices of service and product consumption, as well as their access to resources of knowledge, information, and power to deal with disasters. This seems to explain why actions to mitigate disaster risks (i.e. adaptive measures, pro-environmental actions, and participation in the development of disaster risk management policies and plans) are rarely adopted by people with living difficulties; doing so costs them extra financial resources and time, which they need to use to maintain their daily lives.

Texier (2008) found that although residents in Jakarta’s urban slum areas were aware of flood risks in the area, they still decided to live in the areas because nowhere else was cheaper. The communities also chose to dump their household garbage into rivers because, from their perspectives, it was the only way to prevent danger from household waste (e.g. the proliferation of rats and insects) without costing them extra money. Nigg’s (1996) and Penning-Rowsell’s (1996) studies come up with similar findings. Regarding its negative effects on citizen engagement in environmental risk management, researchers (Cardona, 2004; López-Marrero & Yarnal, 2010; Nigg, 1996; Penning-Rowsell, 1996; Texier, 2008; Wisner et al., 2004) suggest that addressing economic constraints is also essential to strengthen people’s capacity to deal with environmental risks.

(4) Social factors

Researchers argue that social networks are another key factor in improving environmental risk management. According to Aldrich (2012), a social network is defined as a social bond that sets up ties between a set of actors. Social networks generally comprise supportive connections from family, community organisations (e.g., temples, schools, mosques, and community clubs), and stakeholders (i.e. government agencies, business sectors, other civil organisations and the public).

Coles & Buckle (2004) and Paton (2006) argue that building social networks is key to strengthening community resilience. A community with a better supportive connection between the community's members tends to have a more robust adaptive capacity to deal with environmental hazards. The capacity of one community to mitigate adversity is significantly enhanced when members of the community (i.e. government agencies, civil societies, businesses, and the general public) can minimise conflicts and develop mutual understanding and respect among them (Kato et al., 1996; Pooley et al., 2006; Wisner et al., 2004).

The benefit of social networks is discussed earlier (section 2.2.2) through Bourdieu's (1986, 1984) concept of capital. That is, for one actor (e.g. and individual or a community) to effectively mitigate environmental risks, the actor requires an accumulation of capital that supports environmental risk management (e.g. knowledge and power) (Berkes, 2007; McEwen & Jones, 2012). Wisner et al. (2004, 1994) claim that people who have more access to social support cope better than those who have less. Thus, social networks seem to be the only way to permit the accumulation of such capital. According to Yuen et al. (2013), social networks also facilitate social learning processes; people are encouraged to recognise the use of existing knowledge and generate new knowledge, which can then be employed to guide their future actions toward environmental hazards.

Coles and Buckle (2004) further add that as we live in an ecologically interdependent world (see e.g. Dobson, 2003), social networks are not important only within one community but also across communities. In many cases of calamitous incidents, such as floods and hurricanes, a single social system cannot be easily outstripped (Mustafa, 2013). Thus, the connection across networks (e.g. between countries and regions within a country) could strengthen the collective capacity to deal with extreme environmental events.

Norris et al. (2002) and Walsh (2007) found that during difficult circumstances, people rely more often, with greater comfort, on their family and friends than outsiders (even though these outsiders are professional helpers or experts). According to their study of factors that influence resilience to disaster events among people in Kuwait, Al Naser and Sandman (2000) found that the participants from extended families tend to be more resilient than those from nuclear families. Likewise, Kato et al. (1996) found that older evacuees of the 1995 Kobe Earthquake in Japan experienced less emotional affliction than younger ones. The authors contend that having lived in the community for a longer period helped the elderly establish supportive networks in the shelters faster than younger people. They further argue that, like many Asian countries, in Japan, the family-oriented collectivist culture, which prioritises the needs of the family over the needs of each individual, appears to ensure robust family support for the elderly. The last two studies (Al Naser & Sandman, 2000; Kato et al., 1996) highlight the close interrelationship between social and cultural factors. That is, while culture is expanded through social connections, social connections are formed as a part of the culture.

In summary, in this sub-section, I explored factors influencing public engagement in FRM that are evident in the research literature on disaster risk management. Even though there are possibly other factors that I might not come across in this review, the review already helps us to envisage the complexity of factors that influence public engagement in FRM. That is, the review informs us that a person's decision about whether or not to get involved with FRM and how to get involved is shaped by the complex interplay of several factors in both personal and situational dimensions. Factors in the personal dimension include *flood risk perception, perceived self-efficacy in action-taking, empathy with flood victims, a judgement of human responsibility, and flood experience*. These personal factors and opportunities to take action are shaped by situational factors, including *political, cultural, economic, and social* factors.

Concerning the absence of a holistic framework for evaluating public engagement in FRM in particular, based on the result of my review in sections 2.2.2, 2.3.1, and 2.3.2, I will propose a holistic framework to assist the evaluation of such engagement.

2.3.3 Proposing a holistic framework for evaluating public engagement in flood risk management

Based on the public's potential actions in FRM (section 2.2.2), models of pro-environmental behaviours (section 2.3.1), and factors influencing public engagement in FRM (section 2.3.2), a holistic framework for evaluating public engagement in FRM can be depicted as in Figure 2.7. The framework demonstrates two aspects of individuals' engagement with FRM: types of engagement and their influencing variables.

For the types of engagement, adapted from Stern's (2000) types of action to address socio-environmental issues (section 2.2.2), the framework demonstrates four main types of action that people can take regarding FRM: *Take no action*, *Take action in the private sphere*, *Take non-activist action in the public sphere*, and *Take activism (social/political leadership) action*. As discussed earlier in section 2.2.2, I argue that taking non-activist action in the public sphere and activism (social or political leadership) action have the greatest potential to foster the accumulation of capital for FRM. Since mitigating flooding issues requires collective action, taking action in the public sphere appears to be the only way to promote the exchange of knowledge (e.g. expert and local knowledge) and build collaborations among different stakeholders to address the issues (Berkes, 2007; McEwen & Jones, 2012).

For the variables, the framework demonstrates factors that influence public engagement in FRM in both personal and situational dimensions and their functions. By adapting how Hungerford and Volk (1990) organise the factors that determine pro-environmental behaviours (section 2.3.1), as shown in Figure 2.7, I classify the factors that affect public engagement in FRM in the personal dimension into three levels: *Entry*, *Ownership* and *Empowerment*. All factors in the personal dimension can be referred to as capital for FRM. All of them have a positive effect on encouraging individuals to engage in addressing flooding issues; individuals who possess a higher amount of each of these factors tend to be more likely to take action to address FRM.

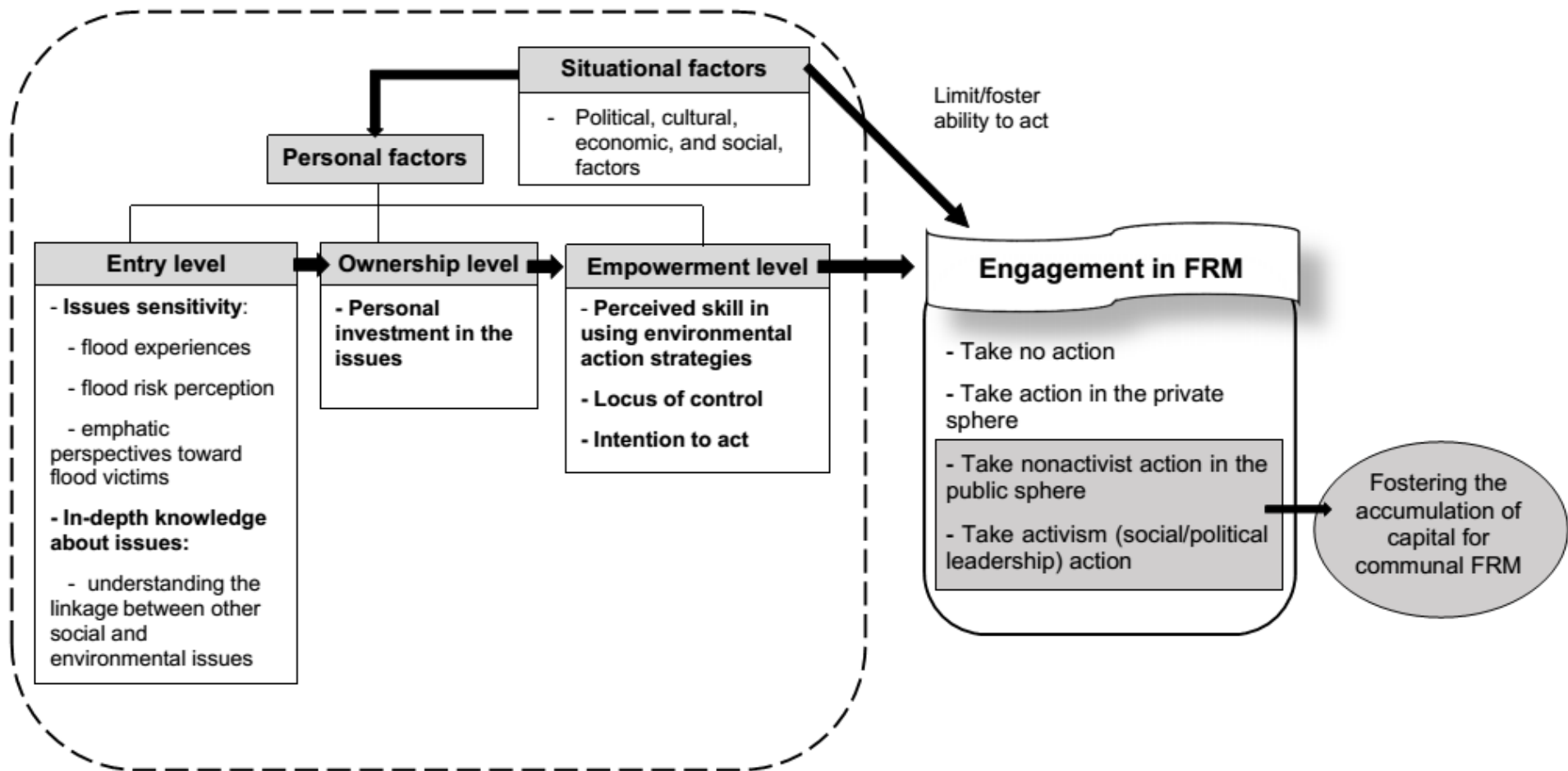


Figure 2.7 Proposed framework for evaluating public engagement in flood risk management

Although the levels of personal factors appear to operate in a linear fashion, these factors operate in some sort of synergistic manner. For example, individuals who perceive higher flood risk intend to invest more in addressing flooding issues than those who perceive less flood risk, but not always. They may do nothing if they do not know flood risk mitigation strategies (low perceived skill in using environmental action strategies).

Factors in the situational dimension (i.e. political, cultural, economic, and social factors) play a significant role in strengthening or weakening those personal factors and limiting or fostering people's ability to act towards FRM, as discussed earlier in sections 2.3.1 and 2.3.2 above. For example, as revealed by Da-Silva-Rosa et al. (2015), although the youths who participated in their study had intentions to influence FRM policies and plans in their communities (in Brazil), their intentions were not put into practice due to a lack of opportunities for them to connect with their communities.

I argue that this proposed framework can assist researchers and practitioners to assess the scenario of public engagement in FRM and identify limiting factors that must be addressed to promote such engagement. In the following section, I will discuss the role of education in supporting the development of FRM.

2.4 Looking for engagement: Education and flood risk management

2.4.1 Education and sustainable societies

Education has been used as a fundamental tool to promote behavioural change in citizens in many aspects, including promoting active and responsible citizenship for building sustainable societies (Hadjichambis & Reis, 2020). The goal of promoting citizenship for building sustainable societies is incorporated in the fields of Science Education (SE), Environmental Education (EE), Education for Sustainability (EfS), Citizenship Education (CE), Education for Disaster Risk Reduction (EDRR), and Education for Environmental Citizenship (EEC).

Many studies in SE underline the role of science education in promoting citizen participation in decision-making processes concerning Science, Technology, Society, and Environment (STSE) (controversial socio-scientific

issues) (Levinson, 2018, 2010; Roth & Désautels, 2004). According to many scholars (Chawla & Cushing, 2007; Schusler et al., 2009), the goal of EE is to develop citizens' ability to act to mitigate environmental issues. However, Chawla and Cushing (2007) argue that educational practices in EE usually focus only on promoting citizens to adopt pro-environmental behaviours (action in the private sphere). In other words, collective actions in the public sphere, which are significant actions for addressing socio-environmental issues (discussed earlier in section 2.2.2), typically are overlooked in EE (Hadjichambis & Reis, 2020).

EfS attempts to promote citizens' values and motivation to act and live for sustainability through the development of citizens' understanding of the interconnection of the three pillars of sustainability: environmental, social and economic (United Nations, 2016). Similar to EE, some scholars (e.g. Du Pisani, 2006) critique that educational practices in EfS often overlook the social dimension of issues (social justice) and the socio-political engagement of citizens. CE (see e.g. Johnson & Morris, 2010) promotes citizens' understanding of how society is governed and their ability to take political action to address social issues, including environmental issues (Hadjichambis & Reis, 2020).

EDRR attempts to promote people's ability to minimise the adverse impacts of environmental hazards among those who are encountering extreme environmental events (Nakano & Yamori, 2021; Shaw, 2014). The field is often recognised as a part of EfS and a key to climate change adaptation strategy (UNISDR, 2004). Finally, EEC aims to promote citizens' ability to, individually and collectively, act and participate in society as an agent of change in the private and public spheres on a local, national, and global scale to address socio-environmental issues and injustices ('Environmental Citizenship') (Hadjichambis & Reis, 2020).

Regarding the ability of education to alter people's behaviour, undoubtedly, education has been assigned to support FRM in many nations around the world (Bosschaart et al., 2016; Molino Stewart, 2007), including Thailand (as discussed earlier in section 2.1.3). How has education been used to support FRM? What are the objectives or expected outcomes of flood education? What are the challenges or limitations of education for FRM? I will explore some answers to these questions in the following sub-section.

2.4.2 Education and flood risk management

According to Dufty (2008), most flood education programmes aim to build awareness about their local flood risks. The programmes expect that the increase in flood risk awareness will motivate citizens to help mitigate flooding issues and cope with future flood events (see Bosschaart et al., 2016). From Dufty's perspective (2008), almost all of these programmes are ineffective due to their poor design (i.e. using a deficit or top-down approach), not being evaluated, and short-term operation. The programmes usually overlook several factors beyond flood risk awareness that determine individuals' engagement in FRM in both personal and situational dimensions (as illustrated earlier in section 2.3). According to these limitations, Dufty (2008) recommends four points to improve the effectiveness of flood education.

First, education to promote public engagement in FRM has to be designed for the specific context in which the education intervention will be applied. In other words, understanding the factors influencing the intervention target audience's engagement with FRM is fundamental knowledge for developing effective education to promote such engagement. Second, in accordance with the first point and the fact that local knowledge (traditional and lay knowledge) is essential for the development of FRM policies and strategies (see e.g. McEwen et al., 2017; McEwen & Jones, 2012; Phanthuwongpakdee, 2016), the public should be invited to collaboratively design flood education programmes for their communities (as a co-designer).

Third, as the capital for FRM (e.g. local flood memories and knowledge of how to live with floods) are commonly fading from people's perceptions (see e.g. McEwen et al., 2017; McEwen & Jones, 2012; Phanthuwongpakdee, 2016), flood education needs to be operated in a long-term manner. Fourth, similar to other educational programmes, flood education programmes need summative and formative evaluations to inform the improvement of future programmes.

Early in this sub-section, Dufty (2008) critiques the ineffectiveness of using a deficit or top-down approach in designing flood education programmes. Regarding Dufty's criticism, I wonder whether, besides the deficit model, there are any other education models for promoting public engagement in addressing socio-environmental issues. My search for answers to the question found that in

Science Education, several models have been developed to promote such engagement, which I will describe below.

2.4.3 Education models for promoting citizen engagement in socioscientific issues: Models of science communication

According to Trench & Bucchi (2010) and Bubela et al. (2009), the field of science communication has emerged for decades to promote public engagement with socioscientific issues. Within the field, several models of science communication, which I will describe later in this sub-section, have been developed to enhance the quality of citizens' decision-making (in the public and private spheres) regarding socioscientific issues to raise national prosperity and enrich their quality of life (Bodmer, 2010). The field has been strongly influenced by the Public Understanding of Science (PUS) movement, initiated in the 1980s in the UK, which encourages scientists to communicate their work to the public and to perceive the task as a duty to do so (Bodmer, 2010).

Different models of science communication are evident in Bucchi's (2008) and Levinson's (2010) works. While Bucchi (2008) argues for three models of science communication: *deficit*, *dialogue*, and *participation*, Levinson (2010) contends for four of them: *deficit*, *deliberative*, *science education as praxis*, and *dissent and conflict*. Regarding some similarities between Bucchi's and Levinson's works, I merged the two works to understand the overall picture of models of science communication. The result is illustrated in Table 2.2 below. I can conclude that there are four models of science communication: *deficit*, *dialogue*, *participation*, and *dissent and conflict/action*, which are different in terms of their emphasis, communication models used, and objectives.

The deficit model

According to Bucchi (2008) and Pouliot (2009), the deficit model is characterised by a top-down communicational method in which scientific knowledge flows unidirectionally from the scientific experts to the non-experts (e.g. the public). Ziman (1991) contends that based on the notion of public ignorance of science, the model focuses on solely dealing with promoting

scientific literacy among the public. The goal of the model is therefore to establish a more welcoming and supportive climate for scientific development; the public is perceived within the model as a supporter of the scientific community (Ziman, 1991). As illustrated in Table 2.2, Bucchi (2008) and Levinson (2010) explain that the model emphasises the one-way transfer of knowledge, and therefore, prioritises scientific content.

Table 2.2 Models of science communication

Note: The information in this table was summarised from Bucchi’s (2008) and Levinson’s (2010) works.

Models of science communication	Emphasis	Communicational models	Objectives
Deficit	Scientific content	One-way transfer (from experts to non-experts), one-time	Transferring scientific knowledge, popularisation
Dialogue (deliberative)	Context	Consultation, negotiation, two-way, iterative	Discussing the implications of research; deliberating about context-oriented problems; making decisions
Participation (science education as praxis)	Content and context	Knowledge co-production, communal knowledge deviation, multi-directional, open-ended	Achieving scientific literacy as collective learning; acting for change; settings the aims, shaping the agenda of research
Dissent and conflict/action	Content and context (political literacy)	Knowledge is distributed, emergent on a need-to-know basis, multidirectional, and open-ended	Developing positive feelings of agency; attaining political understanding and action for changing the agenda of research; generating social and political change

Pouliot’s (2009) diagram of the deficit model (Figure 2.8) demonstrates that within the model, the public is perceived as an undifferentiated group of scientific illiterates, and the production and possession of scientific knowledge solely reside with scientific experts. In relation to flood risk management (FRM), several initiatives could illustrate this model, for example, providing knowledge about

flooding issues (e.g. through newsletters and social media) in order to encourage the public to act more to mitigate flooding issues.

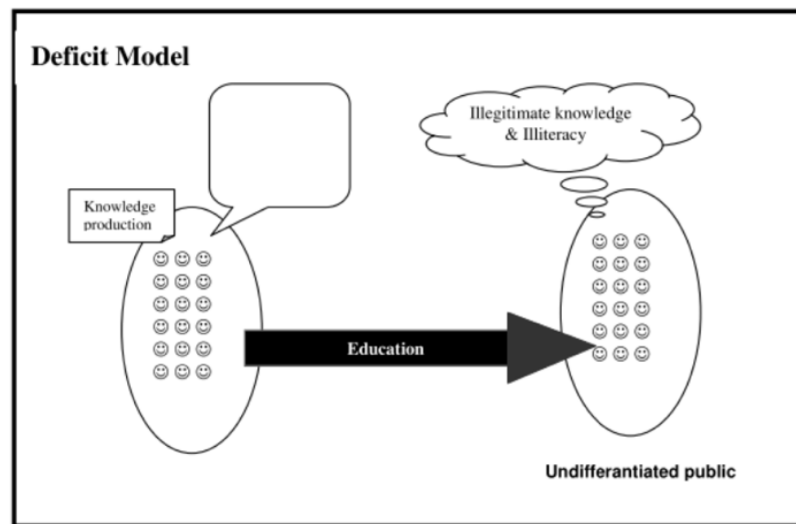


Figure 2.8 Deficit model (Pouliot, 2009)

The dialogic model

Regarding a crisis of trust between science and the public, the House of Lords (2000) argues in their *Science and Society* report that “*the view of the public understanding of science was demeaning and condescending and no longer enough*” (Bodmer, 2010, p. 158). The report underlines the need for opportunities for dialogue between science and society—a public engagement in the development of science (Bubela et al., 2009; Bucchi, 2008; Chilvers, 2012). Indeed, the critiques of a deficit model of science communication have been emerging since before the Science and Society report and have become more intense in the following decades (see e.g. Sturgis & Allum, 2004; Wynne, 1992). In this context, the dialogic model emerged as part of the movement in the field of Public Understanding of Science (PUS) (Bucchi, 2008).

Bucchi (2008) describes the dialogic model as a tool that leads to discussions of the implications of scientific research. As shown in Table 2.2 above, the model emphasises the context of scientific knowledge. Bubela et al. (2009, p. 515) claim that within this model, “*a variety of stakeholders can participate in a dialogue so that a plurality of views can inform research priorities*

and science policy.” Likewise, Levinson (2010) contends that the dialogic (deliberative) framework is an approach that is oriented to solve context-oriented problems. The author further argues that (genuine) dialogue for solving socio-scientific issues should be understood in terms of deliberative democracy in which everyone is free and equal to “supply reasons to settle compelling questions on which they have divergent views” (p.86).

In doing so, Levinson (2010) and Pouliot (2009) underline the need for spaces that offer opportunities for dialogue between divergent stakeholders to emerge. Pouliot’s (2009) diagram of the dialogic model (Figure 2.9) demonstrates that within this model, non-scientific experts’ knowledge “is conceived of as enriching and complexifying the problematization of sociotechnical issues” (p. 53).

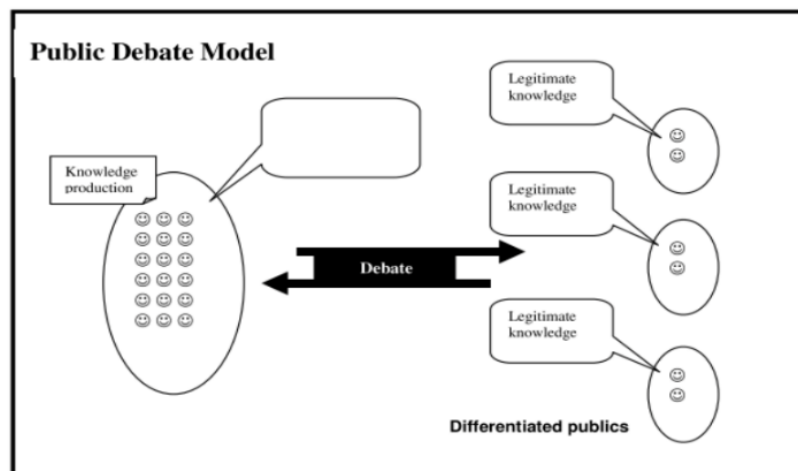


Figure 2.9 Dialogic (public debate) model (Pouliot, 2009)

Deliberative dialogue (public debate) can take place in different institutional contexts and platforms (e.g. parliament, social media, interest groups, and casual conversation between friends and family members) and can be of different forms (i.e. structured deliberation (e.g. consensus conferences where meetings between S&T experts and non-experts are organised for policymaking in specific S&T topics), public discussion (e.g. an organised public meeting for an issue), and casual political talks (e.g. in *Cafe Scientifique*⁷)) (Levinson, 2010; Searing et al., 2007). In relation to FRM, several initiatives could illustrate this model, for

⁷ More information about Café Scientifique can be found at <http://cafescientifique.org/>

example, organised public meetings to discuss the proposal of FRM policies and plans and students' discussions regarding mitigating flooding issues.

The participatory model

The participatory model emerges from criticism of the dialogic model; the dialogic model is a complex version of the deficit model (Miller, 2010). In the dialogic model, despite being valued in terms of their knowledge, citizens are often not allowed to influence the production of (scientific) knowledge (Pouliot, 2009). Given this, Pouliot (2009) argues that the participatory model of science communication is developed to emphasise the idea of co-producing knowledge.

As demonstrated in Table 2.2, within the model, the co-production of knowledge is addressed through multi-way and open-ended interactions among different stakeholders to change or shape research agendas. Pouliot's (2009) diagram of the participatory model (Figure 2.10) indicates that the model emphasises the legitimacy of knowledge through collaboration between experts and citizens (concerned groups). According to Levinson (2010), within this model, scientific knowledge is no longer the centre of solution for socioscientific issues but an inter-disciplinary body of knowledge (an accumulation of capital for addressing socioscientific issues). Scientific knowledge is rather used as a tool to challenge expert knowledge for change and authenticity in addressing the issues of interest.

For example, in the case of the development of disease treatment, Pouliot (2009) argues that the co-production of expert knowledge (from doctors) and life narratives provided by patients helps improve the effectiveness of the treatment significantly. This appears to be similar to the case of the development of effective FRM policies and plans, which requires the co-production of knowledge from multi-stakeholders (McEwen & Jones, 2012).

Regarding the limited opportunity for many groups of people (e.g. marginalised people) to have genuine influence in the development of S&T policies and plans through deliberative and participatory initiatives, Levinson (2010) proposed the dissent and conflict/action model of science communication for democratic participation. The model aims to create citizenship for addressing social justice issues.

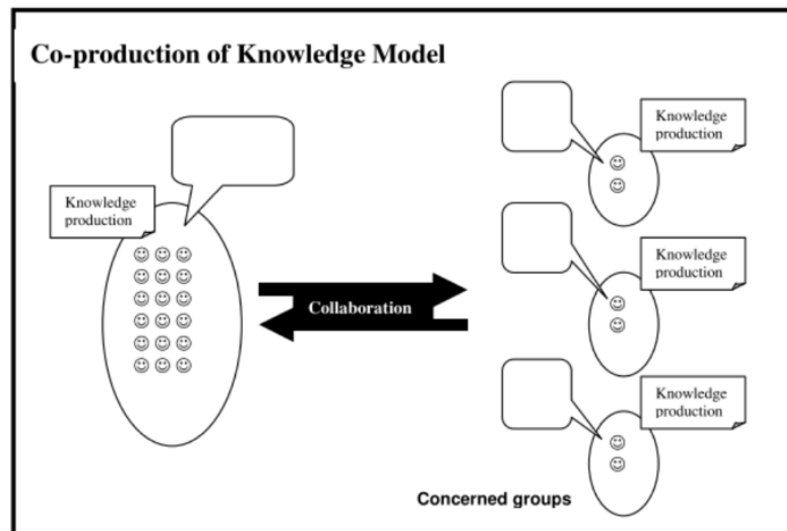


Figure 2.10 Participatory (co-production of knowledge) model (Pouliot, 2009)

The dissent and conflict/action model (science communication for democratic participation)

Within Levinson's (2010) dissent and conflict/action model, scientific knowledge, like the participatory model, is no longer the centre of solution for socioscientific issues, but rather inter-disciplinary knowledge. What lies beyond the participatory model is that Levinson's (2010) dissent and conflict/action model emphasises the promotion of "*political literacy, identifying and analysing the sources of social injustice and both using and producing knowledge to address technoscientific issues related to injustice*" (Levinson, 2010, p. 106). In other words, the model underscores citizens' ability to perceive self-efficacy in self-mobilisation and participation in deliberative dialogue about the issues, assuming that they have the means to take active steps towards solving social issues beyond what they have been told to do (e.g. by the government and schools) (Levinson, 2010).

In doing so, in accordance with Gray & Colucci-Gray (2014) and Hodson (2003), Levinson, (2010) suggests that citizens need to be informed with a basic understanding of how science and technology are impacted by, and impact upon, the physical and socio-political environment. Hodson (2003) argues that without such understanding, citizens "*will be effectively disempowered and susceptible to being seriously misled in exercising their rights within a democratic and*

technologically dependent society" (pp.650-651). The model stresses the emergence of political emotions. (e.g. anger for those who are affected by S&T projects) (Levinson, 2010).

In relation to FRM, this model seems to help promote citizens' adoption of activism (social/political leadership) action to mitigate flooding issues (see section 2.2.2).

2.4.4 Challenges in utilising models of science communication

Challenges in using each model of science communication to promote public engagement in socio-scientific issues are evident in the research literature. Despite being widely adopted in the education sector to promote public engagement in addressing socio-environmental issues, the deficit model ('traditional model of pro-environmental behaviours') has been critiqued by many scholars as ineffective for accomplishing the task (e.g. Davis & Museus, 2019; Hawthorne & Alabaster, 1999; Hines et al., 1987; Hungerford & Volk, 1990; Levinson, 2010; Nakano & Yamori, 2021; Takahashi et al., 2017). The authors argue that the model is oversimplified; increasing knowledge about socio-environmental issues does not straightforwardly lead individuals to take action to address the issues. For FRM, as critiqued by Dufty (2008), the model is not effective enough to promote public engagement in addressing flooding issues.

Levinson (2010) points out that despite the criticisms, some scientific experts may favour the deficit method over other methods of public engagement in socio-scientific issues. Those experts perceive the latter methods (i.e. dialogue, participation, and dissent and conflict/action) as a hindrance to scientific solutions for societal issues. To illustrate, as discussed in the above sub-section, in the deficit model, science is perceived as the main solution to problems. The public is thus expected to understand the benefits and constraints of science research in order to support government investment in science and technology to solve societal issues.

On the other hand, in the other three models, scientific knowledge is considered as a type of knowledge that should be re-worked together with other types of knowledge produced by other interested parties (e.g. lay knowledge) to solve societal problems (Layton, 1986; Layton et al., 1993). As a result, when

experts privilege scientific knowledge, they tend to preserve their cognitive authority and shift the terms of the debate from a societal issue to a technical one. The case of changing regulations to permit the use of embryos in stem cell research in the UK (Parry, 2009) could be seen as an example. To avoid the public's influence on their work, scientific experts maintain a high entry barrier to prevent the public from taking part in addressing the issues (Levinson, 2010). Thus, it can be envisaged that the *dialogue*, *participation*, and *dissent and conflict/action* models are not always welcome to operate.

In summary, in this section I discussed the role of education in flood risk management and reviewed models of science communication that have been developed to promote public engagement in addressing socio-environmental issues. Despite their challenges, these models enlightened me that all types of action to mitigate flooding issues (as presented in section 2.2.2) are possible to be promoted.

Early in this chapter (section 2.1.3), I argue that science museums have the potential (in terms of their resources and professionals) to support FRM in Thailand. To support my argument, in the following section I will explore the development of science museums and their relationship with the promotion of sustainable societies.

2.5 Looking for engagement: Science museums and flood risk management

2.5.1 Generations of science museums

Science museums have been mediators of (science) education and society for centuries. The ideas of *generations* of science museums developed by Friedman (2010) and McManus (1992) help us understand the existence, objectives, and range of their activities over time. According to McManus (1992), the original form of museums corresponds to 'the *Cabinets of Curiosities created by European men of wealth*' during the 17th and 18th centuries. The spaces, usually small rooms or galleries in houses, were used to display private collections, including but not limited to specimens, instruments, paintings, coins, and sculptures (Friedman, 2010). According to McManus (1992), the *first*

generation of science museums derives from opening those Cabinets of Curiosities to the public, as simply explained by Friedman (2010):

“After the French Revolution in the late 18th century, a rational, encyclopedic approach was applied to the collections, and they were treated as instruments for bringing culture to the public at large. The private collections of paintings became art museums; the furniture and memorabilia became history museums; and the seashells became natural history museums.” (p.48)

The primary objective of these earlier science museums was to contribute scientific knowledge to the public through scientific object-rich exhibits developed using an “*authoritative information*” approach (McManus, 1992, p. 160). The objects to display and the information to present about the objects were selected by museum curators from their research collections. In this generation, science communication between science museums and the public has been a one-way communication method. The public was considered by the museums to be passive learners (Durant, 1992) who were invited to observe the exhibits based on the principle “*look but don’t touch!*” (Amodio, 2013, p.29).

The *second generation* refers to science museums as “*fully functional public institutions*” where the preservation and exhibition of scientific collections were replaced by the idea of displaying the development and achievements of the science community (McManus, 1992, p. 160). In the 20th century, according to McManus (1992), there was a shift in science museums’ objective from displaying scientific objects to the (re)presentation of scientific ideas and concepts to the public, which emerged in the 1960s through 1970s in countries such as Canada, the USA, and the UK. The shift in the objective was underpinned by the notion that, as most museums have been operated with public funds, the institutions should therefore be developed *for* and *with* people (the ‘New Museology’) (Hudson, 1977). In other words, museums should take a bigger role in the development of public education (Chadwick & Stannett, 2000; Günay, 2012; Hooper-Greenhill, 1995; Lane et al., 2007; Lang & Reeve, 2017; Lawrence & Tinkler, 2015; McCall & Gray, 2014; Message, 2006; Tressel, 1980). The second generation of science museums has encouraged the inclusion of applied science and technology into museum practices.

The *third generation* of science museums, according to McManus (1992), refers to the institutions that have moved away from object-based approaches

and emphasise enhancing the public's understanding of science (Friedman, 2010). In this generation, science museums combine entertainment and education through operational exhibits and demonstrations addressed to the mass public. One of their primary goals is to present scientific ideas and concepts through interactive and hands-on exhibits; *"they include exhibits that can be touched or operated by button and crank"* (Friedman, 2010, p. 47) to emphasise emotion, wonder, and experiential content. Interactive science centres have therefore been classified as a sort of science museum (see e.g. Zimmerman et al., 2010). According to Amodio (2013), the Exploratorium (San Francisco, USA) and the Ontario Science Centre (Toronto, Canada) appear to be pioneer science museums in this generation.

Friedman (2010) offers a useful way of thinking about these generations of science museums. While there is a chronology behind them, their objectives and operational practices have remained alive over time and have overlapped; *"[a] few first- and many second-generation museums remain today, although they often include some elements clearly recognisable as third-generation"* (Friedman, 2010, p. 47). While the framework provided by MacManus (1992) and Friedman (2010) predominantly reflects the story of science museums in western developed countries (e.g. UK, USA, and Canada), it helps me explain, as will be discussed below, the recent context of science museums in Thailand to the reader who might not be familiar with the context.

2.5.2 Science museums in Thailand

According to the National Science Museum (NSM) Thailand (2019), the development of science museums in Thailand officially began in 1992. The Ministry of Science and Technology (now the Ministry of Higher Education, Science, Research, and Innovation) was assigned by the government to establish the NSM to develop and manage science museums and learning centres for Thai people. Recently, in Thailand, there are a number of science museums and science learning centres providing public education about science and technology for the Thai public. Within the NSM alone, there are four large science museums (e.g. Science Museum and Rama IX Museum) and three science learning centres (National Science Museum, 2019).

Taking the NSM's science museums and science learning centres as examples, the operational practices of science museums in Thailand encompass 'three generations of science museums,' as argued by Friedman (2010) and McManus (1992) above. According to the NSM (2019), these science museums and science learning centres have been developed to become life-long learning resources for the Thai public to learn about science and technology ('second generation'). The NSM also focuses on establishing these museums as "*Edu-tourism*" attractions through the use of the combination of interactive exhibitions and activities ('third generation') and displaying scientific collections (e.g. flora and fauna specimens in the Natural History Museum) ('first generation').

2.5.3 Educational role(s) of science museums - the paradigm shift

The science museum generations proposed by Friedman (2010) and McManus (1992) also help us understand the emergence of educational goals in the development of science museums. Friedman (2010) argues that science museums' objectives over time include conserving, researching, training, collecting, and educating. As illustrated in Figure 2.11 below, public education became the prominent goal in the third generation of science museums.

The education goal of science museums is evident in how science museums are defined and referred to recently as non-formal (or informal) education settings (e.g. Gutwill & Allen, 2010; Rennie, 2007; Riedinger, 2012; Stocklmayer et al., 2010). For example, Riedinger (2012) argues that science museums offer "*learning opportunities [to learn and engage with science] outside of the formal classroom context*" (p. 125). Stocklmayer et al. (2010) argue that science museums (as informal education settings, according to the authors) have the potential to (1) promote free-choice (or internally driven) learning, (2) encourage wonder, (3) present a powerful and useful science, (4) facilitate social/community interaction, (5) promote a vision of science as "*messy*" human and relevant in regard to real problems, and (6) emphasise narratives and personal meaning-making. This underlines that science museums have the potential to educate their audience (the public) in various aspects.

Science museums' defining goals		
1st generation	2nd generation	3rd generation
Conservation	Public education	Public education
Collection	Conservation	
Research	Collection	
Training	Research	

Figure 2.11 Science museums' goals according to their generations (Friedman, 2010)

Public education is primarily associated with the second and third generations of science museums.

Three main educational purposes that science museums adopt to direct their practices can be identified from the research literature: (1) enhancing the public's ability to understand and use science in everyday decision-making ('scientific literacy') (Bell et al., 2009; Caulton, 1998; Christensen et al., 2016; Henriksen & Frøyland, 2000; Hodder, 2010; Miles & Tout, 1992; Science Museum Group (Great Britain) et al., 2017), (2) improving public attitudes toward science (Archer et al., 2015, 2012; Caulton, 1998; Durant, 1992; Enterprising Science, 2016; Kaushik, 1997; Miles & Tout, 1992; Miles, 2015; Science Museum Group, 2020; Shettel, 1968; Solomon, 2013; Wormald, 2018), and (3) enhancing public engagement in addressing societal issues (Bandelli & Konijn, 2012; Bell, 2008; Bell et al., 2009; Bennett, 1995; Cameron & Deslandes, 2011; Dilli, 2016; Kollmann et al., 2013; Krishtalka & Humphrey, 2000; Lane et al., 2007; Marinetto, 2003; Navas Iannini, 2018; Navas Iannini & Pedretti, 2022; Newman et al., 2005; Pedretti & Navas Iannini, 2020).

These educational purposes, particularly enhancing public engagement in addressing societal issues, highlight the role of science museums in supporting the building of sustainable societies. I will describe some examples of science museum practices that aim to support the building of sustainable societies in the following sub-section.

2.5.4 Science museums for sustainable societies

While connections between enhancing scientific literacy and science museums are longstanding (e.g. Bell et al., 2009; Christensen et al., 2016;

Henriksen & Frøyland, 2000; Hodder, 2010), science museums have also recently been encouraged to support discussion and negotiation on societal problems (e.g. environmental crises) by several researchers (e.g. Achiam & Sølberg, 2017; Barrett & Sutter, 2006; Bennett, 1995; Dilli, 2016; Ellenbogen et al., 2007; Henriksen & Frøyland, 2000; Hine & Medvecky, 2015; Janes, 2009; Krishtalka & Humphrey, 2000; Newman et al., 2005; Pedretti & Navas Iannini, 2020; Rennie & Williams, 2006). In other words, they have been called to support the promotion of Education for Sustainability (EfS) by empowering (global) citizens to take action to address social and environmental circumstances (Evans & Achiam, 2021; Janes & Sandell, 2019). According to Cameron and Deslandes (2011), a number of citizens in Australia and the USA have agreed that museums and science centres in their nations should inform and offer them opportunities to engage with deliberative democratic decision-making on societal matters (e.g. climate change).

In doing so, in addition to their traditional functions (i.e. researching, disseminating science, educating, and preserving scientific collections), several researchers argue that science museums can be public service institutions, public meeting spaces, arenas for public debate, dialogue institutions, and contributors to the resolution of local, national, and global challenges (Achiam & Sølberg, 2017; Cameron & Deslandes, 2011; Henriksen & Frøyland, 2000; Marinetto, 2003; Rennie & Williams, 2006). Rennie and Williams (2006) argue that science museums should help improve the public's ability to use scientific knowledge to solve practical problems, promote the public's understanding of the impact of science and technology on society and the environment, and promote citizens' full participation in democratic processes.

Examples of science museums' attempts to promote EfS can already be found in their educational programmes and exhibitions. Efforts to raise the public's awareness, knowledge and active support for flora and fauna conservation can be found in most science museums, zoos, natural history museums, and aquaria around the world (Dilli, 2016; Krishtalka & Humphrey, 2000). Some science museums have launched outreach projects to address environmental issues in their local contexts. For example, the Murray-Darling Outreach Project was launched by the collaboration between the National Museum of Australia (NMA) and the Murray-Darling Basin Commission (MDBC)

to increase community engagement in natural resource management in the Murray-Darling Basin (Lane et al., 2007). The projects provide the community members with online museum exhibition spaces to tell stories of their local environment through a collection of digital images and supporting texts created by the community members themselves. According to the authors, the projects created a stronger connection between the museum and the local community and increased community involvement in the local environmental restoration in the long term.

Some science museums have been established to promote EfS in particular, such as the Brazilian Museum of Tomorrow (opened in 2015) (Museum of Tomorrow, 2021a). The museum is described as an “*applied science museum that looks to explore the opportunities and challenges that humanity will face in the upcoming decades through sustainability and co-existence lenses*” (para 5). The museum provides permanent and temporary exhibitions and educational programmes to provoke and engage their audience with complex questions about socio-environmental circumstances and what the future might look like (Museum of Tomorrow, 2021b).

The Watersnoodmuseum in the Netherlands (opened in 2001) is an example of how museum professionals can support flood risk management (FRM) in their nation (Watersnoodmuseum, 2020). The museum is described as the “*national knowledge and memorial Centre*” for the Netherlands’ remarkable flood event in 1953. The institution provides permanent and temporary exhibitions and educational programmes to educate their citizens about flooding issues and FRM in the Netherlands. In relation to the flood event, the museum provides *facts* (i.e. the flood event and its background), *emotions* (i.e. the story of the victims, the impact on the survivors, and the vigour of the people during flood recovery), *reconstruction* (i.e. the redevelopment of devastated dikes, landscape, villages, and towns), and *future* (i.e. how the Netherlands lives with water). The museum’s exhibits display historical footage, books, newspapers, names and personal stories of the flood victims, reality-based games relevant to the flood event, and ways to live with water (Watersnoodmuseum, 2020).

These examples of science museums’ practices, as discussed above, provide evidence to confirm the potential of science museums to promote public engagement in addressing socio-environmental issues, including FRM. Still, by

considering their practices as discussed above with models of science communication (section 2.4.3), science museums still seem to use informative approaches (the deficit model) instead of dialogic and action-oriented approaches (the dialogue, participation, and dissent and conflict/action models) to promote public engagement in addressing socio-environmental issues.

According to Navas Iannini and Pedretti (2022), the degree of science museums' impact on encouraging public engagement in addressing societal issues depends on two factors: (1) the topics that science museums select to address (e.g. climate change and FRM) and (2) the ways that science museums employ to address such topics (e.g. disseminating information to the public and providing spaces for public debate and collaboration). Navas Iannini & Pedretti (2022) and Pedretti & Navas Iannini (2020) suggest that understanding the typologies of exhibitions in science museums will help us visualise science museums' potential effect on enhancing civic engagement in addressing socio-environmental issues and potential challenges that science museums might encounter. In accordance with their recommendations, I will investigate exhibition typologies in science museums in the following sub-section.

2.5.5 Typologies of exhibitions in science museums

According to Navas Iannini and Pedretti (2022), there are four exhibition typologies that science museums use to promote public engagement in addressing socio-environmental issues: *pedagogical, experiential, critical, and agential*.

- *Pedagogical* exhibitions, according to Wellington (1998), refer to exhibitions that aim to teach something (e.g. facts about water pollution and biodiversity) to their audience, usually through hands-off displays.

- *Experiential* exhibitions, according to Wellington (1998), refer to exhibitions and activities that aim to provide their audience with experiences of phenomena (e.g. gravity, light, electricity, waves, heat, and so on). It aligns strongly on ideas of interactivity between the audience and exhibits. This type of exhibition therefore emphasises the use of hands-on displays in which the audience can touch the exhibits. KlimaX, a climate change exhibition hosted by Heureka The Finnish Science Centre, demonstrates how the museum attempted to inform their

audience about climate change impacts through experiential exhibitions (see Pedretti & Navas Iannini, 2020). Visitors were wearing knee-high yellow rubber boots (offered to them at the entrance of the exhibit) and wading into the 'ocean' (the exhibit floor that is inundated with cold water melting from oversized ice blocks).

- *Critical* exhibitions, according to Pedretti (2002), refer to the exhibitions that “*speak to the processes of science, the nature of science, and science and technology in their sociocultural context*” (p.9). The exhibitions aim to enlighten their audience about science and technology issues in real-life contexts (i.e. social implications and impacts of science and technology) and encourage their audience to think about the issues critically and discuss their opinions with others (e.g. other visitors, people who are affected by the issues, and scientists). Pedretti (2002) argues that “*many of these critical exhibitions are issues-based, inviting visitors to participate actively, consider socio-scientific issues from a variety of perspectives, and critique the nature and practice of science and technology*” (p.9).

According to Kollmann et al. (2010), critical exhibitions emphasise introducing provocative questions about controversial socio-scientific issues (e.g. public health issues) to their audience. The exhibitions are also designed to invite and provide spaces for their audience to participate in discussions and exercise their decision-making about the issues. Unlike the first two exhibitions (i.e. pedagogical and experiential) that aim to teach something to their audience, critical exhibitions are employed to “*increase the public’s socio-scientific argumentation skills,*” significant skills in democratic decision-making about socio-scientific issues (Kollmann et al., 2010, p. 176). It attempts to offer spaces for the public to raise their voices (Mazda, 2004).

- *Agential* exhibitions, as defined by Pedretti and Navas Iannini (2020), are exhibitions that: (1) attempt to critically engage their audience with issues involving science, technology, society, and environment (STSE) (e.g. climate change, biodiversity degradation, and so on); (2) perceive their audience as a political agent of change and transformation; and (3) aim to encourage their audience to take action for change in the private and public spheres. This type of exhibition emphasises ‘action taking.’ It therefore prioritises offering “*novel spaces and practices such as dramatization, fictional stories, empathy-building*

exercises, opportunities for decision-making, and spaces for conversations and deliberation” (Navas Iannini & Pedretti, 2022, p.5).

Based on their characteristics and objectives, the first two exhibition typologies reflect traditional ways of representing science to the public. They focus on delivering scientific content (e.g. theories, explanations of phenomena, scientific ideas, and scientific research findings) without considering the relationship of science and society, especially the negative impacts of science (Pedretti & Navas Iannini, 2020). In other words, they employ the deficit model of science communication (discussed earlier in section 2.4.2), in which science is perceived as a subject separated from the context and the public is viewed as a passive recipient of knowledge.

In contrast, according to Navas Iannini and Pedretti (2022), contemporary exhibition typologies (critical and agential) embrace and address complex subject matter entangled in social-cultural, political, environmental, and ethical considerations. The public is perceived as a significant “actor” in addressing socio-environmental issues. The exhibitions represent, respectively, the dialogue and participant-and-action models of science communication, in which science is placed in the real world and the public is seen as an inquiring expert and a significant contributor to addressing STSE issues (discussed earlier in section 2.4.2). Providing the community members with online museum exhibition spaces to inform and discuss their local environmental issues in the Murray-Darling Outreach Projects (Lane et al., 2007), as described in the above sub-section, reflects the use of these contemporary exhibition typologies.

These contemporary exhibition typologies appear to offer science museums ways to engage the public in addressing societal issues beyond the private sphere. Still, incorporating these contemporary exhibitions (i.e. critical and agential) into science museums’ traditional practices could encounter several challenges (Hodder, 2010; Mazda, 2004; Yaneva et al., 2009), which I will discuss below.

2.5.6 Some challenges to incorporating controversial socio-scientific issues into practice

First, according to Delicado (2009), Hodder (2010), and Macdonald & Silverstone (1992), science museums have avoided incorporating controversial issues into their practices for a long time due to the fact that they are difficult to develop. That is, controversial issues have temporal and spatial restrictions (e.g. devastating floods do not occur often, and not everywhere encounters floods). Thus, the public may lose interest in the issues when the exhibit is opened. According to several researchers (Cameron, 1971; Cameron & Deslandes, 2011; Macdonald & Silverstone, 1992; Rennie & Williams, 2006), usually perceiving themselves and being perceived by society as organisations that are responsible for promoting positive and trustful images of science is another reason for science museums to avoid communicating ambiguous (and potentially controversial) messages to the public.

Second, since science museums are very much dependent on funding from external sources, their financiers' priorities (e.g. the government and the corporate sector) are another factor determining science museum's practice (Cameron & Deslandes, 2011b; Hadjichambis et al., 2019; Navas Iannini & Pedretti, 2022). In this sense, science museums usually do not intend to inform and monitor state governance (Cameron & Deslandes, 2011), especially in the context where civic forms of practice are not prioritised by the government and society.

Despite these challenges and difficulties, similar to several researchers (e.g. Cameron & Deslandes, 2011; Lane et al., 2007; Navas Iannini & Pedretti, 2022; Pedretti, 2002), I argue that putting controversial socio-scientific issues into exhibits will enhance science museums' potential to support advancing the sustainability of society.

2.6 Final comments: Rationale for the study

As discussed throughout this chapter, public engagement is widely accepted by many nations at risk of flooding, including Thailand, as key to effective flood risk management (FRM) (Chapman, 2004; DDPM, 2015; Federal

Emergency Management Agency, 2020; Grothmann & Reusswig, 2006; Singkran, 2017; Speller, 2015). The degree of public engagement in FRM can range from taking action in the private sphere (e.g. preparing for future floods) to taking action in the public sphere (e.g. influencing FRM policies and plans) (Bosschaart et al., 2016; Dufty, 2008, 2008; Federal Emergency Management Agency, 2020; McEwen et al., 2017; McEwen & Jones, 2012; Mustafa, 2009; Singkran, 2017; United Nations, 2016). Since encouraging the public to engage with FRM involves altering people's behaviours, education has been argued to be a fundamental tool for promoting such engagement (Bosschaart et al., 2016; Da-Silva-Rosa et al., 2015; Dufty, 2008; Nakano & Yamori, 2021; Shaw, 2014; Shiwaku et al., 2007).

However, the development of effective educational interventions to encourage public engagement in FRM, especially beyond adopting self-protective behaviours, remains challenging (Mitchell et al., 2008). Research has discovered that citizen engagement in addressing socio-environmental issues is influenced by the complex interplay of several personal and situational factors (Hines et al., 1987; Hungerford & Volk, 1990; McKinley & Fletcher, 2012; Monte & Reis, 2021). Given this, citizen engagement in FRM cannot simply be promoted by raising citizens' awareness and knowledge of flooding issues.

To promote public engagement in FRM effectively, the development of public education needs to be contextually specific ('bottom up') (Dufty, 2008). Thus, understanding factors that influence the target audience's engagement in FRM is key to developing effective education to promote such engagement (Dufty, 2008). Such understanding would help us (researchers and educators) identify what needs to be addressed in our interventions (Dufty, 2008; Evers, 2012; Grothmann & Patt, 2005; Grothmann & Reusswig, 2006; Hungerford & Volk, 1990; Speller, 2015; Stern, 2000; Tobin & Montz, 1997).

Similar to other countries (e.g. the UK and Puerto Rico) (López-Marrero, 2010; Speller, 2015), there is still limited research in this regard to support the development of public education to promote public engagement in FRM in Thailand. Only a few studies have been conducted (Phanthuwongpakdee, 2016; Raks Thai Foundation, 2014; Tanwattana & Toyoda, 2018; Thanvisitthpon et al., 2018). These studies focused on flood adaptation and preparedness (Phanthuwongpakdee, 2016; Raks Thai Foundation, 2014; Tanwattana &

Toyoda, 2018) and the public's understanding of the causes of flooding and satisfaction with FRM (Thanvisitthpon et al., 2018). There is still no research that focuses on examining the public's proactive roles in FRM (e.g. mitigating the causes of flooding issues).

Furthermore, these studies only covered a limited range of public groups in Thailand. Phanthuwongpakdee (2016), Raks Thai Foundation (2014), Tanwattana & Toyoda (2018), and Thanvisitthpon et al. (2018), respectively, studied three flood-affected communities in the central region, 649 flood-affected children (8–15 years old), two flood-affected communities in the northern region, and 400 residents in Bangkok. In this light, to inform the development of public education to promote public engagement in FRM in Thailand, I argue that more research needs to be done to acquire a better understanding of public engagement with FRM and the factors that influence such engagement from a wider range of the Thai public.

Regarding the potential of science museums in supporting the development of sustainable societies (Achiam & Sølberg, 2017; Cameron & Deslandes, 2011; Pedretti & Navas Iannini, 2020; Rennie & Williams, 2006), I argue that science museums in Thailand have the potential to support the promotion of public engagement in FRM in Thailand. To advocate this transformative role of science museums, this study inserts itself in the gap between the fields of science museum development and FRM. It attempts to examine the public's voices and the context of public engagement in FRM in Thailand to inform the development of museum-based flood education to promote such engagement. In doing so, I opted to investigate public engagement in FRM and the limiting factors that must be addressed to promote such engagement from the perspectives of Thai public visitors to a large science museum and FRM key actors in Thailand. The research aims, questions, design, and methodology will be demonstrated in chapters 3 and 4.

Chapter 3: Research design

In this chapter, special emphasis will be placed on the development of the research design (a qualitative approach) that was used to investigate the scenario of public engagement with flood risk management (FRM) in the context of Thailand. Section 3.1 introduces my aims and research questions, while section 3.2 describes the two groups of research participants who were investigated in this study. In section 3.3 I will then explore the main philosophical and methodological perspectives informing these investigations, along with a general discussion of its values and ethical aspects. I will also discuss how these specific positions connect with my research design.

3.1 Research focus: Aims and research questions

As argued in chapter 2 (section 2.2.2), there are many actions that laypeople can take to address flooding issues, ranging from private to public actions, and there are many factors in both personal and situational dimensions that influence people's engagement with FRM. This study was about gaining an understanding of the Thai public's current engagement in FRM to inform the development of interventions to promote public engagement in FRM in Thailand, particularly the development of museum-based flood education. It was developed around two main aims:

- To investigate if and how Thai public visitors to a large science museum engage with FRM in Thailand.
- To investigate if and what limiting factors in both personal and situational dimensions must be addressed to enhance public engagement in FRM in the context of Thailand.

Some more specific objectives, guided by the holistic framework for evaluating public engagement in FRM proposed in chapter 2 (section 2.3.3), behind this investigation can also be outlined:

- To investigate the Thai public visitors' possession of capital⁸ for addressing FRM at all three levels: entry (issue sensitivity and in-depth knowledge about the issues), ownership (their perceived responsibility for FRM), and empowerment (intention to act, perceived strategies to mitigate flooding issues, and locus of control)
- To investigate if and what questions or information about flooding and climate change issues the Thai public would like to ask or inform others about.
- Considering that situational factors play a significant role in the extent of public engagement in FRM, to investigate how FRM key actors in Thailand expect the public to engage in FRM, if and what factors prevent the public from engaging with FRM in their perspectives, and if and how they would like science museums to support FRM.

In order to achieve these main and specific aims, this study endeavoured to answer the following research questions (RQs) and their sub-questions:

RQ1. *What is the Thai public visitors' possession of capital for addressing flooding issues at the entry-level - issue sensitivity (flood experiences, flood risk perception, and empathetic perspectives toward flood victims); and in-depth knowledge about issues (understanding of the causes of flooding issues)?*

RQ1.1 If, and how do, the Thai public visitors experience flooding issues?

RQ1.2 How do the Thai public visitors perceive flooding issues?

RQ1.3 From the Thai public visitors' perspectives, what are the causes of flooding issues?

RQ1.4 How do the Thai public visitors perceive the likelihood of severe flooding?

RQ1.5 How do the Thai public visitors perceive the relationship between flooding and climate change issues?

RQ2. *What is the Thai public visitors' possession of capital for addressing flooding issues at the ownership and empowerment levels - their*

⁸ In accordance with how Bourdieu (1986, 1984) conceptualises 'social capital,' the term 'capital' in this thesis is referred to accumulated, legitimate, valuable, and exchangeable resources that can generate forms of advantage within specific communities to deal with societal issues.

perceived responsibility for FRM, intention to act, perceived strategies to mitigate flooding issues, and locus of control?

RQ2.1 How do the Thai public visitors perceive their relationship with flooding issues?

RQ2.2 If, and how do, the Thai public visitors mitigate flooding issues?

RQ2.3 If any, what questions would the Thai public visitors like to ask about flooding and climate change issues?

RQ2.4 If any, what information, knowledge, or concerns would the Thai public visitors like to inform others about flooding and climate change issues?

RQ3. *How do FRM key actors perceive public engagement in FRM in Thailand?*

RQ3.1 From FRM key actors' perspectives, what are the challenges in improving FRM in Thailand?

RQ3.2 If any, in which ways do FRM key actors expect the public to engage with FRM?

RQ3.3 From FRM key actors' perspectives, if any, what are the barriers hindering the public from engaging with FRM? What are their suggestions to promote public engagement in FRM in Thailand?

RQ3.4 If any, in what ways do FRM key actors see the roles of non-formal education organisations, particularly science museums, in supporting FRM in Thailand?

To answer these RQs, I decided to investigate two distinct participant groups: Thai public visitors and FRM key actors. In the following section, I provide summaries of the investigations of these two distinct participant groups.

3.2 Summarising the investigations of two distinct participant groups: Thai public visitors and FRM key actors

To achieve the study goals (i.e. acquiring insights into how Thai public visitors to a large science museum engage with FRM in Thailand and identifying limiting factors in both personal and situational dimensions that must be addressed to enhance public engagement in FRM), I opted to analyse the

scenario of public engagement in FRM in Thailand from two different perspectives: Thai public visitors to a large science museum (RQs 1 and 2) and FRM key actors (RQ3). The choice to conduct an exploratory investigation into these realities was motivated by the suggestion from previous research (Baggini, 2019; Dufty, 2008) that ‘top-down’ and ‘context-independent’ innovations often fail to enhance public engagement in addressing environmental circumstances (discussed earlier in section 2.6). In agreement with the notion, I believe that a better understanding of personal and situational factors that specifically influence our target audience’s engagement with FRM is key to developing effective flood education programmes (‘bottom-up’) (Dufty, 2008).

The investigation of Thai public visitors to a large science museum was aimed at acquiring a better understanding of the realities of Thai public engagement in FRM through the perspectives of Thai visitors to science museums themselves—the target audience of museum-based flood education programmes (‘bottom-up’). The investigation involved a qualitative analysis of data generated (through draw-and-explain, personal meaning mapping, and interview approaches) from 56 Thai public visitors to the Science Museum in the Bangkok Metropolitan Region (BMR): 18 children (aged 5–12 years old) and 38 adults (aged 13 years old and above), to answer RQs 1 and 2.

The investigation of FRM key actors was conducted to gain a better understanding of the current context of public engagement in FRM in Thailand (‘contextual dependent’). The investigation involved a qualitative analysis of data generated (through interviews) from ten FRM key actors: four researchers involved in disaster risk reduction, four volunteer educators involved in education for enhancing collective actions in solving society’s problems (flooding issues were one of their concerns), and two state authorities from the Bangkok Flood Control Department), to answer RQ3.

The findings of the two investigations were then reinterpreted together (the ‘cross-investigation’) using an adapted version of Stake’s (2006) cross-case analysis to provide insights into barriers to public engagement in FRM in Thailand, in both personal and situational dimensions, that must be addressed in order to promote such engagement.

3.3 Positioning this study in the field of educational research

3.3.1 Qualitative Research and Critical Realism

The choice of using a qualitative approach to examine the realities of public engagement in FRM in Thailand from the perspectives of two distinct participant groups, as mentioned above, was underpinned by the fact that the insights into such realities have not yet been well anticipated (discussed earlier in section 2.6). Qualitative research has a general focus on investigating meanings and explanations for specific contexts and/or experiences in all their complexity, where contextual conditions are not well-known or controlled (Bazeley, 2013; Denzin & Lincoln, 2003; Faria et al., 2020; Hancock & Algozzine, 2016; Merriam, 2009; Quintão et al., 2020). Given this, this type of research seemed to be a natural methodological option for a study that involved RQs based on a combination of descriptions ('what is happening?' – e.g. public engagement with FRM), explanations ('why is this happening?' – e.g. the public's possession of capital for addressing FRM) and generalisation/contextualization (extending beyond a specific context to a large-scale explanation) (Usher, 1996).

According to Denzin & Lincoln (2003) and Creswell (2013), there are divergent research traditions⁹ within qualitative methods that differ in their ontological (our understanding of the nature of reality), epistemological (our understanding of the nature of knowledge production about that reality), and axiological (our recognition of our values as researchers that influence our work) positions. Therefore, the research tradition we apply will affect the whole research course, from instrumental steps (e.g. data generation methods) to finding presentations (e.g. what and how data will be presented), as well as the validity and generalisation of research findings.

In this study, my understanding of the 'reality' of the public engagement practice with FRM went beyond what can be actually seen in questionnaires or heard in interviews about this topic. As discussed in the previous chapter, people's engagement practice in FRM is not just influenced by personal factors but also by situational factors. Therefore, I was not interested in simply investigating what was happening from the two participant groups' perspectives

⁹ for example, Positivism, (Socio-)Constructivism, and Critical Realism

(i.e. Thai public visitors and FRM key actors) and developing each independent explanation for the scenario of public engagement in FRM from the two perspectives. Instead, my objective in studying these two participant groups was to understand the interplay between personal and situational influences behind the 'reality' of specific choices of action that the Thai public adopts (or does not adopt) to mitigate flooding issues (Gorski, 2013). Thus, the ontological assumption of this investigation was that it approached the reality of the research problem as 'layered'; that is, the reality of public engagement in FRM in Thailand is the yield of the interplay between factors in both 'personal' and 'situational' dimensions.

In this light, some ideas from Critical Realism (CR) underpinned this study; that is, perceiving the 'reality' of the social world as stratified. Concisely, considering an ontological position within a CR perspective entails the recognition of social reality (in this study, the public's actions toward FRM) as multi-layered; a social reality is the yield of the interchanges between distinct 'objects' within a wider structure (e.g. laypeople, FRM key actors, FRM in Thailand, resources of public information, scholarship of the fields of Education for Sustainability (EfS) and Disaster Risk Reduction Education (DRRE), and political circumstance) (Bhaskar, 2008; 2017). According to Gorski (2013), Critical Realists will begin to analyse the world into disconnected objects and structures (e.g. human persons or social networks). They then consider how interactions between these objects and structures influence changes in the properties or relationships of these objects and structures and (or) initiate new structures. Finally, Critical Realists will reflect on the temporal, spatial, and cultural scope of these interactions as part of a wider system.

In other words, according to Given (2008), CR focuses on developing multi-layered explanations for the investigated realities; it begins by describing and searching for patterns in an event being studied and then moves onto investigate the causes of the event. This way to assess social reality is known as the 'layered' approach. Since the approach highlights the significance of looking at a research problem from different perspectives and attempts to understand the divergent possible 'causes' behind an event, according to several authors (Given, 2008; Gorski, 2013; Scott, 2010), CR can deal with some criticisms encountered by relativist traditions. That is, because the relativist tradition appears to focus solely

on individual interactions, it ignores the account of a larger social structure in which those interactions are embedded.

Regarding how social reality is perceived from the perspective and the ability of the 'layered' approach in dealing with the relativist traditions' criticisms, CR was adopted as an informative perspective to design this present study. This was because I aimed to understand public engagement in FRM in Thailand and the causes behind the engagement from both 'agential' (personal factors) and 'structural' (situational factors) aspects. In this regard, as outlined in the section above, I therefore opted to examine the scenario of public engagement in FRM in Thailand from two perspectives (i.e. Thai public visitors to a large science museum and FRM key actors).

My choice of understanding this investigated reality as multi-layered (i.e. it is influenced by individual and structural aspects) also offered me a perspective to connect this study's findings with the projection of integrating public flood education into the development of science museums in Thailand. As asserted by CR researchers, by improving an understanding of the multi-layered context, social research can assist in the planning and implementation of change in various settings (Fletcher, 2017; Gorski, 2013; Scott, 2010). To be specific, perceiving social reality as multi-layered helped me envision potential roles and challenges for science museums to address limiting factors inhibiting public engagement in FRM in Thailand revealed by this study.

In summary, adopting the CR perspective in designing this study helped me uncover the scenario of public engagement in FRM in Thailand beyond describing the event. The perspective also helped me reveal some causes of the event (in both agential and structural aspects) and envision potential roles and challenges for science museums in integrating the promotion of public engagement in FRM into their practices.

3.3.2 Knowledge production and validity

Adopting the CR perspective to this research investigation also affected my approach to understanding the knowledge produced from this study (my 'epistemological position'). By accepting social reality as a result of the interaction between various agential and structural aspects, the knowledge I could generate about the scenario of the Thai public's engagement in FRM was naturally multi-

layered (that is, it was a result of the interplay among different perspectives and participants) and grounded in my interpretations of how these various perspectives were linked together.

My approach to understanding the knowledge produced within this study therefore was of an 'interpretive nature' – understanding of social reality is shaped by its meaning to those who experience it (Dey, 1993; Elliott & Timulak, 2005; Merriam & Simpson, 2000; Pelz, 2020; Usher, 1996). Findings about the scenario of public engagement in FRM in Thailand and factors that influence the engagement produced in this study were derived from analysing Thai public visitors' and FRM key actors' perceptions about the scenario through a hybrid thematic analysis approach (integrating data-driven with theory-driven approaches to explain the social phenomenon) (Fereday & Muir-Cochrane, 2006). Thus, the interpretive nature of this study seems to be based on an epistemological relativity perspective. That is, knowledge is viewed as socially constructed through the research process and bound to its specific (social, cultural, and political) contexts where the research is studied (in this study, Thailand, an official democratic nation where flood risks are a significant issue to overcome).

By considering that knowledge of social circumstance is context-bound and social reality is multi-layered, Fletcher (2017, p. 182) argues that "*human knowledge captures only a part of a deeper and vaster reality.*" Social practices are actually influenced by various variables, which are not always easy to access (e.g. unknown conditions) (Scott, 2010). Thus, with the instrumental approaches used in this study (mainly interviews), the study could access only 'a' reality of Thai public engagement in FRM that was grounded in the study participants' perspectives.

According to Bhaskar (2017) and Denzin & Lincoln (2003), this interpretive and relativist perspective of knowledge production has been given some criticism, particularly regarding the validity of the knowledge generated. Critics of an interpretive (relativist) approach have questioned that if knowledge is relative, fallible, and tentative, how then can we assess the validity of the knowledge being claimed by a study? And, can conducting a study based on an interpretive nature be "*interpretatively rigorous*"? (Lincoln & Guba, 2003, p. 275).

In this light, as the knowledge production within this study was of an 'interpretive nature' (i.e. knowledge is socially constructed, fallible, and dynamic), I was concerned about how I could address the validity of my research. I wanted to ensure that my findings and interpretations about public engagement in FRM in Thailand, as well as the limiting factors that impede the promotion of the engagement, were as close to reality as possible to inform the promotion of such engagement effectively.

In this study, the issue of being 'interpretatively rigorous' was initially addressed with the help of adopting the CR perspective and their 'judgemental rationality' approach. According to Yucel (2018), the validity of CR research is discussed in relation to its position between ontological realist and epistemological relativist paradigms. That is, CR believes that despite the 'reality' exists, producing the absolute knowledge about the 'real' ('what exists') is impossible. In other words, explanations about the real world are always incomplete and can be critiqued. CR therefore underlines the significance of both subjectivity (positivism) and socio-cultural (relativism) viewpoints in research knowledge production (Fletcher, 2017; Scott, 2010).

In relation to addressing research validity, Bhaskar (2017, p.20) argues that *"even though our knowledge is relative, we can produce in particular contexts, strong arguments for preferring one set of beliefs, one set of theories about the world to another."* By doing so, he recommends the application of 'judgemental rationality.' According to Scott (2010), while a research approach utilising 'judgemental rationality' still considers knowledge as relative and incomplete, it will constantly reflect on how the knowledge produced relates to other ways of analysing the subject (e.g. from previous research)—the process is known as 'theoretical redescription.' Given this, in order to enhance the validity of knowledge production in this research, I adopted a 'judgemental rationality' strategy to inform my research design.

While there are very few works in social research explicitly describing how 'judgmental rationality' is practically used (Robert Isaksen, 2016; Fletcher, 2017; Gandolfi, 2019), in this study, I endeavoured to address the use of this approach in two main interconnected ways. First, and foremost, a 'judgemental rationality' strategy informed my choice of employing a multi-layered approach to gain an understanding of the situation of public engagement in FRM in Thailand. The

multi-layered ontological perspective offered by CR helps improve the trustworthiness of the knowledge production of the 'reality' being investigated by offering spaces for considering different voices and dimensions in the knowledge construction processes (Fletcher, 2017; Scott, 2010; Yucel, 2018). Given this, employing a consistent interplay between investigating different perspectives (i.e. Thai public visitors and FRM key actors in various sectors) and research discourses previously produced about public engagement in FRM should help, at least partly, improve my research validity.

In doing so, to gain an understanding of the situation of public engagement in FRM in Thailand, I gathered data from different groups of participants (i.e. Thai public visitors and FRM key actors), performed different levels of analysis (i.e. analysed the investigation of each participant group individually and re-interpreted the two investigations' findings together using cross-investigation analysis), and cross-checked my own interpretations with the research participants' explanations and other researchers' (who were outside my research field and the research context) viewpoints. Furthermore, as this research is a cross-cultural study (research data were collected in Thai), the Thai-English translation was cross-checked by a professional English-Thai translator (Regmi et al., 2010).

Second, my aim in this study was not to use this multi-layered approach to simply generate a 'thick description' (Bhaskar, 2017) of public engagement in FRM in Thailand from the perspectives of Thai public visitors to a large science museum and FRM key actors, but also to connect my 'context-specific' interpretations with a wider body of research generated from other contexts (e.g. FRM in other nations). Given this, the process of 'theoretical redescription' was then used to posit my findings and interpretations within educational research (for sustainability) through a constant engagement with different literature in the field (Robert Isaksen, 2016; Scott, 2010), focusing on public education for DRR and science museum development to support EfS.

In summary, in relation to enhancing the validity of this research, I employed the 'judgemental rationality' strategy (in the form of a multi-layered approach) to design this research knowledge production process and searched for agential and structural aspects involved in the realities being investigated (i.e. public engagement in FRM in Thailand) that interconnected with other similar research

in the related fields (i.e. EfS, DRR, and science museum development) ('theoretical redescription'). In other words, my goal was to seek authenticity and validity in my interpretations of the realities of public engagement in FRM in Thailand by considering various perspectives and situating the investigated experiences in relation to other relevant research and contexts.

More detailed accounts of how these processes were operated in this study will be demonstrated throughout the following chapter (chapter 4), which focuses on presenting the research methodology. Subsequently, chapters 5, 6, 7, and 8 will present findings and interpretations produced throughout this study.

3.3.3 Final comments: Some reflexive thoughts and ethical aspects

According to Lincoln & Guba (2003) and Korstjens & Moser (2018), from a non-positivist perspective, any social science research is affected by the researchers' values; the values that influence the researchers' decision-making processes throughout the research course. Considering this study from the interpretive perspective underlines that the study cannot be perceived as 'value-neutral' (Gorski, 2013; Guillemin & Gillam, 2004; Haraway, 1991; Harding, 1991). Thus, as suggested by Korstjens and Moser (2018), it is my (the researcher of this study) responsibility to make my (social and political) values and views that influenced knowledge production in this research obvious to the reader, which I will discuss below.

One critical value that motivated me to conduct this research was my acknowledgement of the need for better FRM in Thailand. My view was not solely inspired by findings from previous research's argument on the inefficiency of FRM in Thailand (i.e. top-down and dominated by technological flood protections) (Marome et al., 2017; Marome, 2016; Phanthuwongpakdee, 2016; Singkran, 2017), but also my personal experiences with both severe floods and continual pluvial floods in the BMR (mentioned earlier in section 1.1). In addition, based on my own experiences as a resident of two big cities (i.e. Bangkok, Thailand, and London, England), I advocate that if improving the environmental situation is the goal, it is essential to promote not just people's behavioural changes, but the change of society's structural system (Chater & Loewenstein, 2022; Levinson et al., 2020; Sörqvist & Langeborg, 2019).

My 'choice of research problem' (Lincoln & Guba, 2003, p.265), to investigate public engagement in FRM in Thailand, was also consistent with my commitment to promoting collaborative work among Thai society to address flooding issues in the nation. This professional view has been inspired by literature in education for socio-environmental movements (e.g. Boyer & Roth, 2006; Layton et al., 1993; Lee & Roth, 2001; Levinson, 2010). According to the authors, as capital for addressing socio-environmental issues is distributed among society's members, collaboration from all sectors, including the public, is critical to improving the situation because it strengthens the exchange and accumulation of such capital.

My 'choice of context' (Lincoln & Guba, 2003, p. 265) for this study (i.e. a large science museum) was also influenced by my agreement with the concept of New Museology that museums should be developed *for* and *with* people (Hudson, 1977). As a non-formal education setting open to the public, I view museums as a potential avenue for hosting public education to promote a sustainable society (Lane et al., 2007; Navas Iannini & Pedretti, 2022; Newman et al., 2005). My selection to investigate this particular context can then be viewed as a yield of my professional interest—my passion for the development of (science) museums.

My 'choice of major data-gathering and data-analytic methods' (Lincoln & Guba, 2003) was also affected by my former research experience during my MSc programme (i.e. investigating the effectiveness of installing biogas systems in Thailand (Tanprasertkun, 2013)) and my living experiences in two large cities (i.e. Bangkok, Thailand, and London, England). That is, addressing socio-environmental issues is complex as it involves different actors (e.g. different groups of the public) and structures (e.g. current situation of environmental management, and social, cultural, and political contexts); it is context-specific. Thus, I opted to look at the research problem (i.e. public engagement in FRM) from a holistic perspective (i.e. personal and situational dimensions) and more than one perspective (i.e. Thai public visitors, FRM key actors, and research literature from various contexts).

In addition, my choice of methodology was also influenced by my own position in this research as a PhD candidate pursuing completion of my academic degree and an outsider of the science museum institution where I recruited the

participant Thai public visitors for this study. For instance, I opted to use convenience sampling to recruit walk-in visitors to the science museum because my aim was to generate research data as rich as possible within the limited period of data collection and my limited access to the science museum visitors' information (e.g. the museum members' contacts).

Hence, it is crucial to address here (once again) that the knowledge produced from this research cannot be perceived as value-free or neutral since the decisions made throughout this investigation course were informed by my points of view, values, and commitments, as discussed above (Guillemin & Gillam, 2004). Consequently, and regarding the ontological and epistemological positions accepted in this research, the data generated throughout this research process are meant as evidence for an inferential process of analysis that was aimed at searching for indicators to illustrate patterns and mechanisms behind the practices being studied. The findings and analyses in this study are then subjective and theory-driven in nature. To minimise imposing my bias on the knowledge production, I positioned myself as 'a learner' (who was learning new knowledge from my research participants) throughout the data collection process. I also, as mentioned earlier, analysed the generated data in this thesis through a rigorous interpretive process underpinned by a 'judgemental rationality' strategy.

Another crucial aspect that needs to be reflected in this study is the ethical issues that naturally emerge from any study involving human beings; it is the researcher's obligation to address ethical issues that potentially arise throughout their research (Christensen & Prout, 2002; Creswell & Creswell, 2018; Hoover et al., 2018; Miles & Huberman, 1994; Scott, 1996). One of the main ethical aspects involved in this research was my aim to not only describe and analyse the Thai public engagement practices from an outsider's perspective but to work alongside the participants (i.e. the public and FRM key actors) to reflect upon their realities of the topic being investigated. In other words, the methodological choices I opted for in this research were connected with an ethical commitment to giving voices and opportunities for reflection to the participants (Christensen & Prout, 2002; Scott, 1996). My research therefore unavoidably involved human participants.

Considering my responsibility toward the research participants (Creswell & Creswell, 2018; Scott, 1996), I adopted several strategies to minimise potential impacts on the research participants that may arise from participating in my study.

The research ethics of this study have been supervised and approved by the Committee of the Institute of Education, University College London (Ref: Z6364106/2018/07/92) on July 30, 2018 (see the research ethics application form in Appendix 2). In brief, first, in accordance with BERA Ethical Guidelines (BERA, 2018) and UCL Data Protection Office (2018), informed consent was obtained from all participants and their guardians (i.e. child visitors' parents or caregivers), and all participants were informed that they could withdraw their consent at any time before December 2019 (my contact card was given). At the beginning of the data collection process, I also ensured to inform the participants that they can avoid answering any questions if they wish.

Second, as argued by Miles & Huberman (1994) and Scott (1996), preventing both physical and mental harm and risk regarding participation in the research is another issue that needs to be addressed. In relation to safety, the data collection took place in the resting area of the museum building, key actors' workplaces, and in cafes. Specifically, for child visitors, their parents or caregivers were asked to be with them throughout the data collection process. In addition, to ensure that no harm would come to the participants, I affirm that every participant remains anonymous; that is, pseudonyms were used to refer to each participant in the situation where personal references are essential in data analysis and presentation, and their original data with their personal information were securely stored in a computer database with password-only access.

More details about these strategies will be illustrated throughout the following chapter 4, which will focus on the sampling processes and methods for data generation and analysis specifically used in this research.

Chapter 4: Research methodology

In this chapter, the settings, sampling, and methods of data generation and analysis adopted throughout this study will be demonstrated. While being both of a qualitative nature and complementary to each other, the investigations of Thai public visitors and flood risk management (FRM) key actors also entailed some distinct methodological choices and procedures that will be described in this chapter.

4.1 The investigation of Thai public visitors

The investigation of Thai public visitors, as mentioned in the previous chapter, was conducted with two main aims: (1) to explore if and how Thai public visitors to a large science museum engage with FRM in Thailand, and (2) to identify (if there are any) limiting factors in both personal and situational dimensions that must be addressed to enhance public engagement in FRM in the context of Thailand. The investigation focused on answering the first two RQs (see all RQs and their sub-research questions in section 3.1):

RQ1. What is the Thai public visitors' possession of capital for addressing flooding issues at the entry-level - issue sensitivity (flood experiences, flood risk perception, and empathetic perspectives toward flood victims); and in-depth knowledge about issues (understanding of the causes of flooding issues)?

RQ2. What is the Thai public visitors' possession of capital for addressing flooding issues at the ownership and empowerment levels - their perceived responsibility for FRM, intention to act, perceived strategies to mitigate flooding issues, and locus of control?

Relevant to my goal of producing in-depth analysis of public engagement in FRM from the perspective of the target (Thai public) audience of museum-based flood education, I opted to carry out this investigation at the Science Museum in the Bangkok Metropolitan Region (BMR), Thailand (the institution I will work for

in the future according to my PhD scholarship contract) using Case Study strategies (Creswell, 2013; Denscombe, 2010; Punch, 2009; Stake, 2005, 1995; Yin, 2013, 2003). A case study is a method that “*investigates a contemporary phenomenon within a real-life context*” (Yin, 2003, p. 13), and it serves to answer questions like ‘how?’ and ‘why?’ that are asked about a specific phenomenon of interest (the ‘case’ being studied) (Yin, 2017), such as the RQs proposed in this investigation. Based on these advantages, using a case study approach to ground this investigation seemed appropriate, particularly given my interest in describing and interpreting engagement practices with FRM of a specific group of the Thai public (the museum audience of a large science museum) and the reasons for their engagement (Stake, 2005).

The investigation (‘case’) can be characterised as ‘instrumental¹⁰.’ Each participant Thai public visitor can also be considered a sub-case due to their differences in nature (e.g. division in education, careers and ages). In the following sub-section, the selection process and characteristics of the participant Thai public visitors will be described.

4.1.1 Setting and sampling

As mentioned earlier, this investigation was carried out at the Science Museum, a large science museum operated by the National Science Museum (NSM), Thailand. The museum is located in BMR, Thailand. The institution is established to be an ‘edutainment’ centre to promote the Thai public’s understanding of the importance of scientific development, positive attitude toward science and technology, and understanding of the application of biodiversity to improve the quality of life (National Science Museum, 2019). Annually, the museum welcomes about 270,000 to 460,000 visitors, including both the public and school students.

The Thai public visitors who visit this particular science museum were purposively selected due to two main reasons. First, the museum and their surrounding communities have a shared experience in dealing with flood events.

¹⁰ A case that is a means to understand and represent a more general phenomenon or reality (Stake, 2005)

They were directly impacted by the 2011 Thailand floods. During the flooding and recovery period, the museum established its building as an emergency flood evacuation centre to help flood-affected people. Given this, I expect that the museum could also help promote FRM in BMR.

Second, due to my official contract to work for this museum after finishing this PhD programme, when compared to other science museums in Thailand, I have the most opportunity to access their visitors and the most potential to foster the development of flood education programmes in this museum. In this respect, I am expecting to use this thesis study as fundamental knowledge to inform the future development of flood education programmes. Furthermore, I have already established a connection with one of NSM's subsidiary directors (during the process of my PhD scholarship contract establishment with the museum), and she showed a willingness to let me carry out my PhD research in the museum.

The sampling process started by contacting the subsidiary director (online) in August 2018 (about a month before the data collection) to explain my research purpose and request access to their public audiences. After the contact, I was introduced to one manager, who (after that) supported me throughout the data collection process in the science museum. I then flew to Thailand at the end of August (after sorting out the research ethical approval, as discussed in the previous chapter) to begin my research fieldwork (September – December 2018).

I started my fieldwork in the museum by arranging a meeting with the museum manager to discuss my initial research plan. The discussion was focused on evaluating possibilities and limitations in accomplishing my data collection and the process of asking official permission to collect data in the museum. The discussion was very useful for me to finalise methods and procedures to generate data from the participant Thai public visitors (e.g. scoped down my target museum visitors from both the museum members and walk-in visitors to only walk-in visitors). This was to minimise adding extra work (e.g. space settings, contacting their members to ask permission to give me their contacts) for museum staff who were already busy with their museum work. After finalising my data collection plan, I sent a formal letter explaining my research purpose and the proposed data collection procedure ('what will be done in the science museum') to the NSM's director to ask for official permission, which was officially approved a few days after the request.

After spending half a month (1-14 September 2018) familiarising myself with the museum context (i.e. observing the museum's exhibitions and talking to museum front-house explainers), planning how to recruit walk-in visitors, and improving the data collection methods (i.e. testing the data collection methods), I began to recruit the participant Thai public visitors on September 15, 2018, using 'convenience sampling'. The recruitment process lasted for 3 months (finished in mid-December 2018).

The participant Thai public visitors were selected based on two main criteria: (1) they were Thai visitors who had 'finished' visiting the Climate Change Exhibition, and (2) they were willing to participate in the research tasks (i.e. drawings or being interviewed). I chose to recruit Thai public visitors who attended the Climate Change Exhibition to increase my chance of getting more participants to participate in my research. That is, I assumed that those who attended exhibitions about environmental risk could be more interested in discussing environmental issues, and the Climate Change Exhibition was the only exhibition about environmental risks in the museum (see the exhibition's details in Appendix 3).

Every weekend day (10.00 am – 3.00 pm) between mid-September to mid-December 2018, I was at the Climate Change Exhibition inviting visitors who had 'finished' visiting the exhibition to participate in my research. There was no specific age group I wanted to recruit because I aimed to explore perceptions of flooding and FRM from museum visitors of all ages¹¹, as long as they were able and willing to participate in the data collection tasks. Weekend days were selected to be data collection days because, according to my observations, there were significantly more visitors of mixed ages (e.g. families, couples, and solo visitors) when compared to weekdays (which were usually mainly with school students).

My rationale for using convenience sampling was to recruit Thai visitors to participate in this study as much as possible within my limited time for data collection (three months) (Denscombe, 2010). My main challenge in using a convenience sampling approach was how to ensure the credibility of the data generation—the main criticism of the approach. To overcome the challenge, I

¹¹ I believe that everyone has the right to be informed about environmental risks and, with support, has the potential to collectively improve the environmental circumstances (Bosschaart et al., 2015, 2013).

applied the 'data saturation' technique, suggested by Fusch & Ness (2015), to inform when to stop recruiting participant Thai public visitors. That is, I stopped recruiting new Thai visitors when I met two criteria: (1) there was no additional new information obtained from new participants for a month, and (2) I had finished all my three months of data collection in the museum as planned (September–December 2018).

The recruitment process yielded a total of 56 participant Thai public visitors (32 females and 24 males), which consisted of 18 young children¹² (aged 5–12 years old) and 38 adults¹³ (aged 13 years old and above), which, hereafter, will be referred to as 'the participant child visitors' and 'the participant adult visitors', respectively. (Details of the participant Thai public visitors' demographic information are presented in chapter 5, section 5.1.)

4.1.2 Data generation and processing

As mentioned above, I employed a case study approach to acquire an in-depth exploration of the phenomena of interest (i.e. public engagement in FRM in Thailand) (Creswell, 2013; Yin, 2013). I therefore opted to use three qualitative methods: draw-and-explain, personal meaning mapping (PMM), and interview approaches to generate rich narratives of the participant Thai public visitors' perceptions of flooding issues and their engagement with FRM, summarised in Table 4.1 below. This adoption of different data collection methods for the participant child visitors (draw-and-explain) and the participant adult visitors (PMM + interview) relates to the effectiveness of each method in generating data from each of these participants. I will discuss the theoretical details of each method and the rationale behind their selection below.

¹² There were 19 young children participating in the data collection process. Nonetheless, one 4-year-old boy was excluded from the study due to my limited ability to interpret the data he contributed.

¹³ None of them was between 26-30 and 51-60 years old.

Table 4.1 Outline of data generation methods and generated data - the investigation of Thai public visitors

Data collection method	Involved participants	Generated data
Draw-and-explain	Child visitors (5-12 years old)	- 18 sets of drawings + drawings' explanation audio-records - Fieldnotes
Personal Meaning Mapping (PMM)	Adult visitors (13 years old and above)	- 38 PMMs
Semi-structured interview	Adult visitors (13 years old and above)	- 25 interview audio-records (15 individual interviews and 10 group interviews) - fieldnotes

Methods detailed (through theoretical lenses)

(1) Draw-and-explain

The draw-and-explain method is an adapted version of the traditional drawing method. Instead of collecting only drawings generated by research participants, the draw-and-explain approach asks the participants to explain and clarify their drawings immediately after they finish them (MacPhail & Kinchin, 2004). The traditional drawing method has been employed in a number of studies to assess individuals' conceptions or perceptions of specific topics and learning outcomes in both formal and informal learning contexts (see e.g. Alerby, 2000; Bezemer et al., 2012; Bucchi, 2008; Liu & Lin, 2018; MacPhail & Kinchin, 2004; Moseley et al., 2010), including flood risk perceptions (Raks Thai Foundation, 2014). Several advantages (i.e. fun and attractive for most children, quick and effective due to no training required, less controlled by researchers' frames of reference, and reducing linguistic skill barriers) make the drawing approach suitable for collecting young children's impressions and perceptions.

The traditional drawing method also comes with limitations (MacPhail & Kinchin, 2004): drawings can represent only values or ideas that can be presented graphically; generating drawing data can be limited by artistic skills; and drawing analysis relies very much on researchers' interpretation. Thus, in the

draw-and-explain approach, asking the participants to explain and clarify their drawings immediately after they finish helps researchers improve the quality of drawing data analysis by minimising bias from the interpreters' judgemental framework (MacPhail & Kinchin, 2004).

In this study, since interviews were unable to generate data from child visitors effectively (that is, during my instrument pilot test, it was very difficult to keep children concentrating on answering interview questions in the science museum environment where there were plenty of more interesting things to do than being interviewed), I therefore opted to use the draw-and-explain method as the primary data collection method with participant child visitors. In doing so, a guideline for collecting drawings and their explanations from the participant child visitors (Appendix 5) was developed to guide the data collection.

In brief, each participant child visitor was asked to provide a drawing about 'non-flooding' and 'flooding' using a flood drawing sheet (Figure 4.1). My goal to ask each participant child visitor to draw both non-flooding and flooding was to facilitate the drawing data analysis; that is, to assist in the identification of similarities and differences between the two circumstances from the participant child visitors' perspectives.

(non-flooding)		(flooding)	
Date	Code	Age	Gender

Figure 4.1 Blank flood drawing sheet (A4 size)

(2) Personal Meaning Mapping (PMM)

The PMM method was developed to measure learning outcomes based on the assumption that learning is a relative and constructive process; it was first developed to assess public attitudes and knowledge about indigenous people in two Canadian museums (Falk et al., 1998). The key process of the method is asking respondents to write down words/phrases/sentences or draw their thoughts that come up regarding a topic being investigated (e.g. in this study, 'flooding') in the PMM. To evaluate the outcome of learning interventions, research participants were asked to fill in the same PMM before and after participating in the intervention being investigated.

Recently, variations of this approach have been utilised in diverse settings and fields (e.g. art, science, history and natural history museums) for various evaluating purposes, such as assessing personal concepts, attitudes, emotions, and understanding of particular topics or objects (Falk et al., 1998; Kelly, 2007). It has been also used as a method to support other data generation approaches (e.g. interviews and questionnaires). Kelly (2007), for example, used the PMM method at the beginning of her interviews with museum visitors to assess their learning identities.

In this study I used the method to support and compliment the participant adult visitors' interviews and also to assess the interviews' influences on the participant adult visitors' perceptions of flooding issues and FRM. In doing so, the participant adult visitors were asked to write down thoughts that came to their minds when they think of the term 'flooding', which was stated in the middle of a flood PMM (Figure 4.2), before and after the interviews (see the participant adult visitors' data collection guidelines in Appendix 6).



Figure 4.2 Blank flood Personal Meaning Map (half A4 size)

(3) Interviews

Interviews are a common method that has been used in museum audience research due to their potential to gain insights into the behaviours, perceptions, feelings, experiences, and words of visitors in rich detail (Diamond et al., 2016; Hesse-Biber & Leavy, 2010; Soren & Armstrong, 2014). The methods can provide researchers access to visitors' experiences and their ways of constructing meaning for them (Diamond et al., 2016).

In this study I employed semi-structured interviews (Denscombe, 2010; Diamond et al., 2016) as the main method to collect data from the participant adult visitors. Although semi-structured interviews might offer less freedom to interviewees to talk about topics being investigated than unstructured interviews (Denscombe, 2010; Diamond et al., 2016), the strategy helped me ensure to ask all necessary questions to address RQs 1 and 2 (section 3.1). The use of open-ended questions also allowed me to explore emerging ideas that I had not anticipated before the interviews (Denscombe, 2010; Diamond et al., 2016).

In doing so, initial participant adult visitors' data collection guidelines, including interview protocol and questions, were developed (in English). I then translated the interview questions into Thai¹⁴ and pilot-tested the instrument with

¹⁴ As suggested by Larkin et al. (2007), the translation was reviewed and amended by my Thai friend who is an experienced English-Thai translator to minimise confusion caused by language and cultural differences between Thai and English.

five museum front-house explainers and five walk-in visitors. The processes helped me improve my interview protocol and questions (e.g. removing repetitive questions). The final interview guidelines (see Appendix 6) covers seven data themes I wanted to explore with the participant Thai public visitors to address RQs 1 and 2:

1. Museum visiting agendas and experiences
2. Flood experiences, perceptions of flooding issues and its causes, and engagement with FRM
3. Desire to know/tell others about flooding issues
4. Climate change perceptions
5. Climate Change Exhibition visiting experiences
6. Perceptions of the relationship between flooding and climate change issues
7. Desire to know/tell others about climate change

Since visiting agendas are a significant factor in determining visitors' engagement and learning in science museums (Falk et al., 1998; Falk & Dierking, 2000; Moussouri, 1997), Theme 1 sought to gather information about why and how the participant adult visitors visited the science museum. I intended to find out whether exhibitions about socio-environmental issues (e.g. the Climate Change Exhibition in this science museum) were a target during their visits. As the participant Thai public visitors were recruited after they had finished visiting the Climate Change Exhibition, Theme 5 sought to gather information to explore what the participants gained from the exhibition. Themes 2, 3, 4, 6, and 7 were developed to acquire information to address RQs1 and 2; that is, to explore the participant adult visitors' possession of capital for FRM at all three levels (i.e. entry, ownership, and empowerment).

Within these themes, I left the wording of my questions slightly flexible and allowed myself to ask new questions framed by the circumstances of the particular interview (Diamond et al., 2016). I also adjusted and refined interview questions and protocols according to the circumstances, the new understandings of the participants, and my own work throughout the data generation course.

Data collection – stories from fieldwork in the science museum

The data collection was performed in Thai. I began with introducing myself (as a PhD student) to the target visitors, informed them about my research briefly, and invited them to participate in the interviews/draw-and-explain tasks for about 30 minutes. I took the visitors who agreed to participate to a resting area on the same floor as the Climate Change Exhibition and then collected data from the participant child and adult visitors following the data collection guidelines for each group (see Appendices 5 and 6, respectively), which I explain below.

All the participant Thai public visitors and child visitors' guardians were informed about their (or their children's) data collection and usage, their rights to withdraw from the research (anytime until December 2019), my contact information, and their rights to not answer any specific questions or tasks. I also informed them explicitly that their identities would be made anonymous to enhance the degree of openness among the participants during the data collection (Gagnon et al., 2015). The participants were also informed that the whole conversation during the data collection process will be audio-recorded. I then asked them if they had any questions or concerns to ensure that the participants and their guardians understood their rights and involvement in my research. Then, I asked the participants (or their guardians) to carefully read and sign consent forms and fill out the demographic questionnaires (Appendix 4) prior to data collection.

For the participant child visitors (draw-and-explain), I provided each participant child visitor with a box of 24 colouring crayons and a flood drawing sheet (Figure 4.1). Then, they were asked to draw about non-flooding and flooding circumstances. They were asked: "*Based on your own understanding, could you draw me what you think about non-flooding and flooding?*" To minimise my influence (as a researcher who facilitated the data collection tasks), the children's questions after this point (if they were not about task instruction clarification) were answered with "*up to you, there is no right or wrong.*" Also, I kept a distance from the children to help them feel more comfortable while they were drawing. The children were given as much time as they needed to complete their drawings, which typically took between five to ten minutes.

After finishing their drawings, the children were asked to explain them and to answer a few questions about their flood experiences, their museum visiting agendas, and their experiences with the Climate Change Exhibition (Appendix 5). I decided to take no control over any child-guardian or peer-to-peer interactions because I wanted to preserve the nature of social interaction that often happens in museum contexts. Their interactions were instead noted down to aid in the analysis of the drawings. As summarised in Table 4.1 above, the data collection process yielded 18 sets of drawings and drawing explanations audio-records and fieldnotes (see an example of the participant child visitors' data set in Appendix 7).

For the participant adult visitors, fifteen of them were interviewed individually, and the rest were interviewed in groups of two or three participants. Whether to be interviewed individually or with their peers was up to the participants to decide to create the most comfortable environment for them. In group interviews, I encouraged each participant to respond to all questions. The participant adult visitors' data collection was begun by discussing their museum visiting agendas and experiences. Then, I moved onto explore the participants' perceptions of flooding issues by first asking the participants to write down their thoughts about the term 'flooding' on a flood PMM (Figure 4.2) using blue pens ('producing pre-interview flood PMM data'). The participants were given as much time as they needed to complete their flood PMMs, which typically took a few minutes.

After the participants finished their pre-interview flood PMMs, I asked them to explain some words or phrases that seem unclear. I then moved onto interviewing them using the rest of the interview themes (see all interview topics and questions in Appendix 6). As I learned from my pilot instrument test (i.e. while some of my pilot interviewees were more familiar with the term 'climate change' in English, the rest were more familiar with the term in Thai, '*Kan Plian-plaeng Sa-phap Phu-mi-ar-kard*'), when discussing climate change, I made sure that I mentioned both terms (climate change in English and Thai) to the participants. When discussing their experiences visiting the Climate Change Exhibition, I also showed the participants pictures of all the displays in the exhibition that I had taken and printed on paper to remind them of their visits.

At the end of the interview, I asked the participants to look at their pre-interview flood PMMs again and asked if they would like to add or amend their responses using red pens ('producing post-interview flood PMM data'). Each interview took about thirty minutes to an hour. As shown in Table 4.1, the process of gathering data resulted in 38 PMMs, 25 interview audio-recordings (15 individual interviews and 10 group interviews), and fieldnotes (see Appendix 8 for an example of the participant adult visitors' data set).

Data processing

I processed the generated data in different ways and stages according to the types of data (i.e. drawings, written responses on the PMMs, audio-records, and my written fieldnotes). First and foremost, I anonymised all data by removing any identifying information and assigning codes to each participant (e.g. C.01 = participant child visitor No.1 and MV.01 = participant adult visitor No.1) and transcribed all audio-records. I did not translate all interview data into English as I decided to work with them in Thai (it was easier for me to make meaning of them that way). I only translated selected pieces of the data when necessary (for example, when I needed to discuss the analysis with others, such as my supervisors).

To enhance the trustworthiness of a cross-cultural study (i.e. the data were collected in Thai about FRM in Thailand but were analysed and presented in English), as suggested by Larkin et al. (2007) and Regmi et al. (2010), I translated three full interview transcripts (of participant adult visitors) and sent them to be checked by a professional English-Thai translator (along with their Thai versions). This translation check helped me improve my translation throughout the analysis process (e.g. I knew more suitable English words to represent Thai terms).

To assist my data analysis, I organised all the data in an Excel file to facilitate my access to them. Figure 4.3 shows the Excel file for this investigation. It has specific cells for the participants' demographic information (i.e. participant code, age, gender, highest education level, occupation, and last museum visit); information about their data (e.g. names of their audio-record files and types of interviews); their flood experiences; their pre- and post-flood PMMs' responses;

and my notes about each participant. The file also helped me see the overview of the data I gathered for the investigation.

Code	File	Flood experience (Y/N)	Type of interviews (G=Group/I=Interview)	Age (1=<13, 2=13-18, 3=19-25, 4=26-30, 5=31-40, 6=41-50, 7=51-60, 8=>60)	Gender (M=Male/F=Female)	Education (E/P/H/V/B/MPND/O)	Occupation	Last visit the museum (1=Never, this is my first time, 2=within the past 6 months, 3=within the past one year, 4 => 1 year)	Flood PMMs		Remarks
									Pre-interview	Post-interview	
C.01	3.MV_03	Y	I	1	f	P	Student	2			
C.02	7.MV_09_10	N	G(±1)	1	F	P	Student	4			
C.03	MV_21	N	I	1	F	P	Student	1			
	MV_22	N	I	1	M	E	Student	1			Removed from the data set due to my limited ability to interpret his drawing
C.04	MV_23	N	I	1	F	E	Student	3			
C.05	MV_24	N	I	1	M	P	Student	3			
C.06	MV_29	N	I	1	F	P	Student	4			
C.07	MV_35	N	I	1	F	E	Student	1			
C.08	MV_36	N	I	1	M	P	Student	1			
C.09	MV_37	N	I	1	M	P	Student	1			
C.10	MV_38	N	I	1	F	P	Student	1			
C.11	MV_39	N	I	1	M	P	Student	1			
C.12	MV_40	N	I	1	M	P	Student	1			
C.13	MV_42	N	I	1	M	H	Student	1			
C.14	MV_43	N	I	1	M	P	Student	1			
C.15	MV_46	N	I	1	M	P	Student	2			
C.16	26.MV_47_48	N	I	1	M	E	Student	2			
C.17	30.MV_53_54	N	G(±1)	1	F	P	Student	1			
C.18	30.MV_53_54	N	G(±2)	1	F	P	Student	1			
MV_05	5.MV_05_06_07	Y	G(±1)	2	F	H	Student	1	Dwelling/difficulty in finding shelters, food, transportation Rubbish/wastewater House problems/House dilapidation	Climate patterns cause phenomenon changes Human destroy the nature and not take care of it	
MV_06	5.MV_05_06_08	Y	G(±3)	2	F	H	Student	1	Food/taste of food Dwelling/dilapidation of house, car, furniture/electrical equipments/not on time	Feeling Thinking Understanding	

Figure 4.3 Excel file for data processing – the investigation of the participant Thai public visitors

4.1.3 Data analysis

As summarised in Table 4.2 below, in order to answer RQs 1 and 2, I used different analytical strategies on the collected data.

Table 4.2 Outline of data analysis - the investigation of Thai public visitors

Note: I employed a hybrid strategy of deductive and inductive thematic analysis for qualitative coding (Brooks et al., 2015; Fereday & Muir-Cochrane, 2006; Hsieh & Shannon, 2005)

Sources of data	Analysis	Used to answer		
		RQ1	RQ2	Influences of interview interventions on participant adult visitors
- participant child visitors' drawings and drawings explanations	- Drawing item analysis + Qualitative coding	/	-	-
- participant adult visitors' flood PMMs	- Qualitative coding	/	-	/
				(by comparing pre- and post-interview responses on flood PMMs)
- participant adult visitors' interviews	- Qualitative coding	/	/	-

Overall, I employed a hybrid strategy of deductive (direct content analysis) and inductive thematic analysis (conventional content analysis) (Brooks et al., 2015; Fereday and Muir-Cochrane, 2006; Hsieh & Shannon, 2005). The deductive approach - through direct content analysis - implies a “*deductive use of theory*,” and it aims to “*conceptually extend a theoretical framework of theory*” (Hsieh & Shannon, 2005, p. 1281). The inductive approach – through conventional analysis - on the other hand, allows “*the categories and names for categories to flow from the data*”; researchers “*immerse themselves in the data to allow new insights to emerge*” (Hsieh & Shannon, 2005, p. 1279). According to Hsieh and Shannon (2005), the inductive approach is particularly useful when “*existing theory or research literature on a phenomenon is limited*” (p.1279). Given this, while I used sub-research questions within RQs 1 and 2 as

overarching themes for the data analysis, within each theme I allowed categories to emerge from the data themselves.

The overarching themes I searched for in the data include:

- (1) *Flood experiences,*
- (2) *Perceptions of flooding,*
- (3) *Understanding of flood causes,*
- (4) *Perceptions of severe flood likelihood,*
- (5) *Thoughts about climate change,*
- (6) *Perceived relationship with climate change issues,*
- (7) *Opinions about the scientific prediction of the increased flood likelihood due to sea-level rise,*
- (8) *Perceived responsibility for flood risk management,*
- (9) *Actions to mitigate flooding issues,*
- (10) *Questions about flooding issues,*
- (11) *Questions about climate change issues,*
- (12) *Desire to inform others about flooding issues,*
- (13) *Desire to inform others about climate change issues, and*
- (14) *Post-interview thoughts about flooding.*

I will describe the details of the data analysis of each data source below.

Drawing and drawing explanation analysis

Collecting drawings and drawing explanations explored the participant child visitors' perceptions of flooding. The process started with analysing the drawings alone using an 'item analysis' approach (Di Leo, 1983). I started by carefully and repeatedly looking at all the drawings to immerse myself and get a sense of them as a whole. I then, in each drawing, compared drawing items in 'non-flooding' and 'flooding' sites to find similarities and differences and noted down their meaning (codes). Figure 4.4 illustrates how C11's drawing was coded as 'People need to be rescued during flooding.'

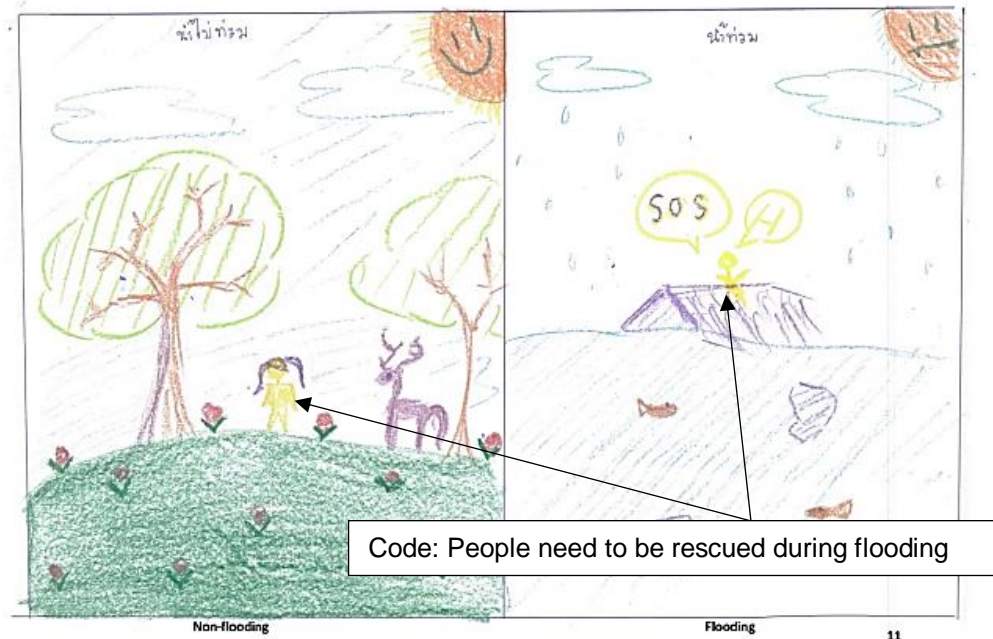


Figure 4.4 C.11's drawing

By comparing drawing items in 'non-flooding' and 'flooding' sites, I identified nine codes representing the child's perceptions of flooding (e.g. Flooding covers most dwellings and People need to be rescued during flooding). For example, the drawing was coded as 'People need to be rescued during flooding' because there is a human symbol with words 'help' and 'SOS' depicted on the flooding site but not on the non-flooding site.

To minimise biases from my analytical framework (i.e. a researcher who has particular concerns about flooding issues and a citizen who lives within the study context) (MacPhail & Kinchin, 2004), after I finished my initial coding, I opted to perform a cross-interpretation analysis. That is, the same coding process (i.e. item analysis) was done by my principal supervisor who is an outsider to the study context. My supervisor's and my coding results were then brought together to discuss and finalise. At the end of this process, there were 17 codes interpreted from the drawing data.

These codes and the whole set of drawing data were then sent to seven other researchers (six PhD colleagues and my subsidiary supervisor) to check the inter-rater reliability of the drawing interpretation and to see if anything else emerged. They were asked to list all drawings that indicate each code, as well as identify any other codes that could be deduced from the drawings. The codes were considered valid for each drawing if six of seven researchers agreed with our interpretation (my principal supervisor and I). The codes that received less agreement than six researchers were brought to discuss with those researchers.

This process helped me clarify, adjust some words, and add or delete some codes.

I then looked at all drawings, their codes, and their explanatory transcripts together to finalise the interpretation. The participant child visitors' own voices were considered the most important to justify the final codes. Apart from justifying the codes, the drawing explanation data added seven more codes that represented the participant child visitors' perceptions of flooding. The process resulted in a total of 23 codes.

Then, all the codes were carefully and repeatedly read again to identify emergent finding themes (by combining the relevant codes). In doing so, I created Table 4.3 to organise the combined codes that represent each finding theme together. The table also illustrates, for each code, drawing indications, examples of drawings, examples of drawing explanation quotes, and the number of participant child visitors who mentioned each code. (See the completed version of the table in Appendix 9.) The findings are reported and discussed in chapter 5 (section 5.3.1).

Table 4.3 Organising the findings from the drawing and drawing explanation analysis

Note: The completed version of the table is provided in Appendix 9

Drawing item analysis				Number of the participant child visitors (n=18)	Identified perception of flooding (Finding theme)
Drawing indication	Example of Drawings	Example of drawing explanations	Code		
The drawing indicates water symbols cover all over human habitat in the flooding site.	C.08, C.10, C.11, C.15, C.19	<i>"Flooding...the city sinks." (C17)</i>	Floodwater covers most dwellings	13	Flood impacts
The damaged trees were drawn in the flooding site to replace the healthy trees in the non-flooding sites.	C.8, C.15, C.19	<i>"If there is no flooding, living things will be plenteous. and forest." (C12)</i>	Trees/ nature were damaged when it floods	10	
The damaged things such as buildings, cars, and houses were depicted in the flooding site.	C.08	<i>"...[Flood] damages our things and properties." (C.08)</i>	Properties/ belongings were damaged when it floods	10	
The damaged vehicles (e.g. upside-down cars) were drawn in the flooding site.	C.08	<i>"[in flooding circumstance,] using cars is forbidden." (C.08)</i>	Flooding affects transport by vehicles	4	

Flood PMM analysis

Pre- and post-interview flood PMM data were analysed separately. I read all the pre-interview flood PMM responses and my clarification notes (i.e. some words, phrases, and drawings) when I asked the participant adult visitors to further explain to achieve immersion and get a sense of their responses. I then created Table 4.4 to code the pre-interview flood PMM responses (the coding worksheet). In this worksheet, I developed initial codes based on the responses and arranged all responses that justified my codes.

Table 4.4 Worksheet for flood PMM data coding

Note: The table presents only examples of responses and codes.

Responses	Code
<i>e.g. House dilapidation: flood marks, repainting, Maintenance Utensils (damaged)</i>	Damaged properties/loss of belongings
<i>e.g. Victims' troubles, flood victims, loss of lives and belongings of those who encountered floods</i>	Suffered flood victims
<i>e.g. Trees died, Environmental loss</i>	Impacts on nature and the environment
<i>e.g. Hygiene, Health, Illness</i>	Personal and family members' health impacts

Several readings of the responses allowed me to refine the code until I had exhausted all of them. I then organised a new table (Table 4.5) where I combined the codes related to each other, which helped me identify emergent findings that represented the participant adult visitors' perceptions of flooding. I also added all the different responses and the number of participant adult visitors who mentioned each code to respectively justify my choices and illustrate the frequency of mentions.

Post-interview flood PMM data were analysed using the same analysis process. Nonetheless, unlike the pre-interview responses, I did not ask the participant adult visitors to clarify their post-interview flood PMM responses.

Therefore, there were a few words: “*polar bear*,” “*feeling*,” and “*trees*,” that I could not make meaning from them from the participant adult visitors’ perspectives. Given this, these words were not included in the finding report. (See all pre- and post-interview flood PMM analysis codes in Appendix 10 and Appendix 11, respectively). The findings from the pre- and post-interview flood PMM data analysis are reported and discussed, respectively, in chapters 5 and 6 (sections 5.3.2 and 6.5).

Table 4.5 Organising the findings from the flood PMM data analysis

Note: See all pre- and post-interview flood PMM analysis codes in Appendix 10 and Appendix 11, respectively.

Flood PMM Response	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>e.g. House dilapidation: flood marks, repainting, Maintenance Utensils (damaged)</i>	Damaged properties/loss of belongings		e.g. Flood impacts: at the personal level
<i>e.g. Hygiene, Health, Illness, Athlete’s Foot disease</i>	Personal and family members’ health impacts		

Interview data analysis

The coding process was done using NVivo (version 12). I began the data analysis by uploading all the interview transcripts and the relevant fieldnotes to the software. Then, I read the interview transcripts and fieldnotes carefully and repeatedly to immerse myself in the data and get an overall sense of it. Avoiding a reductionist approach, as Bellomo (2014) suggests, I did not generate codes for specific words or sentences. Instead, I performed an initial data coding by creating 13 coding ‘nodes’ which represent the overarching themes 1-13 (outlined earlier at the beginning of this sub-section) and coding all relevant data (which could include more than a paragraph) into each node. When this process was done, I was able to narrow my focus to analysing the data in each overarching theme. Figure 4.5 illustrates how this process worked for me; when I clicked on the node ‘*Actions to mitigate flooding issues*’ (an overarching theme), the

software showed me all relevant data, which I could code again to identify sub-themes.

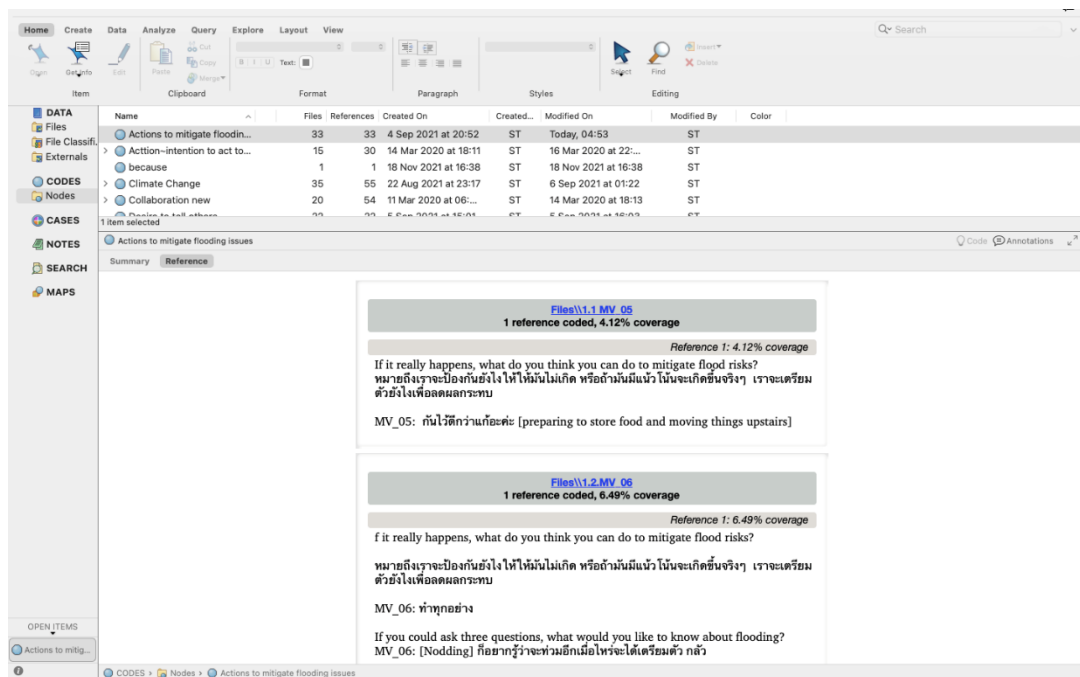


Figure 4.5 A screenshot of the initial coding process of the participant adult visitors' interview transcripts using Nvivo 12

I created a coding node for each overarching theme (e.g. Actions to mitigate flooding issues). I then coded all relevant data (which could be more than a paragraph) into each node. When this process was done, I was able to narrow my focus and analyse the data in each overarching theme by clicking on each coding node to review all relevant data. For example, in this screenshot, when I clicked 'Actions to mitigate flooding issues' node, the software showed all the data that I coded to the node ('the overarching theme') along with the participants' information (which I assigned to the software when I uploaded the data).

Data within most of the overarching themes were coded again inductively, except for the themes, '*Understanding of flood causes*', and '*Actions to mitigate flooding issues*'. The data within these themes were coded deductively according to, respectively, the levels of the causes of flood issues adapted from Wisner et al.'s (1994) PAR model (discussed earlier in section 2.2.1) and Stern's (2000) types of action that citizens can adopt to address environmental issues (discussed earlier in section 2.2.2). Several readings of the transcripts allowed me to refine the codes until I found that I had exhausted all of them. Then, for each overarching theme, I organised a table to present all codes, examples of quotes to justify my choices, and the number of participants who mentioned the codes. Table 4.6 illustrates an example of how most of the findings from the

investigation of the participant Thai public visitors were organised and reported in this thesis.

Table 4.6 Organising and presenting (most) of the findings from the investigation of participant Thai public visitors

Note: No Thai public visitors aged 26–30 and 51–60 years old participated in this study.

Overarching theme (e.g. Perceived future flood likelihood)	Example of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	≥/61 (n=3)	
Sub-theme1 (e.g. Definitely will happen)	<i>e.g. ‘Yes, I think because flood management is still not good enough.’</i>						
Sub-theme 2							
Sub-theme 3							

As mentioned in the previous chapter, my aim for this investigation was not only to produce a case description of the participant Thai public visitors’ perceptions of flooding issues and their engagement with FRM. I also wanted to acquire insights into (both positive and negative) factors that influence public engagement in FRM in Thailand. I therefore considered the findings of this investigation with the research literature on factors influencing public engagement in FRM (reviewed in section 2.3) to identify possibilities for and barriers to public engagement in FRM. The portrait of findings from this investigation and the identified possibilities for and barriers to public engagement in FRM based on the findings are reported in chapters 5 and 6.

4.2 The investigation of FRM key actors

The investigation of FRM key actors, as mentioned in the previous chapter, was conducted with three main aims: to explore (1) how FRM key actors in Thailand expect the public to engage in FRM, (2) if and what factors prevent the public from engaging with FRM from their perspectives, and (3) if and how they

would like museums to support FRM. The investigation focused on addressing the last RQ of this thesis study (see all RQs and their sub-research questions in section 3.1):

RQ3. *How do FRM key actors perceive public engagement in FRM in Thailand?*

As informed by Critical Realism (CR) (i.e. a social reality is the yield of the interchanges between distinct 'objects' within a wider structure (Bhaskar, 2017, 2008; Gorski, 2013)), I opted to add the investigation of FRM key actors as a 'layer' of analysis to my case study. The investigation aimed to gain a better understanding of situational possibilities and constraints for the Thai public to engage with FRM. It was a part of my effort to employ the 'judgemental rationality' approach, as suggested by CR researchers (Easton, 2010; Scott, 2010), to strengthen the validity of knowledge production about the reality of public engagement in FRM in Thailand in this study.

As mentioned in the previous chapter, 'judgemental rationality', at least partially, helps case studies out of their epistemological relativism tradition – a significant critic of the case study approach (Easton, 2010; Scott, 2010). It enhances the credibility and trustworthiness of 'transposition' of its context-based knowledge ('case-based knowledge') to other contexts (Easton, 2010; Scott, 2010). In the scenario of public engagement in FRM in Thailand, I aimed to connect the findings from this investigation (i.e. public engagement in FRM from FRM key actors' perspectives) with the findings from the participant Thai public visitors to provide knowledge in terms of what could influence these realities ('reintroduction').

According to Given (2008), this investigation of the participant FRM key actors' perspectives can be characterised as a 'layer' of the case (i.e. the participant Thai public visitors' engagement in FRM). Each participant FRM key actor can also be considered a sub-case due to their different natures (i.e. division in professions involving FRM). In the following sub-section, the selection process and characteristics of the participant FRM key actors are described.

4.2.1 Setting and sampling

The participant FRM key actors were recruited purposively using snowball sampling. According to Denscombe (2010, p. 35), purposive sampling is “*a way of getting the best information by selecting items or people most likely to have the experience or expertise to provide quality information and valuable insights on the research topic.*” The main challenge in recruiting the participant FRM key actors was my limited knowledge about the FRM key actor population. As suggested by Denscombe (2010), I therefore employed the snowball sampling technique to increase my chance of getting more FRM key actors to participate in this study.

The sampling process started by developing an initial list of target FRM key actors through online searches about FRM key actors in Thailand (July - August 2018); the searches looked for their expertise and experiences connected with FRM in Thailand and their contact information. The process yielded an initial list of four FRM key actors: two volunteer educators, one researcher, and one state authority. The main criterion to select the initial FRM key actors was that they had worked (either officially or voluntarily) toward improving FRM in Thailand.

These four pre-selected FRM key actors were contacted via email with an approach letter explaining my research proposal to inquire about their interest in participating in my research. All of them agreed to participate in my research. Subsequent official agreements for a face-to-face interview with each FRM key actor were arranged during my fieldwork period in Thailand (September–December 2018). The rest of the participant FRM key actors were recruited through nominations by the initial participants. The recruitment ended when no new contact was suggested.

The recruitment process yielded a total of 10 participant FRM key actors (five females and five males), which consisted of four researchers in disaster risk management, four volunteer educators, and two state authorities. (See details of each participant FRM key actor’s expertise, experiences, and perceived roles regarding FRM in chapter 7, section 7.1).

4.2.2 Data generation and processing

Methods detailed (through theoretical lenses) – Interviews

In this investigation, interviewing is the method used to generate data from the participant FRM visitors to answer RQ3. This was to gain the participant FRM key actors' perceptions about public engagement in FRM in rich detail (Diamond et al., 2016; Hesse-Biber & Leavy, 2010; Soren & Armstrong, 2014). Similar to the investigation of the participant Thai public visitors, I opted to use semi-structured interviews with the participant FRM key actors. As I argued before, although semi-structured interviews might offer less freedom to interviewees to talk about topics being investigated than unstructured interviews (Denscombe, 2010; Diamond et al., 2016), having interview guidelines helped me ensure that all necessary questions were asked of the participant FRM key actors. Also, through using open-ended questions, the method was still flexible enough to help me explore emerging ideas that I had not anticipated (Denscombe, 2010; Diamond et al., 2016).

In doing so, the participant FRM key actors' interview guidelines (Appendix 12) were developed to support my interviews. The guidelines cover five data themes to address RQ3, as can be seen below:

1. Their perceived relationship with flooding issues
2. Their opinions about challenges in improving FRM in Thailand
3. Their expectations of engagement from the public
4. Their opinions about challenges and how to promote public engagement in FRM
5. Their expectations of support from science museums to improve FRM
6. Their suggestions for other key actors

Theme 1 sought to gather information about how the participant FRM key actors perceive themselves related to flooding issues, as I wanted to explore their roles in FRM from their own perspectives. Theme 2 endeavoured to explore challenges in improving FRM in Thailand from the participant FRM key actors' perspectives. I intended to discover whether they viewed limited public engagement in FRM as a challenge to improving FRM in the context of the nation.

Themes 3 and 4 focused on exploring the participant FRM key actors' expectations of engagement from the public, challenges (if any) in promoting public engagement in FRM, and their suggestions for promoting such engagement. As the participant FRM key actors are significant influencers in the decision-making of FRM policies and plans, understanding their opinions on these issues had the potential to help me identify possibilities and barriers in promoting public engagement in FRM in the situational dimension. Theme 5 sought to explore their expectations of collaborative support from science museums to improve FRM. Finally, because I used the snowball sampling technique to recruit the participant FRM key actors, Theme 6 aimed to increase the number of participants in the study.

Within these themes, I left the wording of questions slightly flexible and allowed for the possibility of asking new questions framed by the circumstances of the particular interview (Diamond et al., 2016). To be used in the data collection process, all data collection instruments were translated from English to Thai (the translation was checked by a professional Thai-English translator). The initial interview guidelines were pilot tested with two Thai PhD students to adjust and refine the interview questions and protocols. The guidelines were also adjusted according to the circumstances and new understandings of the participants throughout the interviews.

Data collection – stories from fieldwork with FRM key actors

The data collection processes with participant FRM key actors were done in Thai. According to the interviewees' choices, seven of them were interviewed individually and the rest were interviewed in a group of three. All interviews were done in a face-to-face manner. The interview process was as follows.

To set up the interview meetings, I emailed the participant FRM key actors. The email included a research information letter, a consent form, a list of interview questions, and a suggestion of dates and times for the meetings. My reason for sending these documents to the participant FRM key actors before the meetings was to save time on the research introduction during the interview, which resulted in providing me more time to discuss the issues being investigated. And my reason for suggesting dates and times for the meetings was to create and

organise the interview schedules alongside my data collection with the participant Thai public visitors, as both investigations were carried out in the same period (September–December 2018). The interview meeting places (i.e. their workplaces and cafes), dates, and times were arranged according to the participant FRM key actors' preferences.

At the beginning of each interview, I informed the participant FRM key actors briefly about my research, their data collection and usage, their rights to withdraw from the research (anytime until December 2019), my contact information, and their rights to not answer any specific questions. I also informed them explicitly that their identities will be kept anonymous to enhance their degree of openness during the interviews (Gagnon et al., 2015). I then informed them that the entire interview would be audio-recorded and requested them to sign consent forms. Each interview took from forty-five minutes to just over an hour. The data collection process yielded a total of eight interview audio-records (six individual interviews and one group interview), fieldnotes, and some additional documents¹⁵ (e.g. books and information on flood protection systems in the BMR).

Data processing

Initially, I transcribed all audio-records and fieldnotes. I opted to work with these data in Thai because it was easier for me to understand them that way. Similar to the participant Thai public visitors' data, I only translated selected pieces of the data when necessary (e.g. to discuss the analysis with my supervisors). I made all data anonymous by removing identifying information and assigning codes to the participants according to their expertise (e.g. R.01 = researcher No.1, E.01 = volunteer educator No.1, and A.01 = state authority No.1).

4.2.3 Data analysis

Similar to the analysis of the participant Thai public visitors' interviews, I employed a hybrid strategy of deductive (direct content analysis) and inductive

¹⁵ I believed that this was an advantage of sending my research information letter and the list of interview questions to the participant FRM key actors before the interview meetings; that is, they had time to prepare additional data that they thought would be useful for my research.

thematic analysis (conventional content analysis) (Brooks et al., 2015; Hsieh & Shannon, 2005) to analyse the participant FRM key actors' data. While I used sub-research questions within RQ3 as overarching themes for the data analysis, within each overarching theme, I allowed categories to emerge from the data themselves. The overarching themes I searched from the data include:

- (1) Challenges in improving FRM in Thailand,
- (2) Expectations of engagement in FRM from the public,
- (3) Challenges in promoting public engagement in FRM,
- (4) How to promote public engagement in FRM, and
- (5) Expectations of support from science museums in improving FRM in Thailand.

The qualitative coding process was done in Nvivo 12. I began the data analysis by uploading all the interview transcripts and my fieldnotes into the software. I then read the interview transcripts and my fieldnotes carefully and repeatedly in order to achieve immersion and get a sense of the information as a whole. Avoiding a reductionist approach, as Bellomo (2014) suggests, I did not generate codes for specific words or sentences. Instead, I created five coding 'nodes' which represent the five overarching themes, as mentioned above. I then started to code all relevant data (which could include more than a paragraph) into each node. When this process was done, I was able to scope my focus to analyse the data in each overarching theme. Data within most of the overarching themes were coded again inductively, except for the theme '*Expectations of engagement in FRM from the public*'. The data within this theme were coded deductively according to Stern's (2000) types of action that citizens can adopt to address environmental issues (discussed earlier in section 2.2.2).

Several readings of the transcripts allowed me to refine the codes until I had exhausted them all. I then organised a table for each overarching theme to present all codes, examples of quotes to justify my choices of code, and the number of participants who mentioned the codes. Table 4.7 illustrates an example of the tables for organising findings from the investigation of participant FRM key actors.

Table 4.7 Organising the findings from the investigation of participant FRM key actors

Overarching theme (e.g. Challenges in promoting public engagement in FRM)	Examples of their responses	Number of participants (n=10)
Sub-theme 1 (e.g. the public has limited awareness of flood risks to themselves and others)	e.g. <i>“People think that disastrous floods do not occur frequently. So, they think why do they have to know about it?” (R.01, male)</i>	
Sub-theme 2		

I then created a portrait of the findings from the investigation, focusing on revealing insights about possibilities for and barriers to promoting public engagement in FRM from the participant FRM key actors’ perspectives. The findings from the investigation of participant FRM key actors will be reported in chapter 7.

4.3 Cross-investigation analysis

As mentioned earlier, my main aim in carrying out the two investigations (i.e. the participant Thai public visitors and the participant FRM key actors) was not only to build portraits of each investigation. It was also to connect the findings from these two investigations to produce better understanding of the factors that have been influencing the reality of public engagement in FRM in Thailand. Therefore, after building individual portraits of each investigation (the first level of analysis), I reinterpreted the findings from each investigation together (‘cross-investigation’) using the cross-case analysis approach (Merriam, 1998; Stake, 2006; Yin, 1984) to inform my cross-investigation analysis, which I will demonstrate below.

Stake (2006) suggests three possible analytical tracks for cross-case analysis. In Track I, when the ‘uniqueness’ of the cases becomes a predominant piece, the various findings of each case are emphasised. Track II focuses on merging findings across the cases without preserving the contexts of the findings (Stake, 2006). Track III focuses on the factors as “[a]nalysts working in a

quantitative mode usually convert themes or findings into variables or factors to be measured and compared or correlated" (p.64). As the addition of the investigation of the participant FRM key actors was intended to produce better insight into factors that influence public engagement in FRM, I decided to follow Track II and Track III to merge the findings and highlight (if any) new findings from connecting the two investigations together.

The cross-investigation process started with creating Table 4.8 with the topics of the mechanisms (possibilities and limiting factors) behind the Thai public's engagement identified from each investigation. I then listed all findings from each investigation in Table 4.8 with their level of significance (low (L), medium (M), and high (H), which meant the findings were mentioned by less than 1/3, between 1/3 and 2/3, and more than 2/3 of the participants, respectively). The display of findings from both investigations in the same table helped me better visualise how similar and different the public engagement in FRM was from the perspectives of the participant Thai public visitors and the participant FRM key actors, which allowed me to merge and identify special findings from the cross-investigation process.

I then developed a matrix (Table 4.9) to present the merged and special findings from the cross-investigation analysis process. The findings from the cross-investigation analysis will be reported and discussed in chapter 8 (section 8.2).

Table 4.8 Organising the findings from each investigation – the cross-investigation analysis

Note: The table was adapted from Stake (2006), letters were used to indicate the significance of the findings. They stand for L = Low (mentioned < 1/3), M = Medium (mentioned between 1/3 and 2/3), and H = High (mentioned > 2/3).

The table presents only some examples of how the findings were organised. The completed version of the table is demonstrated in chapter 8, Table 8.1.

Mechanisms	Findings from the participant Thai public visitors	Findings from the participant FRM key actors
<u>Possibilities for promoting public engagement in FRM</u>		
Personal aspect	e.g. The public is a potential contributor to FRM in both the private and public spheres (H)	e.g. It is essential for the public to alter their behaviours and cooperate with flood risk mitigation initiatives to mitigate flood risks (H)
Situational aspect	N/A	e.g. The participant FRM key actors perceived that it is essential for the public to influence decision-making in the development of policy and plan (L)
<u>Limiting factors inhibiting public engagement in FRM</u>		
Personal aspect	e.g. The public had limited awareness of flood risks to themselves (L)	e.g. The public had limited awareness of flood risks to themselves (H)
Situational aspect	e.g. Inadequate public communication about flood risk and FRM information (L)	e.g. Inadequate public communication about flood risk and FRM information (M)

Table 4.9 Sheet developed for organising merged and special findings

Note: The sheet was adapted from Stake (2006).

The table below presents only some examples of how the merged and special findings were organised. The completed version of the table is demonstrated in chapter 8, Table 8.2.

Factors influencing public engagement in FRM in Thailand	Merged findings	Special findings
<u>Possibilities</u>		
Personal aspect		
e.g. According to their possession of capital for FRM, the public is a potential contributor to FRM	x	
Situational aspect		
e.g. Despite their limited perspective on the public's roles in FRM, FRM key actors have recognised the importance of public engagement in FRM	x	
<u>Limiting factors</u>		
Personal aspect		
e.g. The public's limited awareness of flood risks to themselves and others	x	
Situational aspect		
e.g. Inadequacy of public communication about flood risk and FRM information	x	

Following this methodological chapter, in the next four chapters (chapters 5, 6, 7, and 8), I will report and discuss the research findings.

Chapter 5: Thai public visitors' flood experiences, flood risk perceptions, and understanding of the causes of flooding

In this chapter I report findings and analyse the data generated by the investigation of the participant Thai public visitors. The chapter focuses on answering RQ1:

What is the Thai public visitors' possession of capital for addressing flooding issues at the entry-level — issue sensitivity (flood experiences, flood risk perception, and empathetic perspectives toward flood victims) and in-depth knowledge about issues (understanding of the causes of flooding issues)?

I start the chapter by providing a description of the participant Thai public visitors' profiles and their science museum visits in section 5.1. I hope these descriptions help the reader understand the background of the Thai public visitors who participated in this study.

In sections 5.2, 5.3, 5.4, and 5.5, respectively, I will report findings about the participant Thai public visitors' flood experiences, perceptions of flooding issues, understanding of the causes of flooding, and perceptions of severe flood likelihood. Then, in section 5.6 I will discuss the participant Thai public visitors' perceptions of the relation between flooding and climate change issues. The section also presents their responses to scientific information about the increase in flood risks in the Bangkok Metropolitan Region (BMR) due to the impact of climate change (sea-level rise). Based on the findings, in section 5.7 I will discuss implications for promoting public engagement in FRM, focusing on identifying possibilities and limiting factors that must be addressed.

5.1 Thai public visitors' profiles and their science museum visits

In this section I present the participant Thai public visitors' profiles and their museum visits. The data were explored using short questionnaires and interviews (chapter 4). My aim here was to understand the participants' backgrounds and why and how they visited the science museum.

5.1.1 Thai public visitors' profiles

There were a total of 56 Thai public visitors (32 females and 24 males) who participated in this research. They consisted of 18 children (aged 5–12 years old) and 38 adults (aged 13 years old and above). Table 5.1 illustrates the participant Thai public visitors' profiles: age, gender, highest education, occupation, and living location. In this thesis, the codes C.xx and MV.xx were used, respectively, to refer to the participant Thai public visitors aged 5–12 years old and 13 years old and above.

5.1.2 Thai public visitors' museum visits

Most of the participants visited the science museum with their family members (n=46). The rest came with their school classmates/friends (n = 8) or came alone (n = 2). More than two-thirds visited the museum for the first time (n=40). The rest had visited the museum in the past six months (n = 6), the past year (n = 6), and more than a year (n = 4).

Their reasons to visit the science museum were coded inductively. The analysis revealed that, in accordance with Chen (2015) and Subhamitr & Chen (2013), most of the participant Thai public visitors came to the science museum for learning purposes, either for their own or their children's benefits. Table 5.2 illustrates the participant Thai public visitors' answers about their museum visit agendas.

Although all of the participants were recruited after attending the Climate Change Exhibition¹⁶ in the science museum (described in chapter 4), more than two-thirds of them (n = 45) did not recognise the exhibition. The rest (n=11) mentioned having a brief visit:

“Yes, I visited the [climate change] exhibition, but briefly... only a few exhibits. Didn't really engage... I don't really understand.”

(MV.17, male, 13-18 years old)

¹⁶ More information about the exhibition can be found at <https://www.nsm.or.th/nsm/index.php/en/node/3888>

Table 5.1 Participant Thai public visitors' profiles

	Age groups (years old)						Total	%
	5-12	13-18	19-25	31-40	41-50	=/>61		
1. Number of participants	18	9	9	6	11	3	56	100
2. Gender								
2.1 Female	8	5	7	5	6	1	32	57
2.2 Male	10	4	2	1	5	2	24	43
3. Highest education level								
3.1 Elementary school	3	-	-	-	-	-	3	5
3.2 Primary school	15	-	-	-	-	1	16	29
3.3 High school	-	8	-	-	2	-	10	18
3.4 Vocational	-	1	-	-	1	-	2	4
3.5 Bachelor	-	-	9	5	6	2	22	39
3.6 Master	-	-	-	-	1	-	1	2
3.7 PhD	-	-	-	1	1	-	2	4
4. Occupation								
4.1 Student	18	9	6	-	-	-	33	58
4.2 Housewife	-	-	-	1	2	1	4	7
4.3 Self-employed	-	-	-	1	1	-	2	4
4.4 Engineer	-	-	1	-	-	-	1	2
4.5 Government officer	-	-	-	1	1	-	1	2
4.6 Government employee	-	-	-	1	-	-	1	2
4.7 Consultant	-	-	-	-	1	-	1	2
4.8 Freelancer	-	-	-	-	1	-	1	2
4.9 Programmer	-	-	-	-	1	-	1	2
4.10 Military officer	-	-	-	-	1	-	1	2
4.11 Bank officer	-	-	-	-	1	-	1	2
4.12 Teacher	-	-	-	-	-	1	1	2
4.13 N/A	-	-	2	2	2	1	8	14
5. Living location								
5.1 Bangkok Metropolitan Region (BMR)	8	9	8	4	10	3	42	75
5.2 Central	6	-	-	2	1	-	9	16
5.3 Northern	1	-	-	-	-	-	1	2
5.4 North-eastern	-	-	1	-	-	-	1	2
5.5 Southern	3	-	-	-	-	-	3	5

Table 5.2 Summary of the participant Thai public visitors' museum visiting agendas

Note: One participant mentioned more than one reason for their visits

Museum visiting agenda	Examples of responses	Number of participants (years old)						Total (n=56)
		5-12 (n=18)	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. To 'explore' or 'learn' new things (no target activity or exhibition to attend)	<p><i>"Just visit to see what's in the museum."</i></p> <p><i>"Come to learn about science."</i></p> <p><i>"I also try to see every exhibition to see whether there is anything useful for my daily life."</i></p>	17	3	7	-	-	-	27
2. Take their children/students to visit for "learning" or "exploring" new things	<p><i>"I take my son to visit; better for him to explore new things. So, he can stay away from his computer games."</i></p> <p><i>"Bring my students to visit the museum to learn outside the school."</i></p>	-	-	-	6	11	2	19
3. Find resources for their school's/university's projects	<p><i>"Looking for ideas to make my school science project."</i></p>	-	4	2	-	-	1	7
4. Visit specific exhibitions based on their interest	<p><i>"I want to visit the Star Exhibition [a temporal gallery exhibiting photos of the night sky from various locations around the world]."</i></p> <p><i>"I want to see dinosaurs."</i></p>	1	2	-	-	-	-	3
5. Spend their day off	<p><i>"Spend my day off."</i></p>	-	-	-	-	1	-	1

Based on my observation, I assumed that the participant Thai public visitors' not recognising their engagement with the Climate Change Exhibition could be a result of how the exhibition was set up. That is, unlike the climate change exhibition in the Science Museum in London (the Atmosphere Gallery¹⁷), where the exhibition was set up in a closed gallery, the climate change exhibition in this study was set up in an open hall with exhibitions about other topics. In other words, there was no clear boundary or sign that made the climate change exhibition in this study obvious to the science museum visitors.

According to their museum visiting agendas and engagement with the Climate Change Exhibition, as mentioned above, I am arguing here that the exhibition was not a target for the participant Thai public visitors to visit.

5.2 Thai public visitors' flood experiences

In this section I discuss the data generated from the participant Thai public visitors to address RQ1.1:

If, and how do, the Thai public visitors experience flooding issues?

The choice of asking this question was to explore the participant Thai public visitors' past flood experiences, which is a significant motive that encourages people to take action to mitigate flood risks (Baldassare & Katz, 1992; Bickerstaff, 2004; Burton et al., 1993; Ge et al., 2021; Grothmann & Reusswig, 2006; Hulme, 2012; Laska, 1990; Trenberth et al., 2015; Weinstein, 1989; Zaleskiewicz et al., 2002).

The data revealed that the participant Thai public visitors experienced flooding differently, as shown in Table 5.3 below. While most of the participants had either never experienced flooding or had been affected by floods, one participant reported that he used to experience flooding as a volunteer helping flood victims.

¹⁷ More information about the gallery can be found at: [https://www.sciencemuseum.org.uk/see-and do/atmosphere](https://www.sciencemuseum.org.uk/see-and-do/atmosphere)

Table 5.3 Participant Thai public visitors' flood experiences

Type of flood experience	Characteristics of the experience	Examples of the responses	Number of participants	
			5-12 years old (n=18)	13 years old and above (n=38)
1. Had never experienced flooding			17	8
2. Had been affected by flooding			1	29
1.1 Experienced direct-severe flood impacts	Suffered greatly, both physically and mentally, during flood situations: being trapped in their houses for months, not being able to diet properly, being injured physically, losing family members	<p><i>"I was trapped in my house. The flood was very high around Sukhumvit [a district in Bangkok]. My parents could not go to work. Everyone was trapped in the house."</i></p> <p><i>"My granddad passed away during flooding because he was sick, hard to transfer ill people."</i></p> <p><i>"We had nothing to eat. Had to wait for food and living supplies from people. The food didn't taste good... We even didn't know whether it was still edible."</i></p>	-	18
1.2 Experienced direct-not severe flood impacts	Contacted flood physically, but could manage to live with floods as it was not critical	<i>"Yes, but it was not severe. Mostly, about the knee-high. Never get severe."</i>	1	5
1.3 Experienced indirect-flood impacts	Did not contact flood directly (e.g., moved to stay in the not-affected area on time)	<i>"We moved out before floodwater reached our house. Decided to leave first... Some furniture was damaged, and we had to massively clean our house [when the flood has gone]."</i>	-	6

Type of flood experience	Characteristics of the experience	Examples of the responses	Number of participants	
			5-12 years old (n=18)	13 years old and above (n=38)
3. Had volunteered to address flooding issues	<ul style="list-style-type: none"> - Volunteered to help flood victims in flood-affected areas. - Organised his company's projects to build natural dams in watershed forest areas 	<i>"Yes, I used to help people in Ayutthaya, in 2011... I'm working with [the company's name] and used to organise projects to build natural dams in watershed forest areas as a company CSR [Corporate Social Responsibility] project..."</i>	-	1

As indicated in the table above, more than two-thirds of those who mentioned 'had never experienced flooding' were child participants (almost all of them). According to their parents/caregivers, although some of them had physically experienced flood circumstances in 2011 (discussed earlier in section 2.1), they were too young to remember. (The participant Thai public visitors' data were collected in 2018, approximately seven years after the last devastating flood event in 2011).

For those who mentioned that they had been affected by floods, more than half of these participants had experienced direct-severe flood impacts. They reflected that they did suffer greatly - both physically and mentally - during flood situations (i.e. they were trapped in their houses for months, not able to diet properly, injured physically, and lost family members). While discussing their flood experiences, a few participants also mentioned the significance of having understood local flood characteristics. As illustrated in the interview conversation below, they argued that knowledge of local floods would have made their past flood experience less severe:

Researcher: Can you tell me more about your flood experiences?

*MV.06: During that time [when floodwater arrived at her house], I knew only that my mum told me to move our clothes upstairs, but it was not on time. We had to leave our house through floodwater, which was so difficult, dirty, and wet. **I wish we had known how severe it was going to be. So, we would leave our house earlier than we did [before the flood had really arrived].***

Researcher: Had you got any flood warnings before?

MV.06: We heard about it, but many said that it wouldn't be severe.

(Excerpt from MV.06's interview transcript)

5.3 Thai public visitors' perceptions of flooding

The goal of this section is to present and analyse the data generated from the drawing-and-explain and personal meaning mapping (PMM) approaches (see chapter 4 for details of the instruments) to address RQ1.2:

How do the Thai public visitors perceive flooding issues?

It aimed at exploring the participant Thai public visitors' thoughts about flooding. The coding of the drawings, the drawings' explanations, and the pre-interview PMMs' responses were informed by inductive strategies of thematic analysis (see chapter 4).

5.3.1 Participant child visitors' thoughts about flooding

As shown in Table 5.4, the drawing and drawing explanation data revealed that the participant child visitors responded to the term 'flooding' in six themes. '*Flood impacts*,' '*Describing flood phenomenon*,' and '*Flood causes*' were the top three themes that received the largest number of mentions. In common, the participant child visitors appeared to understand that, when compared to non-flooding, flooding is a phenomenon where there is a higher amount of water on the earth's surface, which covers both natural and man-made environments. Floods cover most of the dwellings and damage trees, nature, and properties/belongings.

More than half of the participant child visitors viewed flooding as a result of observable weather conditions: raining, having less sun (when compared to non-flooding circumstances), and having dark clouds or a dark sky. A small number of the participant child visitors did recognise socio-environmental issues (i.e. destroying trees/forests, urban development, and global warming/climate change) as causes of flooding.

About half of the participant child visitors mentioned people in their responses about flooding. Nonetheless, none of them referred to people as proactive agents in addressing flooding issues; people were mentioned as a cause of flooding (i.e. people damage forests and litter) and victims who need to be rescued during flood events.

Table 5.4 Participant child visitors' answers about the term 'flooding'

Note: There were a total of 18 participant child visitors. Each of them mentioned more than one topic.

Responses about the term 'flooding'	Number of Responses
1. Flood impacts	49
(1) Flooding covers most dwellings	13
(2) Trees/ nature were damaged when it floods	10
(3) Properties/belongings were damaged when it floods	10
(4) Flooding affects transport by vehicles	4
(5) Flooding affects agriculture	2
2. Describing what flooding is	41
(6) Flooding is having a higher amount of water on the earth's surface	18
(7) Flooding covers both natural and man-made environment	12
(8) Flooding does not happen in natural areas	4
(9) Flooding happens in rural areas	4
(10) Flooding happens in urban areas	3
3. Flood causes	39
3.1 Observable causes	27
(11) Flooding happens when it rains	10
(12) There is less sun during flooding	9
(13) Flooding happens when clouds/sky are/is dark	8
3.2 Unobservable causes	11
(14) Destroying trees/forests causes flooding	5
(15) Urban development associated with flooding	4
(16) Global warming/climate change causes flooding	2
4. Role of people towards flooding	8
(17) People cause flooding	4
(18) People need to be rescued during flooding	2
(19) You cannot see people when it floods	2
5. Role of nature towards flooding	4
(20) Nature/trees prevent flooding	4
6. Attitude towards flooding	7
(21) Flooding is negative	4
(22) Flooding has both advantages and disadvantages	2
(23) Flooding is positive	1
Total responses	147

5.3.2 Participant adult visitors' thoughts about flooding

Figure 5.1 displays the participant adult visitors' pre-interview flood PMM responses. 'Flood impacts' received the largest number of mentions (66 of 115 responses). As illustrated in Figure 5.1 below, most of these responses referred to flood impacts on a personal level: damaged properties/loss of belongings; living difficulties; personal and family members' health impacts; household economic impacts; emotional impacts; unpleasant environmental conditions; and disturbing educational process.

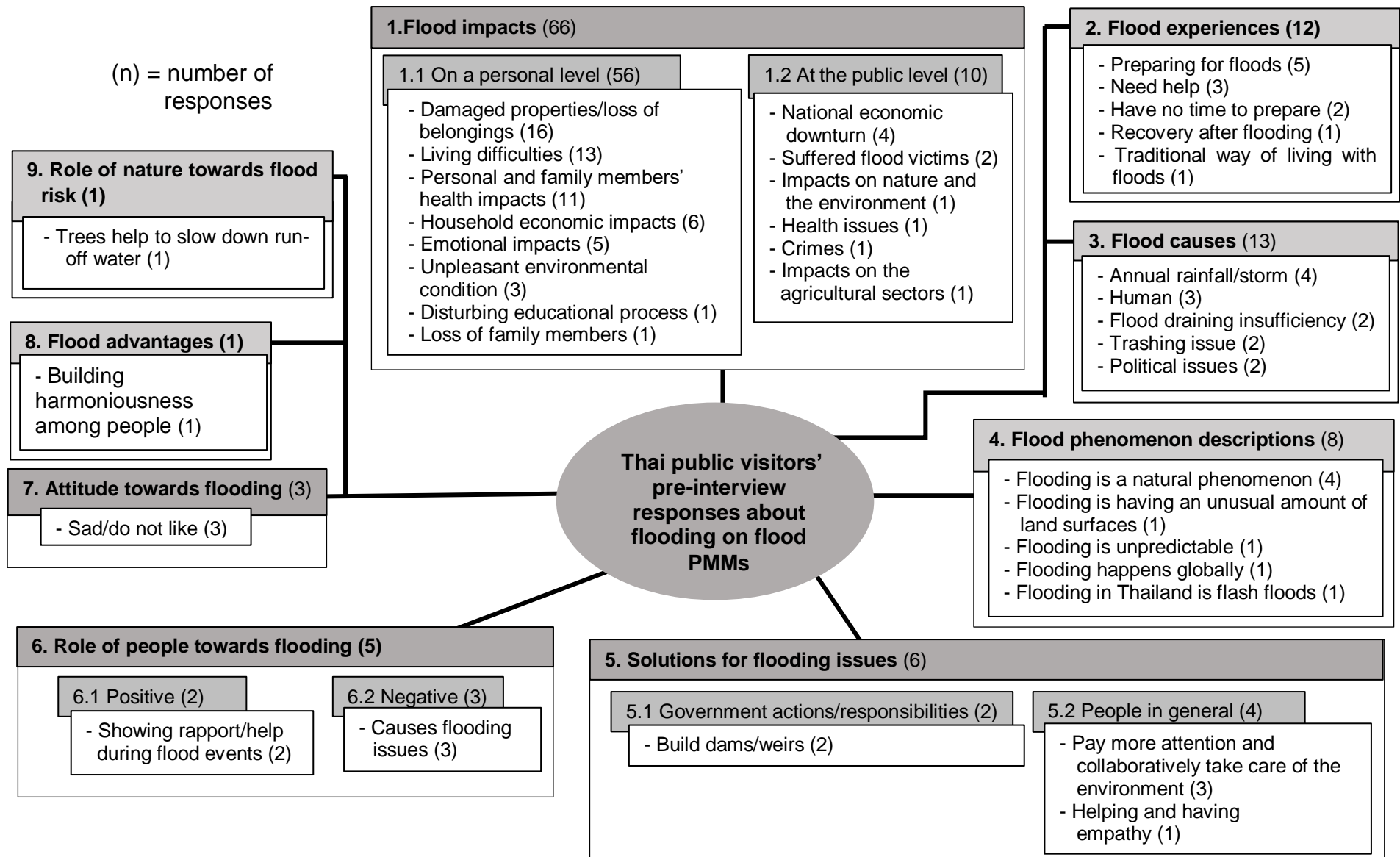


Figure 5.1 Participant Thai public visitors' pre-interview responses about flooding on flood personal meaning maps

Note: The data were generated solely from the participant adult visitors (aged 13 years old and above).
(See the participants' responses that indicate each theme in Appendix 10)

Atypically, one participant adult visitor emphasised a Thai traditional way of living with floods (see section 2.3.2); she drew a Thai traditional house ('a stilt house') on her flood PMM (Figure 5.2) and said:

"In the past, houses were built like this. It would flood only underneath our house; floods never reached our houses. So, we lived normally [during flooding periods]. It flooded for 2-3 days and gone, unlike nowadays."

(MV.48, female, 41-50 years old)



Figure 5.2 MV48's flood PMM illustrates a Thai traditional way of living with floods

5.4 Thai public visitors' understanding of the causes of flooding issues

In this section I focus on presenting and analysing the data generated from the participant Thai public visitors to address RQ1.3:

From the Thai public visitors' perspectives, what are the causes of flooding issues?

I was motivated to ask this question by the fact that an in-depth understanding of the causes of socio-environmental problems is an essential factor that guides people's judgments about how to deal with such problems (Hines et al., 1987;

Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020). To answer this question, the data generated from the participant Thai public visitors in all forms (i.e. the drawings, the drawing explanations, the pre-interview flood PMM responses, and the interviews) were coded using a hybrid strategy of deductive and inductive thematic analysis.

As described in chapter 4, the levels of the causes of flood risk, adapted from Wisner et al.'s PAR model (1994), were used as overarching themes to analyse the data. The four overarching themes include *'Don't know,' 'Unsafe condition'¹⁸,* *'Dynamic pressure'¹⁹,* and *'Root causes'²⁰.* Within these themes, I allowed sub-themes to emerge from the data themselves. Table 5.5 presents the number of participants who mentioned each theme.

The data indicated that causes of flooding at the 'Dynamic pressure' level received the largest number of mentions. (They were mentioned by more than two-thirds of the participants, particularly adults.) To different extents, they argued that socio-environmental issues and humans destroying nature/not taking care of the environment are causes of flooding issues. The top three socio-environmental issues that were mentioned are urbanisation/ inadequate city planning, littering, and deforestation.

Causes of flooding at the 'Unsafe condition' level received the second most mentions, especially from the participant child visitors. They mentioned 'nature' as the (a) cause of flooding issues. According to their responses, believing that nature is the sole cause of flooding issues tends to make several participant adult visitors feel powerless in addressing the issues:

"It's a natural disaster. So, we can do nothing about it."

(MV.51, female, 31-40 years old)

¹⁸ refers to explicit forms of causes in terms of time and space concerning flooding issues (e.g. heavy rains).

¹⁹ refers to processes and activities that are the effects of root causes and lead to unsafe conditions (e.g. deforestation and climate change).

²⁰ refers to society's structural systems that create inequality in access to resources regarding economic and political processes that influence the distribution of such resources (e.g. political system).

Table 5.5 Participant Thai public visitors' understanding of the causes of flooding issues

Note: The data were categorised using the levels of the causes of flood risk, adapted from Wisner et al.'s PAR model (1994). Several participants mentioned more than one cause.

Flood cause level	Examples of responses	Number of participants (years old)						Total (n=56)
		5-12 (n=18)	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	≥/61 (n=3)	
1. Don't know	<i>"Don't know."</i>	1	-	-	-	1	1	3
1. Unsafe condition		10	3	2	1	1	1	18
1.1 Nature	<i>"[C.01 drew raining symbols in flooding site] because raining causes flooding."</i> <i>"[The rainy] season or monsoon, which can come any time. It's, like, natural. It happens by nature."</i> <i>"It's a natural disaster. So, we can do nothing about it."</i> <i>"Like, Bangkok is a bowl shape... It's a natural lowland."</i>	10	3	2	1	1	1	18
2. Dynamic pressure		8	6	7	5	10	2	38
2.1 Socio-environmental issues		8	6	7	5	10	2	38
- Urbanisation/ inadequate city planning	<i>"Nowadays, there are a lot of buildings in areas that used to be natural waterways. It changes the water's pathway or blocks it... It floods because we've got so much development."</i>	4	-	6	2	6	2	20

Causes of flooding	Examples of responses	Number of participants (years old)						Total (n=56)
		5-12 (n=18)	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
- Littering	<i>"People's trashing practice, I think. They litter. It blocks drains."</i>	-	6	2	6	2	-	16
- Deforestation	<i>"Deforestation"</i>	5	2	-	3	2	-	12
- Global warming/ climate change	<i>"...and global warming too."</i>	2	1	1	1	1	1	7
- Overconsumption of environmental resources	<i>"We consume too much...like goods and energy."</i>	-	2	-	-	-	-	2
2.2 <i>Humans destroy nature/ do not take care of the environment</i>	<i>"It's a human problem. Like, nature used to be well out there, but humans destroy it, so it floods. Besides, when problems occur, there is no collaboration to solve them. People still live the same way [not taking care of the environment] or even worse [destroying nature even more]."</i> <i>"Like, [people] do not pay attention to the environment because we love convenience."</i> <i>"It's caused by humans cutting down trees, making the world ecologically out of balance."</i>	4	6	2	4	2	-	18
2.3 <i>Ineffective state FRM</i>	<i>"Like, they [state authorities] ignored the problem...because their lives aren't affected [by floods]. They only have to pass that area sometimes. So, they don't really care about solving the issues."</i>	-	3	3	1	4	1	12

Causes of flooding	Examples of responses	Number of participants (years old)						Total (n=56)
		5-12 (n=18)	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
	<i>"It is caused by poor state flood management and a lack of collaboration between the government authorities in taking care of the water management system."</i>							
2.4 Discrediting politicians ^a	<i>"In my opinion, it happened because of political conflict, discrediting the government at that time. Many people said that."</i>	-	-	-	2	3	-	5
3. Root causes		-	-	-	1	-	-	1
3.1 Lack of transparency in the state's governance	<i>"Corruption... [the national] budget has not been used for people."</i>	-	-	-	1	-	-	1

Remark: ^a There was an opinion among some groups of the public in Thailand (particularly those known as 'Red Shirts') that, in 2011, the BMR was intentionally flooded by Bangkok Governor to discredit the government led by Yingluck Shinawatra (the former prime minister of Thailand, 2011-2014). More information can be found at: <https://aseanow.com/topic/506490-signs-of-public-doubting-yinglucks-abilities-as-bangkok-braces-for-deluge/page>

5.5 Thai public visitors' perceptions of severe flood²¹ likelihood

The goal of this section is to present and analyse the data generated from the participant Thai public visitors to address RQ1.4:

How do the Thai public visitors perceive the likelihood of severe flooding?

Given that the perception of severe flood likelihood is a significant component of flood risk perception²² (Becker et al., 2014; Bubeck et al., 2012; Grothmann & Reusswig, 2006), the decision to ask this question was influenced by my attempt to assess flood risk perceptions among the participant Thai public visitors. Flood risk perception, as discussed in section 2.3.2, appears to be significantly related (in both positive and negative ways) to flood risk prevention awareness and response behaviours (Birkholz & Jeffrey, 2013; Grothmann & Reusswig, 2006; Peacock et al., 2005). That is, while risk perception can lead to feelings of helplessness or hopelessness in attempting to improve risk circumstances (Bourn, 2021; Hicks, 2018), it is still an important factor in informing individuals to take risk mitigation actions (Grothmann & Patt, 2005; Knocke & Kolivras, 2007).

The participant Thai public visitors' responses to the likelihood of severe flooding were coded inductively. The process helped me to develop five themes to represent the different degrees of the participants' perceptions of severe flood likelihood: *'Definitely will happen,' 'Possibly will happen,' 'Rarely will happen,' 'Will not happen,' and 'Don't know.'* Table 5.6 presents the participant Thai public visitors' perceptions of severe flood likelihood.

The data revealed that more than two-thirds of the participant adult visitors believed that severe floods would happen 'definitely' or 'possibly' in the future. According to their responses, I could identify four reasons that underpin their beliefs: (1) they believed that most people will continue living without taking care of the environment (n = 23):

²¹ Like the devastating flood in Thailand in 2011 (discussed earlier in section 2.1). The flood event was mentioned to the participant Thai public visitors during the interviews to build a mutual understanding of what I meant by severe floods.

²² In this thesis study, hazard risk perception is understood as individuals' judgement of the consequence of the perceived hazard likelihood (Becker et al., 2014; Bubeck et al., 2012; Grothmann & Reusswig, 2006; Raaijmakers et al., 2008; Slovic, 1987)

“Yes, because people live the same way. Not change at all. Sometimes, they change, but not in a better way—worse.”

(MV.05, female, 13-18 years old)

“I think it will [flood again] because people are still not taking care of nature. Like, recently, people...what they call...cut trees, and destroy nature. It results in many changes. But if we help each other, in terms of nature, trees need to be replanted. In the city, waste problems and city planning need to be sorted out. If we do not fix these problems, we can't solve flooding issues.”

(MV.26, female, 31-40 years old)

(2) they considered that the existing state FRM is insufficient to prevent floods or will deteriorate over time (n = 6):

“By looking at the current situation, it will flood again for sure. And if it floods again soon after 2011... there are flood protection systems for Bangkok. So, the flood situation may not be as severe as in 2011. But in the far future, like in 10 years... we don't know whether the systems will still work... People who know the system well might be replaced. Will they use the system effectively?”

(MV.30, male, 41-50 years old)

“Yes, I think so because our flood management is still not good enough.”

(MV.28, male, 19-25 years old)

(3) they perceived flooding as a common natural event in Thailand (n=3):

“I think so. It's a natural event that typically recurs.”

(MV.12, female, 41-50 years old)

and (4) they perceived that the BMR, Thailand, is currently affected by sea-level rise (n = 1):

“I think so. Actually, this [sea-level rise] is what currently affects us. If we are not protected, Bangkok would have been flooded a long time ago. According to the statistics, the sea level increases every year. The government sees this, but not the people... I think in the future, the capital of Thailand needs to be moved. Nowadays, in Bangkok, when it rains only a little bit, it floods, which generates traffic jams for several hours.”

(MV.31, female, 41-50 years old)

Table 5.6 Participant Thai public visitors' perceptions of severe flood likelihood

Note: The data were generated from the participant adult visitors only.

Perceptions of severe flood likelihood	Words/phrases that indicate the perception	Example of responses	Number of participants (years old)					Total (n=38)
			13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	≥/>61 (n=3)	
Definitely will happen	"Yes," "Of course," "I think so [were given without hesitancy]."	"Yes, I think so. Because our flood management is still not good enough."	9	7	4	5	1	26
Possibly will happen	"Possible," "Might happen"	"It might happen if we don't know how to manage flood water and its solution."	-	2	2	2	1	7
Rarely will happen	"Rarely," "Very rarely"	"I think very rarely because we know how to protect the city from it [flooding]."	-	-	-	2	-	2
Will not happen	"Don't think so."	"I don't think it [flooding] will happen again if we conserve the upstream forest, which we have done quite a lot already. So, I don't think so."	-	-	-	1	1	2
Don't know	"Don't know"	"I don't know."	-	-	-	1	-	1

In contrast, for those participant Thai public visitors who stated that severe floods ‘rarely will happen’ or ‘will not happen’ (a small number), as shown in Table 5.6 above, they appeared to believe that the environmental condition and flood protection systems had been sufficiently improved.

5.6 Thai public visitors’ perceptions of the relationship between flooding and climate change issues

The goal of this section is to present and analyse the data generated by the participant Thai public visitors to address RQ1.5:

How do the Thai public visitors perceive the relationship between flooding and climate change issues?

The reason for asking this question was to understand whether or not the participant Thai public visitors recognised climate change as a cause of flooding issues in Thailand (IPCC, 2018; Kulp & Strauss, 2019; OECD, 2015). Understanding the causes of flooding issues is fundamental for understanding how to mitigate the issues at their source (Hines et al., 1987; Hungerford and Volk, 1990; Smederevac-Lalic et al., 2020). Given this, understanding the relationship between flooding and climate change issues is significant knowledge for informing people that addressing climate change is a way to mitigate flood risks.

To explore their perceptions of the relationship between the two issues, the participant Thai public visitors were asked to reflect on three specific topics: *‘their perceptions of climate change,’ ‘their relationships with climate change,’ and ‘their opinions about the scientific prediction of the increase in flood likelihood in the BMR, Thailand, due to sea-level rise.’* The data were collected from the participant adult visitors only due to the limitation of the data collection methods²³. I will discuss the participant Thai public visitors’ answers to each of these topics below.

²³ As described in chapter 4, interviews did not work well with young children, and the draw-and-explain approach used in this study only asked the participant child visitors about flooding issues.

5.6.1 Thai public visitors' perceptions of climate change

As described in chapter 4, to explore the participant Thai public visitors' perceptions of climate change, I asked the participants to reflect on their thoughts about the term 'climate change.' Their answers were coded inductively. The coding process helped me identify five overarching themes to represent the participant Thai public visitors' perceptions of climate change: *'Never heard of climate change before,' 'Describing climate change phenomena,' 'Causes of climate change,' 'Climate change impacts,' and 'Responses to climate change.'* Table 5.7 displays the participant Thai public visitors' responses regarding the term 'climate change.'

The data revealed the absence of a link between flooding and climate change issues from the participants' responses about climate change. Four participants mentioned that they have 'Never heard of climate change before', and among these participants, one appeared to not recognise the relationship between climate change and global warming; he did not perceive global warming as a cause of climate change:

"Nothing [that she wants to say about climate change]. I'm more concerned about global warming."

MV.16 (female, 13-18 years old)

For a small number of the participants who did mention 'Climate change impacts,' flooding issues did not receive a mention.

Table 5.7 Participant Thai public visitors' perceptions of climate change

Note: The data were generated solely from the participant adult visitors. Several participants mentioned more than one response.

Perceptions of climate change	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Never heard of the term before	<i>"Never heard of it."</i>	-	1	-	1	2	4
2. Describing climate change phenomena		6	7	7	6		26
- Hotter temperature	<i>"Compared to nowadays, when I was young, like in 1987, the weather was a lot colder than these days."</i>	2	4	3	4	-	13
- Weather pattern change	<i>"Actually, in Thailand, there should be three seasons [winter, summer, and rainy], but I don't know whether those seasons still exist. Seems like we have no winter at all." "It rains a lot [during winter] ...Storms occur frequently."</i>	4	3	4	2	-	13
3. Causes of climate change		5	3	2	1	-	11
- Global warming	<i>"Increase of industrial factories, global warming, pollution, changing temperatures, melting of ice sheets."</i>	3	1	1		-	5
- Human actions	<i>"In my opinion, it's a consequence of human actions such as deforestation, littering... overconsumption of natural resources."</i>	2	-	1	1	-	4
- Industrial pollution	<i>"It's caused by industrial pollution."</i>	-	2	-	-	-	2
4. Climate change impacts		2	1	2	1	-	6
- El Niño/ La Niña	<i>"It causes La Niña and El Niño, I think."</i>	-	1	1	1	-	3

Perceptions of climate change	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
- Health impacts	<i>"It's hot nowadays. It makes me feel dizzy often."</i>	1	-	1	-	-	2
- Doomsday	<i>"The Earth will explode. We can no longer live here."</i>	1	-	-	-	-	1
5. Responses to climate change		-	-	-	2	-	2
- Not their concern	<i>"I heard about it, but it's not what I should pay attention to. I have no time to care about it. I have so many other things to focus on."</i>	-	-	-	1	-	1
- Need to take care of the nature more	<i>"I want everyone to take care of nature. This could make the situation better."</i>	-	-	-	1	-	1

5.6.2 Thai public visitors' perceived relationships with climate change issues

In this section, I present and analyse the data gathered about how the participant Thai public visitors perceived themselves in relation to climate change issues. As described in chapter 4, the data were coded using inductive strategies of thematic analysis, which helped me identify three overarching themes to represent the participant Thai public visitors' perceptions of their relationships with climate change issues. The themes include *'Being affected by climate change,' 'Causing climate change,' and 'Having no relationship with climate change.'* Table 5.8 presents the participant Thai public visitors' answers about their relationship with climate change issues.

The data revealed that, although more than two-thirds of the participant Thai public visitors mentioned *'being affected by climate change,'* only one of them mentioned being affected by climate change in the form of flooding issues:

"Of course, when it rains often, it's difficult for me to go to work, like when it floods."

(MV.08, female, 31-40 years old)

Apart from mentioning that they cause greater climate change issues through their daily practices (e.g. energy consumption), three participants further argued that although they want to help mitigate the issues, they are unable to do so due to their economic condition:

"Yes, I think everyone relates because we know what environmental issues are, but we do nothing about them. It's not because I don't want to do it, but because of my economic conditions and because I have so many things to take care of. I cannot replant forests. What I can do is plant small trees at my place and try to recycle my household trash."

(MV.08, female, 31-40 years old)

"Yes... [awkwardly laughs] I'm doing rice farming. There are straws, weeds, and small trees that I need to get rid of, and I burn them [agricultural open burning is a significant source of greenhouse gases that cause global warming]. Although I don't want to, I don't know how to get rid of it. I know that I can make organic fertiliser, but it takes too long, 1-2 years."

(MV.41, male, 61 years old or above)

Table 5.8 Participant Thai public visitors' perceived relationships with climate change issues

Note: The data were generated from the participant adult visitors only. Several participants mentioned both 'Being affected by climate change' and 'Causing climate change'.

Perceived relationship with climate change issues	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	≥/61 (n=3)	
1. Being affected by climate change		4	7	5	8	3	27
- Health impacts due to hotter climate	<p><i>"It's hot nowadays. I get sick easier than before."</i></p> <p><i>"The weather is really hot nowadays, giving me headaches often."</i></p> <p><i>"My skin is burned."</i></p> <p><i>"Cannot adapt to an uncertain climate. I feel sick often."</i></p>	4	7	5	8	2	26
- Career impacts	<p><i>"I'm a farmer... we [farmers] are affected by droughts. This year, drought problems are very severe. I think it's because of the [climate] change."</i></p>	-	-	1	-	1	2
2. Causing climate change	<p><i>"Like, everyone else, I use air-conditioners."</i></p> <p><i>"Make global warming."</i></p> <p><i>"Use electricity."</i></p> <p><i>"Use a lot of chemical substances."</i></p> <p><i>"Use foam containers, and don't dispose of them properly."</i></p> <p><i>"We are humans. We produce air pollution."</i></p> <p><i>"Open burn [straw, weeds, and small trees]."</i></p>	3	6	4	3	1	17

Perceived relationship with climate change issues	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
3. Having no relationship with climate change	<i>"No, I'm healthy."</i>	1	-	-	2	-	3
	<i>"I don't think so. It [climate change] is a natural process."</i>						
N/A	-	3	-	1	-	-	4

5.6.3 Thai public visitors' opinions about the scientific prediction of the increase in flood likelihood due to sea-level rise

As a part of the interviews, I introduced the scientific information about the increase in flood likelihood in the BMR (Thailand) due to sea-level rise (i.e. scientists' claims and the inundation prediction map, see Appendix 6) to the participant adult visitors and asked them to comment on the information. My choice for doing so was to explore the influence of the scientific information on the participant adult visitors' perceptions of the relationship between flooding and climate change issues. Initially, the interview data revealed that most of the participants mentioned that they had never come across the information before (n = 36). Two of them mentioned having seen the map before, but did not understand the meaning of the information:

*"I came across it before, but I don't know its meaning."
(MV.55, male, 13-18 years old).*

The further coding of their responses (using inductive strategies of thematic analysis), as presented in Table 5.9, revealed that most of the participants 'Agreed with the scientists.' Nine and seven of these participants, respectively, explicitly expressed their fear of the increasing flood likelihood and the need for better flood prevention and preparation:

*"Oh! We will be affected too because we are in the BMR... I'm
scared now."
(MV.05, female, 13-18 years old)*

*"I used to see it. It has been said that Bangkok is now a pan-shaped
city... Actually, it's scary. I think that is a reason why military people
in top positions have moved out of Bangkok. I heard about it from my
husband [her husband works in the military sector]."
(MV.08, female, 31-40 years old)*

*"I think their claim is true because this issue [the sea-level rise]
affects flood situation... So, I think we should prevent this from
happening."
(MV.49, male, 13-18 years old)*

Interestingly, responses from one participant indicate her feelings of powerlessness in addressing flood circumstances:

“I think so. Ayutthaya [from the north, a province before the BRM] already floods every year because it’s a lowland. I don’t want it to happen, but we can do nothing.”

(MV.52, female, 19-25 years old)

Apart from mentioning their agreement (or disagreement) with the scientists’ claim, several participants also commented on the usefulness of the information. Five participants explicitly mentioned that the information is useful for them and that they need to be more informed about flood risks:

“Although it’s scary, I think we need to be more informed about this [flood risk] information... I think this information is essential for us to learn [...] to prepare. I think this one [the inundation prediction map] is better [easier for her to understand].”

(MV.48, female, 31-40 years old)

One participant disagreed with the scientists’ claim at first, but had changed his viewpoint after examining the inundation prediction map:

Researcher: *[Before showing the inundation prediction map] What do you think when many researchers say that climate change will increase the frequency of severe flood events in Thailand?*

MV.56: *I’m not a scientist. I don’t believe it. I see what is near to me. Like, if we live near a mountain, we learn to grow trees and live with them...If we help increase forests, it [flood] won’t happen, from my perspective as a layperson.*

Researcher: *[Introduced the inundation prediction map] So then what do you think about this information?*

MV.56: *Oh...in this case, I agree. In terms of high tide, if the global temperature is warmer, it [ice sheets] will melt.’*

(Excerpt from MV.56’s interview transcripts)

Table 5.9 Participant Thai public visitors' opinions on the scientific prediction of the increase in flood likelihood due to sea-level rise

Note: The data were generated from the participant adult visitors only.

Opinion on the scientific prediction of the increase in flood likelihood	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Agreed with the scientists	<p><i>"I agree because I heard that melting polar ice sheets will raise the sea level."</i></p> <p><i>"I believe it. It's like the last time when Dr Smith Dharmasaroja [a well-known Thai scientist] said that there was going to be a tsunami. People laughed at him, but it did happen. I believe it because it came from scientists."</i></p>	9	8	4	10	1	32
2. Neither agreed nor disagreed	<p><i>"...Hmm...it's a prediction; it may or may not happen... People like us are human, right? We need things to happen first, then we believe."</i></p> <p><i>"It's a future story. No one can tell."</i></p>	-	-	1	1	1	4
N/A	-	-	-	1	-	1	2

Importantly, one participant argued that risk information will only cause people to panic. She argued that knowing how to mitigate risks is more important:

“It’s not what I need to know. They said it, but people will be frightened. They didn’t tell us how to solve it. Thus, it doesn’t make people want to help solve the problems... They need to tell us how to handle it too. If not, they will only leave us with fear.”

(MV.13, female, 41-50 years old)

In summary, this section aimed to explore whether or not the participant Thai public visitors recognised climate change as a cause of flooding issues in Thailand (IPCC, 2018; Kulp & Strauss, 2019; OECD, 2015). Throughout the analysis of their perceptions of climate change, their relationships with climate change, and their opinions on the scientific prediction of the increase in flood likelihood in the BMR due to the rising sea level, I found that the majority of the participant Thai public visitors did not yet acknowledge the relationship between flooding and climate change issues.

When they were introduced to the scientific information about the increase in flood likelihood in the BMR (Thailand) due to sea-level rise (i.e. scientists’ claims and the inundation prediction map), the majority of participant Thai public visitors agreed with the scientists’ claims. Several participants mentioned that the information was helpful and wished to be informed more about their risks of flooding. One participant further expressed her concern that simply providing risk information will cause people to panic. According to her opinion, how people can mitigate the risks is more important.

5.7 Discussion and implications for promoting public engagement in flood risk management

In this chapter, I explored the participant Thai public visitors’ possession of capital for addressing flooding issues at the entry-level. As discussed in section 2.3, these types of capital are crucial to encouraging individuals to engage with FRM. While the limitations of this investigation need to be acknowledged (i.e. the data were generated from a small group of the Thai public), as presented throughout the chapter, this part of the investigation provided insights into flood experiences and perceptions of flooding issues among (a part of) Thai public

visitors to the science museum (the target audience of museum-based flood education).

As argued in section 3.1, my goal in conducting this investigation was not to simply describe the participant Thai public visitors' possession of capital that fosters their engagement with FRM. My goal was also to identify possibilities that support and limiting factors that inhibit public engagement in FRM in Thailand to support the promotion of such engagement. By considering the findings in this chapter with relevant previous research (reviewed earlier in chapter 2), I can identify several possibilities and barriers that must be addressed to promote public engagement in FRM in Thailand, which I will discuss below.

5.7.1 Possibilities for promoting public engagement in flood risk management

First and foremost, considering that the capital for improving socio-environmental issues is distributed among society members (Funtowicz & Ravetz, 2003; Levinson, 2010; McEwen & Jones, 2012), the study findings provided empirical evidence that the Thai public is a potential contributor to improving FRM. The majority of Thai public visitors who participated in this study (more than two-thirds) already possess 'flood experiences,' 'knowledge of flood impacts on a personal level,' 'strong or moderate beliefs of severe flood likelihood,' and 'understanding that local socio-environmental issues (i.e. urbanisation/ inadequate city planning, and littering) cause flooding issues in Thailand' (see sections 5.2, 5.3, and 5.4, respectively). Importantly, although it was atypical, one participant has been actively volunteering to mitigate flooding issues (i.e. helped flood victims in flood-affected areas and organised his company projects to build natural dams in watershed forest areas) (section 5.2) and one possesses Thai traditional knowledge of how to live with the floods (section 5.3).

This lay knowledge and flood risk awareness are critical for establishing flood resilience in flood-prone communities (in this study, the BMR, Thailand) (McEwen et al., 2017; McEwen & Jones, 2012; Phanthuwongpakdee, 2016). A few participant Thai public visitors in this study (section 5.2) argued that understanding local flood characteristics would have made their past flood

experience less severe as it could help them respond better to flood warnings (i.e. would have decided to evacuate sooner than they did). Similarly, based on my personal flood experiences, I totally agree with these participants.

During the devastating flood events in Thailand in 2011, I also experienced indecisiveness about whether or not to evacuate from my university dormitory (I was doing my master's programme at that time). I received warnings about floods from many channels (i.e. my family, friends, and news). However, it took me several days after the warnings to evacuate because it was during term time and many people (including my programme tutors) said that it would not be severe (not higher than the ankles, they said). Fortunately, because I did not want to make my parents worried, I moved out only a few days before the floods hit. The flood level was about 1.4 metres high and lasted for two months. Several students had been stuck in the university buildings and needed to be rescued over several days. If I had known that floods in such areas could be this severe, I would have informed other students and not waited that long to evacuate.

Therefore, I am here arguing that, as they have experienced floods themselves, the majority of the participant Thai public visitors are potential contributors to improving FRM. Their flood experiences, personal knowledge of flood impacts, strong or moderate beliefs about future flood likelihood, and understanding that local socio-environmental issues are causes of flooding issues are all extremely valuable knowledge that should be preserved and shared among Thai society.

Second, in accordance with Chen (2015) and Subhamitr & Chen (2013), the findings about the participant Thai public visitors' museum visits (section 5.1) indicate that 'learning' or 'exploring' is the main purpose of the Thai public visiting science museums. Thus, this could be beneficial for science museums to engage their audience in public flood education programmes as the audience is already aiming to learn some things.

5.7.2 Barriers to promoting public engagement in flood risk management

In the personal dimension

(1) The public's limited awareness of flood risks to themselves and others

Flood risk awareness ('perception') has a significant relationship with individuals' flood risk mitigation behaviours (Birkholz & Jeffrey, 2013; Grothmann & Reusswig, 2006; Ho et al., 2008; Nash et al., 2019; Peacock et al., 2005). Individuals tend to not act to reduce their flood risk when their awareness of the risk is absent (Kuroda et al., 2021; Ludy & Kondolf, 2012). Awareness of flood risks to others is a significant foundation for empathy²⁴, a significant motivational precursor of helping behaviours (Bekkers, 2006; Harmon-Jones et al., 2003; Marjanovic et al., 2012; Zhou et al., 2003). According to Keller (2016), empathy is essential for making fair decisions in designing disaster risk management policies and strategies. The study shows that to a different extent, there were still participant Thai public visitors who were not aware of flood risks to themselves and others yet.

In terms of their own flood risks, there were still participant Thai public visitors (in a small number) who had not yet recognised their own flood risks, particularly the children. As presented in section 5.3, when the participant child visitors were asked to reflect on the term 'flooding' (through drawing), they rarely mentioned personal flood impacts or their involvement with flooding. This appears to be in contrast with Raks Thai Foundation (2014), which discovered that personal flood impacts were a dominant topic that flood-affected children referred to when they drew and discussed flooding. As the difference between the children in these two studies is their flood experience, I therefore assume that a lack of flood experience can be a reason why most of the children in this study did not perceive themselves as being at flood risk.

In addition, a small number of the participant adult visitors also still believed that severe floods would be less likely to occur or would not occur again because they believed that FRM and upstream forest conservation in Thailand were sufficient (section 5.5). According to Kuroda et al. (2021) and Ludy & Kondolf (2012), this positive attitude toward environmental risk is likely to discourage people from taking part in risk-reduction efforts.

In terms of flood risks to others, the findings reported throughout this chapter reveal that the Thai public visitors who participated in this study rarely expressed

²⁴ The ability to feel and understand what another person is feeling (Eisenberg & Miller, 1987)

their compassion for flood-affected people when they discussed flooding. Thus, given that flood risk awareness toward themselves and others is a significant motive to promote individuals' engagement in FRM (Bekkers, 2006; Harmon-Jones et al., 2003; Keller, 2016; Kuroda et al., 2021; Ludy and Kondolf, 2012; Marjanovic et al., 2012; Zhou et al., 2003), I am arguing here that the public's limited awareness of flood risks to themselves and others is one of the limiting factors that must be addressed to promote public engagement in FRM in Thailand.

(2) The public's limited understanding of the causes of flooding issues

An in-depth understanding of the causes of socio-environmental problems is a critical factor in directing people's judgments about how to deal with the issues (Hines et al., 1987; Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020). As discussed earlier in section 2.1, regarding Wisner et al.'s (1994) categorisation of causes of environmental risks, flood risks in BMR (the study area) have been caused by a number of factors at all levels: unsafe conditions (e.g. being a natural flood-prone area), dynamic pressure (e.g. environmental degradation and climate change), and root causes (e.g. social and economic inequality and poor FRM). The study shows that many of these causes, especially at the dynamic pressure and root cause levels, were not recognised yet by the Thai public visitors who participated in this study.

As described in sections 5.3, 5.4, and 5.6, only about half and a few of the participant Thai public visitors, respectively, mentioned some causes of flooding issues at the dynamic pressure and root cause levels. Almost all of the remaining participants simply mentioned 'nature' (unsafe conditions) as the sole cause of flooding issues, and a few participants could not even come up with a cause of the issues. The findings also revealed that perceiving 'nature' as the sole cause of flooding issues makes some participants feel powerless or hopeless to improve the circumstances (section 5.4). According to Bourn (2021) and Hicks (2018), feelings of powerlessness and hopelessness are significant factors that keep people away from engaging in addressing socio-environmental issues.

In this study, I also paid extra attention to exploring the participant Thai public visitors' perceptions of the relationship between flooding and climate

change issues. This is because I agree with the notion that climate change is a significant and urgent cause of flood risk in Thailand that needs more attention from Thai society to address (IPCC, 2018; Kulp & Strauss, 2019; Marome, 2016; OECD, 2007). As reported in section 5.6, the study shows that climate change has not yet been recognised as a cause of flooding issues; some participants had even never heard of climate change before. Manandhar et al. (2015) surveyed the climate change perceptions of 87 households (35 years old and above) in Yang Luang Village in the north of Thailand and found comparable results. While more than two-thirds of their participants mentioned the increase in local environmental risks (i.e. droughts, floods, and landslides), climate change was not mentioned by these participants as a cause of such environmental risks.

Given that an in-depth understanding of the causes of socio-environmental problems is a critical factor in directing people's judgments about how to deal with the issues (Hines et al., 1987; Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020), I am here arguing that the public's limited understanding of the causes of flooding issues is another barrier that needs to be addressed to promote public engagement in FRM in Thailand.

(3) The public's not recognising the significance of laypeople in FRM

Individuals' perceptions of themselves toward environmental problems play a substantial effect on their response to environmental challenges (Edwards, 2013; Stapleton, 2015; Young et al., 2020). People who believe that they are less significant and powerless tend to engage less in addressing socio-environmental circumstances (Dresner et al., 2015; Horton, 2005; Newman et al., 2005; Paton, 2006). The findings presented throughout this chapter revealed that the majority of the Thai public visitors who participated in this study had not yet recognised laypeople as active agents in addressing flooding issues.

As illustrated in section 5.3, only a small number of the participants mentioned people in their responses about the term 'flooding.' Most of these responses refer to people as flood victims or as a cause of flooding issues, not active agents. One participant mentioned explicitly that people can do nothing about flooding issues when she discussed the causes of the issues (section 5.3). Given that individuals' perceptions of themselves toward environmental problems

play a significant role in how they respond to environmental challenges (Edwards, 2013; Stapleton, 2015; Young et al., 2020), I argue that the public's not recognising the significance of laypeople in FRM is another issue that needs to be addressed to promote public engagement in FRM in Thailand.

(4) The public's limited knowledge of flood risk mitigation strategies

Knowledge of environmental action strategies is a foundation of self-efficacy in action-taking (locus of control), individuals' beliefs about the effectiveness of their actions to influence situational outcomes, which intrinsically motivate individuals to engage with addressing environmental circumstances (Hines et al., 1987; Honneth, 1992; Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020). The findings revealed the issue of limited knowledge of such strategies among the participant Thai public visitors. When discussing their relationship with climate change issues (section 5.6.2), a small number of the participants mentioned that although they felt obligated to help mitigate environmental problems, they could not do so. They argued that their ability to perform their perceived solutions for environmental risks (i.e. reforestation and adopting environmentally-friendly agricultural practices) was limited by their economic constraints.

In fact, instead of replanting the forest themselves (actions in the private sphere), there are a number of alternative private and collective actions of which people can take to address forest degradation issues, such as impelling and supporting the national reforestation and forest conservation policies through nonactivist and activist actions and raising awareness of deforestation issues among people in their own networks. Therefore, I am arguing here that the public's limited knowledge of flood risk mitigation strategies is another barrier that needs to be addressed to promote public engagement in FRM in Thailand.

In the situational dimension

(1) Inadequate public communication about flooding issues

Although improving public access to risk information and warnings has been already stated in the recent Thailand's national disaster risk reduction plan (DDPM, 2015) (discussed earlier in section 2.1), the issue of not being informed enough about flood risks and how to mitigate them was still raised by several participant Thai public visitors. As reported in section 5.6, the majority of the participants mentioned that they had never come across information about the increase in flood likelihood in the BMR due to sea-level rise before. A few participants mentioned that although they had seen the information before, they did not understand its meaning. After reviewing the information (with me), several participants stated that the information was useful to them and that they would like to be more informed about flood risks and how to mitigate the risks.

By comparing Thai people's perceptions of the relationship between climate change and the increase in local environmental risks discovered in this study and other research (Manandhar et al., 2015; Seah et al., 2020), I found that the understanding of such relationship seems to still be confined to professionals at the governance level. While Manandhar et al. (2015) and I found a limited perception of the link between local environmental issues and climate change among the Thai public, Seah et al. (2020) found that floods, sea-level rise, and biodiversity loss are the top three climate change impacts that were mentioned by Thai people who work in education, research, business, civil society, NGOs, media, government, intergovernmental, and international organisations.

One participant in this study (MV.31, a government official from the Department of Pollution Control who has a PhD in Environmental Engineering) also explicitly complained about the issues of inadequate public communication about flood risk (section 5.5). This inadequate communication appears to be a root cause of the limited flood risk awareness and the limited understanding of the causes of flooding issues among the Thai public. I therefore argue that inadequate public communication about flood risk and FRM is another limiting factor that needs to be addressed to promote public engagement in FRM in Thailand.

(2) Diminishing flood memory and traditional knowledge about living with floods in Thai society

The study found the absence of flood memories (i.e. knowledge of local floods, living experiences during flood periods, and flood impacts on a personal level) among those participant Thai public visitors who had never experienced floods themselves. As presented in section 5.3, unlike the participant adult visitors, when asked to consider the term ‘flooding,’ flood impacts on a personal level and flood experiences were rarely mentioned by the participant child visitors. This tends to be because they never experienced flooding before (section 5.2). In addition, similar to Arunotai (2008) and Phanthuwongpakdee (2016), the study underlines the absence of Thai traditional knowledge about how to live with floods²⁵ from the Thai public’s perceptions. According to the findings reported in this chapter, when discussing flooding, only one participant Thai public visitor (MV.48) referred to Thai traditional ways to live with a flood (i.e. stilt house) (section 5.3).

Flood memory (e.g. local flood characteristics and knowledge about local flood impacts) and traditional (‘local or lay’) knowledge about how to live with floods are critical capital for improving (and maintaining) flood resilience in flood-prone communities (McEwen et al., 2017; McEwen & Jones, 2012). It helps improve experts’ and locals’ awareness of the frequency and magnitude of local flood events and the ability to live with floods (Berkes, 2007, 2000; Fletcher et al., 2013; Floke, 2004; Maldonado, 2014). As demonstrated in section 5.2, the importance of knowing about local flood characteristics and impacts was mentioned by several participant Thai public visitors. They argued that the knowledge will help them improve their flood responses (e.g. they would evacuate sooner than they did during the past flood event). Given this, the diminishing flood memory and traditional knowledge about living with floods in Thai society appear to be another root cause of the limited flood risk awareness, the limited understanding of the causes of flooding issues, and the limited knowledge of how to mitigate the risks among the Thai public. Thus, it is another situational limiting factor that needs to be addressed to promote public engagement in FRM in Thailand.

²⁵ As discussed earlier in section 2.3.2, in Thailand, knowledge about how to live with floods already appears as a part of traditional Thai culture (e.g. Thai traditional (stilt) houses and using boats as a common way to transport) (Arunotai, 2008; La Loubère, 1693; Phanthuwongpakdee, 2016).

In summary, in this chapter I reported the first part of the findings from the investigation of the participant Thai public visitors. The chapter focused on revealing the participants' possession of capital for addressing flooding issues at the entry level (i.e. flood experiences, perceptions of flooding issues, understanding of the causes of flooding, perceptions of severe flood likelihood, and perceptions of the relation between flooding and climate change issues). By considering these findings with previous relevant research, several possibilities and barriers that must be addressed to promote public engagement in FRM in Thailand were identified. In the following chapter I will move onto report the findings from the investigation of the participant Thai public visitors to answer RQ2.

Chapter 6: Thai public visitors' engagement with flood risk mitigation

In this chapter I continue presenting and analysing the data generated by the investigation of the participant Thai public visitors. The chapter focuses on answering RQ2:

What is the Thai public visitors' possession of capital for addressing flooding issues at the ownership and empowerment levels - their perceived responsibility for flood risk management (FRM), intention to act, perceived strategies to mitigate flooding issues, and locus of control²⁶?

The chapter also aims to explore the influence of the interview intervention on the participant Thai public visitors' possession of capital for FRM.

In section 6.1 I will illustrate the participant Thai public visitors' perceived responsibility for FRM. I will then move onto present the participant Thai public visitors' actions to mitigate flooding issues in section 6.2. Sections 6.3 and 6.4, respectively, will demonstrate questions the participant Thai public visitors would like to ask about flooding and climate change issues and their desire to inform others about the issues. Section 6.5 will illustrate the participant Thai public visitors' post-interview responses on their flood personal meaning maps (PMMs). Lastly, based on the findings reported in this chapter, in section 6.6 I will then discuss implications for promoting public engagement in FRM, focusing on identifying possibilities and limiting factors that must be addressed to promote such engagement.

6.1 Thai public visitors' perceived responsibility for flood risk management

In this section I present and analyse the data generated from the participant adult visitors' interviews to address RQ2.1:

²⁶ Individuals' beliefs about the effectiveness of their actions to influence situational outcomes (Hungerford & Volk, 1990)

How do the Thai public visitors perceive their relationship with flooding issues?

The question was asked to explore the extent to which the participant Thai public visitors perceived themselves as responsible for addressing flooding issues. As discussed in section 2.3, the judgement of human responsibility ('personal investment in issues') is a significant factor that fosters individuals' willingness to take action to address socio-environmental issues (Ajzen, 1991; Hines et al., 1987; Hungerford & Volk, 1990; Marjanovic et al., 2012). The participants' responses regarding their relationship with flooding issues were coded inductively.

As demonstrated in Table 6.1 below, the analysis revealed that the participant Thai public visitors perceived themselves differently towards FRM in three ways. I will discuss each of these perceived roles as follows.

Table 6.1 Participant Thai public visitors' perceived responsibility for flood risk management

Note: The data were generated from the participant adult visitors only.

Perceived responsibility for FRM	Number of participants (years old)					Total (n=38)
	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Are not responsible for FRM	2	7	2	9	2	22
2. Are responsible for reducing their contribution to the causes of flooding	7	2	4	1	1	15
3. Are a proactive agent in addressing FRM	-	-	-	1	-	1

6.1.1 Are not responsible for flood risk management

Almost two-thirds of the participants perceived themselves as not responsible for FRM. According to the conversations with them, in relation to flooding issues, these participants considered themselves victims who are 'affected' by flood circumstances and have no relation to the causes of flooding. The data also revealed that they did not perceive themselves as a cause of

flooding issues because of two reasons. First, despite their understanding that flooding issues are partly caused by humans' ways of living, they believed that they already live carefully enough to avoid creating impacts on the environment:

"I am affected... There is no maintenance of the drainage system in my village. Do I contribute to the causes of flooding? I think... very low because I always take care of the environment."

(MV.11, female, 41-50 years old)

"Not at all... Floods may be caused by people... But I don't think I relate. I live without destroying nature and I take good care of the environment."

(MV. 52, female, 19-25 years old)

Second, they believed that flooding is a natural disaster, which humans can do nothing about it:

"It's a natural disaster. So, we can do nothing with it."

(MV.51, female, 19-25 years old)

6.1.2 Are responsible for reducing their contribution to the causes of flooding

About one-third of the participants argued that they are responsible for reducing their contribution to the causes of flooding (i.e. *"littering," "causing pollution," "invading forest areas,"* and *"energy consumption"*):

"Like everyone else, I might contribute to the causes of flooding, like littering, which may block the drainage system. I'm trying to dispose of it in its [appropriate] places, but with only me trying, it's not gonna work."

(MV.08, female, 31-40 years old)

"It [flooding] could be caused by our energy consumption, which causes pollution, and littering in waterways."

(MV.55, male, 13-18 years old)

Interestingly, aside from reflecting on her role in flooding issues, one participant shared her experience with how a limited opportunity to witness

diminishing forest areas results in a lack of awareness of forest degradation issues among younger generations:

“I think everyone is involved in invading forest areas. When humans want to live somewhere, the development will occur; we build our living spaces... Younger generations are often unaware of what the area once belonged to [she refers to animals] ... Me, in the middle of my life, I see the change... In the past, there were a lot of trees, and they keep decreasing... Nowadays, I can't really remember my hometown. In the past, it used to have lots of trees, cassava, and rice fields. Every year, it [the forest area] has been destroyed to build accommodations and roads. But my children were born with those buildings. [So, they do not notice the change.]”

(MV.48, female, 31-40 years old)

6.1.3 Are a proactive agent in addressing flood risk management

Atypically, one participant argued that he is a proactive agent in addressing FRM and shared what he has done to address FRM:

“I helped build about 2,000 check dams in watershed forests under my company's projects. The projects attempt to conserve watershed resources. It also reduces flood risks in the country [Thailand]. Lucky for me, I had an opportunity to learn about it [how to conserve forests] by participating in the Utopakat Foundation, King's Rama IX's foundation [the foundation has been established to promote community sustainable water management]. So, I have opportunities to contribute to the development of local communities.”

(MV.56, male, 41-50 years old)

6.2 Thai public visitors' actions to mitigate flooding issues

The goal of this section is to present and analyse the data generated from the participant adult visitors' interviews to address RQ2.2:

If, and how do, the Thai public visitors mitigate flooding issues?

My choice of the question was motivated by my curiosity that emerged from my review of recent relevant research, policies, and plans in the context of Thailand (e.g. DDPM, 2015; Singkran, 2017; Thanvisitthpon et al., 2018). That is, better public engagement in FRM is argued to be key to improving FRM in Thailand and

understanding the current scenario of public engagement in FRM helps improve the promotion of such engagement. Still, in Thailand, the way the public currently acts toward flood risk mitigation has not yet been widely explored, especially of those who are science museums' target audience.

In this section I also aimed to explore the participant Thai public visitors' intention to act, perceived strategies, and perceived self-efficacy in action-taking ('locus of control') to mitigate flooding issues. As discussed in section 2.3, these factors significantly influence individuals' decision-making on whether or not to address socio-environmental issues and how (Evers, 2012; Hines et al., 1987; Hungerford & Volk, 1990; Newman et al., 2005; Paton, 2006; Speller & Ravenscroft, 2005).

As discussed in chapter 4, the participants' responses on their actions to mitigate flooding issues were coded using a hybrid strategy of deductive and inductive thematic analysis. Stern's (2000) types of citizen engagement in addressing environmental issues (section 2.2) were used as the overarching themes to guide my analysis. The themes include '*Take no action*,' '*Take action in the private sphere*,' '*Take non-activist action in the public sphere*,' and '*Take activism (social/political leadership) action*.' Within these overarching themes, I allowed sub-themes to emerge from the data themselves. Table 6.2 presents an overview of the participant Thai public visitors' actions to mitigate flooding issues. I will discuss and present some relevant data that indicates each type of action as follows.

Table 6.2 Participant Thai public visitors' actions to mitigate flooding issues

Note: The data were generated from participant adult visitors only. The data were categorised using Stern's (2000) types of citizen engagement in addressing environmental issues. Several participants mentioned more than one action.

Actions to mitigate flooding issues	Number of participants (years old)					Total (n=38)
	13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Take no action	2	5	2	6	1	16
2. Take action in the private sphere	7	4	3	3	2	19
2.1 Reduce their personal and household flood risks (i.e. moving houses, elevating houses, moving all belongings, changing their careers, and adapting their teaching practice)	5	4	2	2	2	15
2.2 Reduce flood causes (i.e. properly disposing of litter, planting more trees, and not destroying nature)	1	-	2	2	-	5
3. Take non-activist action in the public sphere	-	-	-	1	-	1
3.2 Cooperate with flood risk mitigation initiatives/regulations				1		
4. Take activism (social/political leadership) action	-	-	-	2	-	2
4.1 Teach their children about flooding issues	-	-	-	1	-	1
4.1 Initiate forest conservation projects	-	-	-	1	-	1

6.2.1 Take no action

To *'take no action'* was mentioned by almost half of the participants. According to the data, there were four reasons for these participants to take no action to mitigate flooding issues. First, they did not know what to do (n = 9):

"No, I don't know what to do"
(MV.19, female, 19-25 years old)

Second, they believed that they, as laypeople who are powerless, are not capable to do so (n = 3):

"I can do nothing. I'm just a layperson, like an ant."
(MV.32, female, 31-40 years old)

Third, they believed that they would not be affected by future floods (n=3):

"I don't think so. I think my house won't be affected, just in front of my house, perhaps. I have just moved to stay at my mum's house, like the last time."
(MV.11, female, 41-50 years old)

Lastly, they believed that mitigating flooding issues were not laypeople's responsibility (n = 1):

"We can do nothing because it's all the state [responsibility]...laypeople can do nothing...Management budget and knowledge need to come from the government."
(MV.50, male, 31-40 years old)

6.2.2 Take action in the private sphere

In this research, as discussed earlier in section 2.2.2, taking action in the private sphere is understood as personal actions that are aimed at reducing personal flood vulnerability and direct contributions to the causes of flooding (Stern, 2000). As illustrated in Table 6.2 above, it was mentioned by just more than half of the participants. Within this type of action, reducing their personal or household flood risks received the largest number of mentions. The terms *"prepare early," "have to prepare before,"* and *"will be better to prepare"* were

dominant in their responses. Several participants also elaborated on how they are going to prepare for and adapt to flood circumstances. This includes (1) taking flood warnings seriously (they have learned from their previous flood experiences) (n = 10):

“I will prepare more food. I will also pack my belongings as soon as I get the warning. The past flood experience is a significant lesson for me. I will put my things as high as I can this time.”

(MV.07, female, 13-18 years old),

(2) moving to live in new areas (n = 2):

“What can I do? [laughing] Find a house in another province to live in, need to check well the area [whether it is at high flood risk or not]. We sold that house already, the one in the flood-affected area.”

(MV.51, female, 19-25 years old),

(3) elevating their houses (n = 2):

“I want to level up my house floor, so when floods come again, we will be okay.”

(MV.08, female, 31-40 years old),

(4) changing to more flexible careers (n = 2):

“Now, I am already prepared to reduce flood risks... I changed my career to one that is more flexible, one that I can do everywhere. I don't do my business in Bangkok anymore because I don't trust the government, or really anyone, because of the politics in Thailand... It's like we have to take care of ourselves. I've lost all my savings since the previous flood event.”

(MV.13, female, 41-50 years old),

and (5) finding ways to teach their students during flood events (n = 1):

“As a teacher... During the past flood period, students could not come to school. I need to find ways to teach them during flood events.”

(MV.41, male, 61 years old and above)

Apart from reducing their personal and household flood risks, as illustrated in Table 6.2 above, five participants mentioned taking pro-environmental actions to mitigate the likelihood of floods, including properly disposing of litter (n = 4), planting more trees (n = 2), and not destroying nature (n = 1):

“Properly dispose of litter.”

(MV.55, male, 13-18 years old)

“Plant more trees, but I can do it only around my house.”

(MV.26, female, 31-40 years old)

“It’s hard to say, but I try, like when I went to visit natural landscapes, I tried not to destroy them.”

(MV.12, female, 41-50 years old)

6.2.3 Take non-activist action in the public sphere

In this research, as discussed earlier in section 2.2.2, non-activist actions in the public sphere are defined as the act of supporting or accepting public policies and interventions to address socio-environmental issues (Stern, 2000). Only one participant mentioned this type of action. He mentioned his willingness to cooperate with flood risk mitigation initiatives/regulations:

“I’m only a layperson. What I can do is cooperating with the government and other private sectors that work on water management. I will cooperate as much as I can.”

(MV.01, male, 41-50 years old)

6.2.4 Take activism (social/political leadership) action

In this research, as discussed earlier in section 2.2.2, activism action is defined as the act of initiating social and political movements to address socio-environmental issues (Stern, 2000). The action was mentioned by two participants. The mentioned actions include teaching their children about flooding issues and initiating communal upstream forest conservation projects:

“I teach my children about flooding issues every time I have a chance.”

(MV.13, female, 41-50 years old)

“As I mentioned earlier, I initiated communal upstream forest conservation projects, which help reduce flood risks.”

(MV.56, male, 41-50 years old)

6.3 Thai public visitors' questions about flooding and climate change issues

The goal of this section is to present and analyse the data generated from the participant adult visitors' interviews to address RQ2.3:

If any, what questions would the Thai public visitors like to ask about flooding and climate change issues?

My choice of the question was motivated by my curiosity about whether or not the Thai public who visits science museums have any curiosity about flooding and climate change issues. The data were coded inductively. In the following sub-sections, I will present the questions that the participant Thai public visitors asked about each issue.

6.3.1 Questions about flooding issues

There were a total of 26 questions about flooding issues asked by 23 participants. As shown in Table 6.3, the data revealed that these participants would like to know more about flooding issues on four topics. The government's plans to mitigate flooding issues received the largest number of mentions. In addition to asking questions, one participant expressed her concern about the limitation of public communication about state FRM plans:

“At present, do they [the government] consider water drainage issues when they construct transportation infrastructure? I feel that we never get informed about it... It should be communicated to us not only about what is constructed and by whom but also about its positive and negative impacts... They need to make the information explicitly available to us... They always think that people are not interested in it. That's not true, we are. But we have so many things to handle in our daily lives. When the information is not explicitly available, we are too tired to seek the truth. So, there's not much we can do. We can only complain amongst ourselves.”

(MV.13, female, 41-50 years old)

Table 6.3 Participant Thai public visitors' questions about flooding issues

Note: The data were generated solely from the participant adult visitors. Some participants mentioned more than one question.

Question topics	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. The government's plans to mitigate flooding issues	<p><i>"I want to ask the Ministry of Environmental Resources. How are they going to help manage [flooding issues]? Like, are they going to warn people early enough? So, people can plan to save themselves."</i></p> <p><i>"I wonder about water management. Why does [the government] not improve it?"</i></p> <p><i>"Will Thailand be able to manage flooding issues?"</i></p>	3	2	2	4	-	11
2. Causes of flooding issues	<p><i>"I want to know why it [the past flood that she experienced] happened. Did it happen because of human actions, damaged dams, heavy rain, or water that was not drained?"</i></p> <p><i>"Like in 2011, although they are close to each other, why was Bangkok flooded, not Nakhon Nayok [a province in Thailand]?"</i></p>	4	3	2	-	-	9
3. Ways to solve flooding issues (i.e. FRM in other countries and King Rama IX's FRM approaches ^a)	<p><i>"I would like to ask the leaders of other countries around the world. How do they deal with this kind of disaster?"</i></p> <p><i>"I want to know the approaches that King Rama IX used to prevent floods. I used to see Kaem Ling reservoirs [artificial lakes for water management]. How can they help reduce flood risk?"</i></p>	1	1	1	-	-	3

Question topics	Example of responses	Number of participants (years old)					Total (n=56)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
4. Flood risk	<i>“When flood will happen again, so I can prepare?”</i>	1	-	2	-	-	3
	<i>“What do flood victims have to encounter and what do they have to do?”</i>						

Remark: ^a There are several flood-prevention projects created by King Bhumibol Adulyadej, King Rama IX of Thailand. More details can be found at: <https://www.bangkokpost.com/thailand/special-reports/1557358/king-rama-ixs-water-legacy-lives-on>

6.3.2 Questions about climate change issues

There were a total of 23 questions about climate change issues asked by 21 participants. As illustrated in Table 6.4, the data revealed that these participants would like to know more about climate change issues on four topics. Climate change and its impacts received the largest number of mentions. In addition, when discussing their curiosity about climate change, one participant revealed his doubt about improving the environment:

Researcher: Do you have any questions to ask about climate change? Anything.

MV.27: Is there a way that we can make our world more like what it used to be in the past [less prone to environmental problems]? Actually, does it really have an answer? And who could answer? They said that the ozone was destroyed and asked people to help a long time ago, like by saving energy. But really, can it be fixed?

Researcher: Have you heard that there is scientific research showing that the ozone holes have begun to narrow down?

MV.27: Right, then, where is the evidence? No one tells us about that.

(Excerpt from MV.27's interview transcript)

Table 6.4 Participant Thai public visitors' questions about climate change issues

Note: The data were generated solely from the participant adult visitors. Some participants mentioned more than one question.

Question topics	Example of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Climate change and its impacts	<p><i>"Will it be worse than this? Will it be like what they have predicted?"</i></p> <p><i>"What causes storms? Are they related to climate change? That's what I want to know."</i></p> <p><i>"What is it? I don't think I understand it clearly. I could not really tell what it is."</i></p> <p><i>"I want to know about sea-level rise. I heard several people talk about it."</i></p>	4	2	2	2	-	10
2. Ways to mitigate climate change issues	<p><i>"How to eliminate it? How to make it [the climate] be what it used to be?"</i></p> <p><i>"How to make everyone help on this?"</i></p> <p><i>"If it is possible, I would like to ask everyone that, in their daily lives, what do they do to make climate change issues better or worse?"</i></p>	2	3	1	1	-	7
3. Causes of climate change	<p><i>"What causes climate change?"</i></p>	1	1	1	-	-	3
4. The government's plans to mitigate climate change issues	<p><i>"How will the government manage this?"</i></p>	-	1	1	1	-	3

6.4 Thai public visitors' desire to inform others about flooding and climate change issues

The goal of this section is to present and analyse the data generated from the participant Thai public visitors' interviews to address RQ2.4:

If any, what information, knowledge, or concerns would the Thai public visitors like to inform others about flooding and climate change issues?

I aimed to explore whether or not the participant wanted to inform others about flooding and climate change issues. If yes, what information, knowledge or concerns would they like to share with others? To answer the question, the data were coded using inductive strategies of thematic analysis.

6.4.1 Desire to inform others about flooding issues

According to the data, almost half of the participant Thai public visitors mentioned having nothing to inform others about flooding issues. Almost all of the rest wanted to inform other laypeople: they would like other laypeople to be concerned about the environment and take better care of it, to be better prepared for future floods, to teach their children to care for the environment and to select their political representatives carefully. A few participants wanted to ask the government to improve FRM (i.e. flood protection systems, community training for flood preparedness and responses, and flood risk communication). Table 6.5 presents the participant Thai public visitors' responses.

Interestingly, six of those who mentioned having nothing to share with others also expressed, as laypeople, their feelings of powerlessness to drive change in flooding situations. For example, one participant said:

"Nothing. We are very small. We can only take care of ourselves. No one can change it [flooding situations], the government only. Laypeople can only prepare to clean their houses."

(MV.25, male, 31-40 years old)

Table 6.5 Participant Thai public visitors' desires to inform others about flooding issues

Note: The data were generated solely from the participant adult visitors. Some participants mentioned more than one topic.

Desires to inform others	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Had nothing to share with	<i>"Nothing."</i>	5	6	1	4	2	18
2. Wanted to inform other laypeople		4	3	5	7	1	20
2.1 To be concerned about the environment and take better care of it	<i>"I wish to tell people to take care of the environment, not to destroy the forest. And in the case of Bangkok, it's about littering, which blocks the drainage system. Everyone can help."</i>	2	-	3	6	1	12
2.2 To be better prepared for future floods	<i>"Have to prepare because it will definitely flood again."</i>	2	2	2	2	-	8
2.3 To teach their children to care for the environment	<i>"And please teach children to be responsible for society. Be their example."</i>	-	-	-	1	-	1
2.4 To select their political representatives carefully	<i>"We need to... It is our responsibility to elect those who will best represent us. It is a part of our responsibility for our well-being."</i>	-	-	-	1	-	1
3. Wanted to inform the government		-	2	-	-	1	3
3.1 To improve flood risk management (i.e. improve flood protection systems,	<i>"I want to have zoning like in other countries... [the government should] evaluate our FRM system by comparing it to other countries that have effective flood risk management... I really want the government to give us</i>	-	2	-	-	1	3

Desires to inform others	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
community training for flood preparedness and response, and flood risk communication)	<p><i>training for flood responses. Not by saying that we need to prepare. Like just giving us flyers and leaving us to manage it [flood risk] on our own. We can't do it because we don't know how to do it. The state needs to help us because they hold the most power in terms of expertise."</i></p> <p><i>"[There is] not enough communication, especially in news. [For example, in 2011,] flood warnings were announced only a short time before the floods arrived. And when the floods had gone, there was no information about long-term solutions. No more information to help people prepare for their future. The government needs to help us."</i></p>						

In addition, one participant pointed out that economic conditions were the main barrier to her contribution in addressing the environmental crisis:

“There are more people who cut down trees than who grow them. Although I know about it, I have no money to grow it back. If I was rich, I would help... But, in reality, I cannot do anything because I have to work to survive and get only two days off a week. I also work on my second job. If not, I will not have enough money to take care of my family.”

(MV.08, female, 31-40 years old)

6.4.2 Desire to inform others about climate change issues

According to the data, more than two-thirds of the participant Thai public visitors mentioned having nothing to inform others about climate change issues. Similar to flooding issues, most of the rest of the participants wanted to inform other laypeople to be concerned about the environment and take better care of it and to prepare and adapt to living with change. A few participants wanted to ask the government to be more serious about tackling the issues and to inform the public more about climate change impacts. Table 6.6 presents the participant Thai public visitors' responses.

Four of those who mentioned having nothing to inform others also expressed their feelings of hopelessness about the future environmental situation. For instance, one participant said:

“No, I feel that the environment is getting worse. The world's climate is getting worse. I think there's nothing we can do.”

(MV.12, female, 41-50 years old)

Table 6.6 Participant Thai public visitors' desires to inform others about climate change issues

Note: The data were generated solely from the participant adult visitors. Some participants mentioned more than one topic to inform others

Desires to inform others	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
1. Had nothing to share with	<i>"Nothing."</i>	6	5	4	8	3	26
2. Wanted to inform other laypeople		3	4	2	3	-	12
2.1 To be concerned about the environment and take better care of it	<i>"I want to tell other people, if possible, to take care of the climate. Deforestation causes global warming. Everyone should help save electricity and water."</i> <i>"Like, help reduce waste... and use technology to make a better climate, like electronic cars, solar cells, wind energy. It's clean. In the future, the world should be better, but I really don't know whether ice sheets or ozone will be like in the past or not."</i>	3	2	2	3	-	10
2.2 To prepare and adapt to living with change	<i>"Have to prepare because it's gonna change. We need to adapt to survive."</i>	-	2	1	-	-	3
3. Wanted to inform the government		-	-	-	3	-	3
3.1 To be more serious about tackling the issues	<i>"I would like to ask the government to promote more awareness of the issues. Usually, they don't promote it seriously, only for a day, such as Earth Day. I wish they would take it more seriously."</i>	-	-	-	2	-	2

Desires to inform others	Examples of responses	Number of participants (years old)					Total (n=38)
		13-18 (n=9)	19-25 (n=9)	31-40 (n=6)	41-50 (n=11)	=/>61 (n=3)	
3.2 To inform the public more about climate change impacts	<i>"I wish they inform us more [about climate change and its impacts] because laypeople like me are less likely to read this kind of research. We are informed through news mostly."</i>	-	-	-	1	-	1

6.5 Thai public visitors' post-interview thoughts about flooding

Figure 6.1²⁷ displays the participant adult visitors' post-interview thoughts about flooding. There were a total of 32 post-interview responses (words or phrases) added to flood PMMs by 26 participants. (Five and seven participants, respectively, did not do the task and had nothing to add.) 'Solutions to mitigate flooding issues' received the most mentions (26 of 32 responses).

Apart from their post-interview responses on flood PMMs, two participants verbally reflected that the interviews made them realise that they have to teach their children about flooding issues. They also reflected on their need for support to help them teach their children about the issues. For example, one participant said:

“One thing that I could think of now after talking with you [the interviewer] is that I have to teach this one [her son] to prepare for his future. But it’s hard to make him know what flooding looks like. Like, floods that I used to experienced. It would be nice if, in here [the science museum], they make something...like...models that children can visualise about flood events.”

(MV. 08, female, 31-40 years old)

²⁷ As described in chapter 4, my choice of collecting pre- and post-interview flood PMMs was to investigate the interviews' influence on the participants' thoughts about flooding issues. I therefore opted to present the post-interview thoughts about flooding in the same format as the pre-interview ones (Figure 5.3 in section 5.3) to facilitate comparing these pre- and post-interview thoughts.

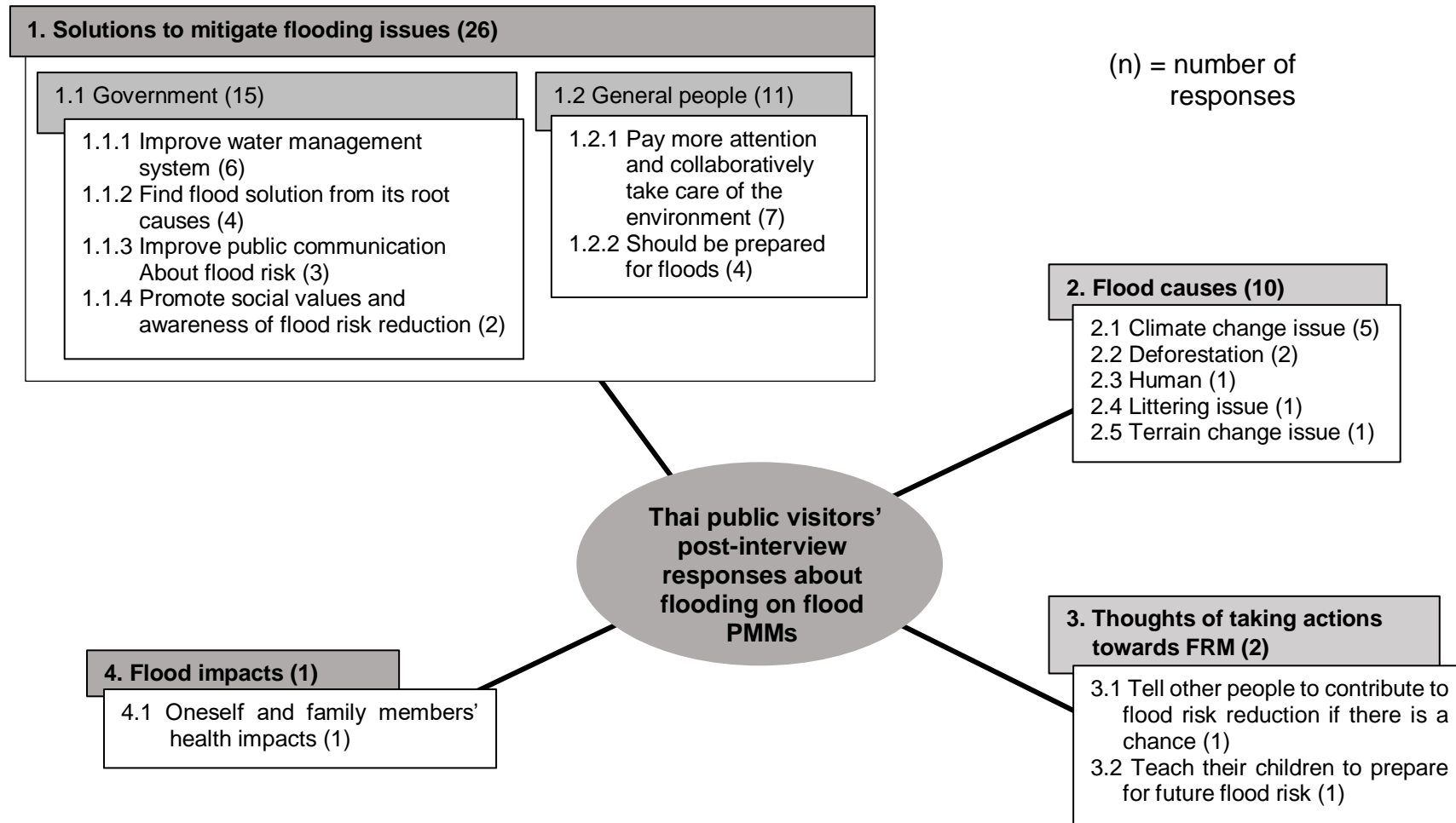


Figure 6.1 Participant Thai public visitors' post-interview responses on flood personal meaning maps

Note: The data were generated solely from the participant adult visitors (aged 13 years old and above).
 (See the participants' responses that indicate each theme in Appendix 11)

6.6 Discussion and implications for promoting public engagement in flood risk management

In this chapter, I explored the participant Thai public visitors' possession of capital for addressing flooding issues at the ownership and empowerment levels (It is important to note here that when I mention 'the participant Thai public visitors' in this discussion section, I refer to the participant adult visitors only because the data in this part of the investigation were generated solely from them.) While the limitation of this investigation needs to be acknowledged (i.e. the data were generated from a small group of the Thai public), as presented throughout the chapter, this part of the investigation allowed me to explore the complex realities of public engagement in FRM in Thailand.

Based on the Environmental Citizenship perspective—that is, citizens' actions in both the private and public spheres are crucial to addressing socio-environmental issues (Hadjichambis & Reis, 2020; Levinson et al., 2020; Stern, 2000)—the study revealed that the participant Thai public visitors had limited engagement with FRM. When discussing their actions to mitigate flooding issues (section 6.2), just more than half of the participants expressed intentions to act on addressing the issues. More precisely, most of the actions that were mentioned are actions in the private sphere (i.e. taking flood preparedness and adaptation to reduce their personal or household flood risks and taking pro-environmental behaviours to reduce their direct contribution to flood causes). Despite their curiosities and desires to inform others about flooding and climate change issues (revealed in sections 6.3 and 6.4), taking these social actions was rarely mentioned as what they would like to do to mitigate the issues.

Considering the participants' intentions to address flooding issues (reported in this chapter) and their possession of capital for addressing FRM at the entry-level (chapter 5) indicates that extensive knowledge of flooding issues and flood risk awareness do not always translate into flood risk mitigation action. While the majority of the participants possess flood experiences, knowledge of flood impacts on a personal level, strong or moderate beliefs of severe flood likelihood, and an understanding that local socio-environmental issues cause flood problems in Thailand (reported in chapter 5), as mentioned earlier, only just over half of them expressed intentions to act on mitigating the issues.

By considering the participant Thai public visitors' possession of capital for addressing flooding issues at the ownership and empowerment levels (discovered in this chapter) with relevant previous research (reviewed earlier in chapter 2), several possibilities and barriers that must be addressed to promote public engagement in FRM in Thailand can be identified, which I will discuss below.

6.6.1 Possibilities for promoting public engagement in flood risk management

The findings revealed that the participant Thai public visitors, which varied from one participant to another, already possessed the capital for addressing flooding issues at the ownership and empowerment levels (i.e. perceived responsibility for FRM, intention to act, perceived strategies to mitigate flooding issues, and locus of control). More than one-third of the participants already perceived themselves as responsible for reducing their contribution to the causes of flooding issues. More than half of the participants further expressed intentions to take action in the private sphere to mitigate flooding issues (section 6.2) and one participant already took a proactive role in addressing FRM (e.g. initiating watershed forest conservation projects) (section 6.1). In addition, the study revealed that several participants expected the issues to be addressed (sections 6.3, 6.4, and 6.5).

Given that such capital is a significant motivator for people to take action to address flooding issues (Ajzen, 1991; Evers, 2012; Hines et al., 1987; Honneth, 1992; Hungerford & Volk, 1990; Marjanovic et al., 2012; Smederevac-Lalic et al., 2020; Speller & Ravenscroft, 2005; Stern, 2000), it tends to be easier to encourage these Thai public visitors (i.e. who already possess these types of capital for FRM) to engage with addressing the issues. For example, raising their awareness of the flooding issues is no longer necessary for those who already intend to mitigate them. In addition, as I already argued in the previous chapter, by possessing capital for addressing flooding issues, the Thai public is a potential contributor to FRM. For instance, they can help inform and persuade others in their connections (e.g. their children) to address flooding issues.

In this study, while the capital for addressing flooding issues existed among several participants (as revealed in chapter 5 and this chapter), the capital was still absent among many of them. The absence of such capital inhibits public engagement in FRM, which I will discuss as follows.

6.6.2 Barriers to promoting public engagement in flood risk management

In the personal dimension

(1) The public's limited awareness of flood risks to themselves and others

In accordance with the previous chapter, the findings reported in this chapter advocate that the limited awareness of flood risks to themselves and others was a reason that prevented some participant Thai public visitors from engaging with FRM. As reported in section 6.2, a small number of the participants mentioned directly that they would do nothing about the issues because they believed that they would not be affected by future floods. According to Kuroda et al. (2021) and Ludy & Kondolf (2012), positive attitudes toward environmental risks seem likely to discourage people from taking part in risk-reduction efforts. The findings throughout this chapter also revealed that intentions to reduce others' risk of flooding were rarely mentioned by the participant Thai public visitors when they discussed how they would mitigate the issues.

(2) The public's limited understanding of the causes of flooding issues

Similar to the previous chapter, the findings reported in this chapter revealed that the limited understanding of the causes of flooding issues is another reason for the Thai public's limited engagement in FRM. In accordance with their limited perceptions of the causes of flooding issues (reported in the previous chapter), actions to reduce flood likelihood mentioned by the participants were limited to properly disposing of litter and planting more trees (section 6.2). Mitigating other significant causes of flooding issues in the BMR (the study area), such as climate change and poor FRM (discussed earlier in section 2.1), appeared to be absent

from the majority of participant Thai public visitors' perceptions. This finding supports the claim of several researchers (e.g. Hines et al., 1987; Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020) that a limited understanding of the causes of environmental issues is another barrier to advancing individuals' engagement in addressing the issues.

(3) The public's not recognising the significance of laypeople in FRM

Feelings of powerlessness are a significant factor that discourages individuals from engaging in environmental risk management (Ajzen, 1991; Bourn, 2021; Edwards, 2013; Huckle, 2014; Newman et al., 2005; Paton, 2006; Stapleton, 2015; Young et al., 2020). In line with the previous chapter, the findings reported in this chapter revealed that several Thai public visitors perceived themselves as insignificant (powerless) in FRM. As reported in section 6.1, the majority of the participant Thai public visitors did not recognise their proactive role in dealing with FRM. Three of them directly mentioned that they would do nothing to mitigate flooding issues because they are 'just laypeople' who have no power to address the issues (section 6.2).

In addition, as presented in section 6.3, when discussing questions that they would like to ask about climate change issues, one visitor expressed his doubt about humans' efforts to solve environmental problems (particularly, by taking pro-environmental actions in the private sphere). According to Bourn (2021) and Hicks (2018), feelings of hopelessness about improving environmental circumstances are another significant factor that demotivates individuals to address environmental issues. That is, we tend to stop trying to solve environmental problems if we feel that our efforts will not result in a better environmental situation.

(4) The public's limited knowledge of flood risk mitigation strategies

As discussed earlier in this thesis, knowledge of environmental action strategies is another factor determining how individuals will engage in addressing environmental problems (Hines et al., 1987; Honneth, 1992; Hungerford & Volk, 1990; Smederevac-Lalic et al., 2020). The findings reported in this chapter

underline the limited knowledge of flood risk mitigation strategies among the participant Thai public visitors. While there are a variety of ways to address flooding issues in both the private and public spheres (e.g. adapting to live with floods, adopting pro-environmental behaviours, supporting FRM regulations, and being socially and politically active citizens for a better FRM), nine participants explicitly stated that they would do nothing to mitigate the issues because they did not know what to do (section 6.2).

One participant's (MV. 08) reflections on her actions to mitigate flooding issues (section 6.2) provide evidence that the limited knowledge of flood risk mitigation strategies appears to be a cause of individuals' feelings of powerlessness in transforming the environmental situation. Despite her sense of obligation to help mitigate environmental problems, she perceived herself as incapable of doing so; her perceived strategies (i.e. direct reforestation) cannot be implemented within her living conditions (i.e. financial circumstances). However, as mentioned earlier in the previous chapter, instead of replanting the forest herself, there are a number of alternative private and collective actions that she could do to address forest degradation within her limited conditions (e.g. impelling the national reforestation and forest conservation regulations through social and political actions, and raising awareness of deforestation among people in her connections). I am assuming here that expanding the Thai public's perceptions of action choices to mitigate flooding issues could support them to engage more with FRM.

(5) The public's perception that FRM is not laypeople's responsibility

As mentioned earlier in this thesis, the belief that they are responsible for mitigating the flooding issues (personal investment in addressing the flooding issues) is a crucial factor that motivates individuals to engage in solving flood problems (Marjanovic et al., 2012; Rees et al., 2015). That is, individuals who believe that laypeople are insignificant in addressing socio-environmental issues tend to be less likely to take part in addressing the issues. The findings in this chapter (section 6.1) revealed that more than half of the participant Thai public visitors did not perceive themselves as responsible for FRM because of two reasons. First, they perceived that nature is the sole cause of flood problems.

Therefore, humans can do nothing about it. Second, although they viewed humans as a cause of flooding issues, they believed that they were doing enough to avoid causing floods through their daily actions (i.e. properly disposing of litter, planting more trees in their area, and not further destroying nature). This highlights the importance of establishing an understanding of the limitations of pro-environmental actions in the private sphere (i.e. they are not effective enough to compensate for unsustainable environmental circumstances) among people. (Levinson et al., 2020; Sörqvist & Langeborg, 2019).

In the situational dimension

(1) Inadequate public communication about flood risk and FRM information

In accordance with the previous chapter, in this chapter, some participant Thai public visitors also revealed their dissatisfaction with the amount of state public communication about flood risks and FRM (sections 6.3 and 6.4). They claimed that a lack of public communication about flood risk and FRM information is a reason for their inability to plan for future floods. According to Phanthuwongpakdee (2016) and Thanvisitthpon et al. (2018), the dissatisfaction with public communication (especially in terms of the potential impacts of being designated as floodways and the timeliness and credibility of advance flood risk warnings) was also mentioned by residents in one community that was designated as a floodway to protect Bangkok from floods and residents in flood-affected districts in Bangkok.

It might be difficult for the reader who is outside flood-risk areas to envisage the importance of getting clear and honest communication about flood risks from the government. Therefore, I would like to use the Coronavirus Pandemic²⁸ as an example to demonstrate how messages from the government may lessen people's cooperation in risk mitigation. After the first lockdown in Thailand in 2020, despite the signs of new spreading clusters happening around the country, warnings from infectious disease specialists and hospitals' reports of rapidly rising infectious cases, the government told Thai people to believe that the

²⁸ a global public health crisis caused by the spreading of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which has been spreading from Wuhan, China, since December 2019 (Ullah et al., 2021).

spreading was under control and COVID-19 was “*not a big deal.*” For example, during his announcement about the national COVID-19 prevention plan on December 5, 2020, *Anutin Charnvirakul*, the Deputy Prime Minister and Minister of Public Health of Thailand (2019 - present), told reporters:

“Because we are very ready, whatever, we can control it [the spreading]. In the next six months, there will, for sure, be vaccines. So, please rest assured that a local lockdown is not required because COVID is not a big deal... We [the government] can manage.”

(Prachachat Online, 2020, translated from Thai)

This type of message encouraged many Thai people to ease their preventive measures and travel to visit their families and friends during the 2021 New Year’s holidays. Consequently, Thailand encountered a second wave of spreading that was worse than the first one; eventually, the country imposed a second full-scale national lockdown.

By raising such an example, I by no means argue that the government was deceitful. They could have believed in their pronouncements. What I am attempting to demonstrate here is that how risks are communicated by the state can have a major impact on how people react to risk situations in general. Thus, if public engagement in FRM is the primary objective, making information about flood risks, FRM, and strategies to mitigate flooding issues available to the public is a critical task that must be addressed.

(2) Diminishing traditional knowledge about living with floods in Thai society

In accordance with Phanthuwongpakdee (2016), this study discovered that traditional (‘local or lay’) knowledge about how to live with floods, a sort of critical capital for improving (and maintaining) flood resilience in flood-prone communities (McEwen et al., 2017; McEwen & Jones, 2012), appears to be absent among Thais. Although, in Thailand, knowledge about how to live with floods already appears as a part of traditional Thai culture (e.g. Thai traditional (stilt) houses and using boats as a common way to transport) (see e.g. Arunotai, 2008; La Loubère, 1693; Phanthuwongpakdee, 2016), in which ideally should

have existed among Thai people, this sort of traditional knowledge was not mentioned by the participant Thai public visitors when they discussed how they would mitigate flooding issues (section 6.2). Given this, I am assuming that Thai traditional knowledge of how to live with floods is diminishing in Thai society, which appears to be a reason for the limited knowledge of how to mitigate the risks among the Thai public.

(3) Limited opportunity and encouragement for the public to take social/political actions

Similar to Da-Silva-Rosa et al. (2015), this study indicates that limited opportunities and encouragement for the public to take social/political actions is another situational limiting factor that needs to be addressed to promote public engagement in FRM. By considering the conversations with the participant Thai public visitors about their intention to act to address flooding issues, their curiosities about and their desire to inform others about flooding and climate change issues together (sections 6.2, 6.3, and 6.4, respectively), it shows that over half of the participants had curiosities about and wished to inform others to help mitigating the issues. However, without being encouraged to do so (they were asked directly in the interviews), they seemed less likely to express these curiosities and desires; none of these intentions to ask or share with others was mentioned when they discussed how they would mitigate flooding issues (section 6.2)

Given this, I am arguing here that the limited opportunity and encouragement for the public to take social/political actions is another situational barrier to promoting public engagement in FRM in Thailand, particularly in the public sphere. Indeed, at the end of the interview, one participant stressed the need for support, in terms of educational mediums, to help her teach her children about flooding issues (section 6.5).

6.6.3 Influence of the interview interventions on Thai public visitors' perception of flooding issues

As mentioned in chapter 4, I opted to collect pre- and post-interview flood personal meaning maps (PMMs) to assess the influence of the interview interventions on the participant Thai public visitors' perception of flooding issues. By comparing the pre- and post-interview responses on flood PMMs (sections 5.2 and 6.5), it seems that after the interviews concluded, more participants acknowledged the need for a better FRM. There were just six participants who mentioned solutions for flooding issues before the interviews, but twenty-six participants more after the interviews. Two participants mentioned directly that the interviews made them realise that they need to teach their children more about flooding issues.

In addition, while none of the participants mentioned climate change as a cause of flooding issues before the interviews, five did after. I assume that it was because, during the interviews, I informed them about the effects of climate change (sea-level rise) on flooding issues in BMR (the study area). Given this, I am arguing here that the interview process in a non-hierarchical manner is a tool for the reciprocal exchange of knowledge, opinions, and needs regarding FRM among different sectors (in this case study, the public and a researcher (me)).

In summary, in this chapter I reported the final part of the findings from the investigation of the participant Thai public visitors. The chapter focused on revealing the participants' possession of capital for addressing flooding issues at the ownership and empowerment levels (i.e. perceived responsibility for FRM, intention to act, perceived strategies to mitigate flooding issues, and locus of control). It also focused on assessing the influence of the interview interventions on the participant Thai public visitors' perceptions of flooding issues. By considering the findings in this chapter with previous relevant research and the findings reported in the previous chapter, several possibilities and barriers that must be addressed to promote public engagement in FRM in Thailand were identified. In the following chapter, I move onto report the findings from the investigation of the participant FRM key actors to address my last research question (RQ3).

Chapter 7: FRM Key actors' views on public engagement in flood risk management

The goal of this chapter is to present and analyse data generated from the investigation of the participant FRM key actors to address RQ3:

How do FRM key actors perceive public engagement in FRM in Thailand?

The investigation aimed at depicting the reality of public engagement in FRM in Thailand from the FRM key actors' perspectives. Special attention was paid to exploring the participant FRM key actors' expectations of support from the public to improve FRM, views on challenges to and strategies for promoting public engagement in FRM, and expectations of support from science museums to improve FRM. As argued in chapters 3 and 4, by considering the scenario of public engagement in Thailand as multi-layered (i.e. public engagement in FRM is influenced by both personal and situational factors), the knowledge produced from this investigation can be employed to build a better understanding of the situational possibilities and limitations that influence public engagement in Thailand.

To present the main findings from this investigation, in section 7.1 I begin by providing profiles of the participant FRM key actors, focusing on their expertise regarding FRM and their roles towards FRM from their own perspectives. I then move onto present the participant FRM key actors' perceptions of challenges in improving FRM in Thailand, expectations of support from the public, views on challenges to and strategies for promoting public engagement in FRM, and expectations of support from science museums, respectively, in sections 7.2, 7.3, 7.4, and 7.5. Lastly, in section 7.6, according to the findings, I will discuss supportive and limiting factors in the situational dimension that influence public engagement in FRM in Thailand.

7.1 Participant FRM key actors' profiles

A total of ten FRM key actors (five females and five males) participated in this part of the study, including four researchers in the field of disaster risk

management, four volunteer educators who have experience running interventions to promote public engagement in FRM, and two state authorities from the Bangkok Food Control Centre (referred to in this thesis using codes R.xx, E.xx, and A.xx, respectively). Table 7.1 illustrates the participant FRM key actors' expertise, their perceived roles in FRM, and their experiences in promoting public engagement in FRM.

Table 7.1 Participant FRM key actors' profiles

Note: Codes regarding their expertise were used to refer to each participant FRM key actor: R.xx = researcher, E.xx = volunteer educator, and A.xx = state authority.

Key actor	Gender	Expertise regarding FRM	Reflection on their roles regarding flooding issues	Experiences in promoting public engagement in FRM
R.01	male	Researcher in disaster adaptation	<i>"A researcher in disaster adaptation, including flooding... public perception and adaptation, urban planning, and the government management system, compared with other countries to find suitable approaches for Thailand."</i>	N/A
R.02	female	University instructor and researcher in community disaster risk resilience	<i>"Not a flood victim. I might be a close observer...flooding is a problem that we [Thailand] have been encountering for hundreds of years, but now, when compared to other countries and even to our [Thai] predecessors, we are less capable of dealing with it ...So, I just feel that something needs to be done. So, I decided to work on this."</i>	Running community training for flood preparation and response for a few communities in the north of Thailand
R.03	female	University instructor and researcher in urban disaster resilience	<i>"My academic expertise directly relates to flooding issues. However, I look at it in the context of climate change. Also, I was affected by floods in 2011; my house was flooded up to my neck."</i>	Developing and facilitating board game sessions to improve stakeholders' (e.g. state departments and businesses) understanding of city planning in the context of climate change. However, the general public was not yet the project's target audience.

Key actor	Gender	Expertise regarding FRM	Reflection on their roles regarding flooding issues	Experiences in promoting public engagement in FRM
R.04	male	University instructor and researcher in disaster risk communication	<i>“As a citizen and academic who works on the issue, I work in disaster risk communication. Flooding issues are my main concern... [because] it is a disaster that Thailand encounters the most.”</i>	N/A
E.01	female	Volunteer instructor teaching the design thinking approach for developing innovations for society	<i>“As a Thai citizen... who was affected. At the same time, I contribute to the causes of the issues.”</i>	Organising workshops to encourage undergraduate students to apply design thinking to develop solutions for improving the living conditions of communities that are affected by floods on an annual basis
E.02 ^a	female	Activist from a civic society organisation who works to promote collaborative actions to address societal challenges	<i>“As someone who has been impacted by floods almost every year and severely in 2011. I also helped flood-affected people.”</i>	Creating and facilitating board game sessions using flood situations as a context to raise public awareness of the importance of mitigating collective risks in Thailand
E.03 ^a	female	Activist from a civic society organisation who works to promote collaborative actions to address societal challenges	<i>“I helped people who were affected by floods [in 2011]. We went to the affected areas to donate some supplies, listened to the victims, and played with children in those affected areas.”</i>	Creating and facilitating board game sessions using flood situations as a context to raise public awareness of the importance of mitigating collective risks in Thailand
E.04 ^a	male	Activist from a civic society organisation who works to promote collaborative actions to address societal challenges	<i>“During the 2011 flooding, I assisted in the development of electric current checking tools [for people to check electric current in floodwater to avoid being electrocuted] and EM balls [effective microorganism balls, which were used to treat wastewater caused by floodwater].”</i>	Creating and facilitating board game sessions using flood situations as a context to raise public awareness of the importance of mitigating collective risks in Thailand

Key actor	Gender	Expertise regarding FRM	Reflection on their roles regarding flooding issues	Experiences in promoting public engagement in FRM
A.01	male	State authority from the Bangkok Flood Control Centre	<i>"My duty. I'm working in the Flood Prevention System Control Department. We monitor flood-related information, such as rain locations and water levels in each canal, to inform and cooperate with the operating authorities to manage floods."</i>	Informing the public through social media about precipitation and the likelihood of floods
A.02	male	State authority from the Bangkok Flood Control Centre	<i>"I'm an academic in the Water Drainage Department looking after Bangkok's water drainage master plans... We make plans to prevent floods...analyse the impacts and causes of flooding circumstances."</i>	N/A

Remark: ^a E.02, E.03, and E.04 were from the same organisation.

7.2 Lack of public engagement – a challenge in improving flood risk management in Thailand from FRM key actors' perspectives

This section presents and discusses the data generated from the participant FRM key actors' interviews to address RQ3.1:

From FRM key actors' perspectives, what are the challenges in improving FRM in Thailand?

My aim in asking this question is to explore whether the participant FRM key actors view limited public engagement in FRM as a challenge to improving FRM. Since I did not want to direct their opinions, I opted to discuss challenges in improving FRM in Thailand from their perspectives in a broader sense. Table 7.2 displays the participant FRM key actors' answers to the question.

It is evident from the participant FRM key actors' interview data that all the participant FRM key actors viewed a lack of public engagement in FRM as a significant challenge in improving FRM in Thailand. Among the three dimensions (i.e. social, governance, and technical), challenges in the social dimension, which referred to the challenges caused by the public, were mentioned most frequently (13 of 24 responses). As shown in Table 7.2 below, the public's behaviours (i.e. littering, improper wastewater management, and covering waterways for land expansion) were referred to the most.

Half of the participant FRM key actors further argued that the public's lack of engagement in FRM is partly caused by inadequate public information and communication about flood risk in Thailand (one of the challenges in the governance dimension that was mentioned).

Table 7.2 Challenges in improving FRM in Thailand from the participant FRM key actors' perspectives

Note: Each participant FRM key actor mentioned more than one challenge.

Dimension	Challenges	Examples of responses	Number of participants (n=10)
1. <u>Social</u> (10 participants)	1.1 The public's behaviours (i.e. littering, improper wastewater management and covering waterways for land expansion)	<p><i>"Typically, the drainage system [in Bangkok] can drain about 50-60% of total rainwater. However, garbage and wastewater have clogged the system up in recent years. People don't understand how the drainage system works, so they keep littering."</i> (A.01, male)</p> <p><i>"This [littering habit] was evident from our experiences with the children who participated in our activities. Most of the time, when they finished the activities, they left without taking care of the activities' residuals. Being responsible for society has not yet been nurtured in them."</i> (E.03, female)</p> <p><i>"Many people bury natural waterways to build roads and buildings."</i> (E.02, female)</p>	6
	1.2 Thai society's perception of flooding as an abnormal or unwelcomed phenomenon (when flooding is in fact common in lowland areas like Bangkok)	<p><i>"It's the whole system of society, the educational system, and people's understanding. We see floods as a problem that needs to be fixed... a bad thing we shouldn't let happen in our society. And we think that the solution is to prevent it from happening. Because flooding is something we don't want, we're less inclined to consider how to adapt to it. We often overlook the fact that the central region of Thailand is naturally prone to flooding... The younger generations are unaware that their neighbourhoods are at risk of flooding... because they were already protected... However, if floods occur in some years as a result of climate change-related causes such as increased rainfall, more intense storms, and sea-level rise, the [existing] protection can no longer protect them from floods. They will be left unprepared to deal with the risk."</i> (R.01, male)</p>	2

Dimension	Challenges	Examples of responses	Number of participants (n=10)
	1.3 The public's perception of themselves as helpless flood victims	<i>"Based on my experience [in improving community flood preparedness] ... communities at risk of flooding are more likely to act like victims and simply seek aid from others, even though they can help themselves more than they thought... There is no risk-safety culture in Thai society... always rely on the patronage system and flood-prevention structures." (R.02, female)</i>	2
	1.4 The public's lack of flood risk awareness	<i>"People don't know, are unaware [of flood risks]... In the aspect of climate change, I'm not talking about a single disaster event; when it comes to climate change, I'm talking about risks in a 20- or 30-year time frame... Preparing our people to understand and be aware of the issues has to be set as an emergency task... This is what I'm now working on." (R.03, female)</i>	2
	1.5 The public's lack of knowledge to cope with flood risks	<i>"[The public's] lack of knowledge to cope with flood risks. I remember that in 2011 when the devastating floods occurred, a group of people known as 'RuSuFlood²' tried to communicate the risks using short animation video clips. Literally, these infographics should be added to the educational curriculum because we have experienced periodic floods. Although the knowledge of how to deal with floods is fundamentally essential, it doesn't exist yet in Thai society. Unlike in Japan, where earthquakes are their critical disasters, their children must learn how to withstand earthquakes." (R.04, male)</i>	1
2. <u>Governance</u> (6 participants)	2.1 Inadequate public information and communication about flood risk	<i>"The government pays less attention to disaster risk reduction... They dominantly focus on post-disaster compensation... lack of risk communication...no substantial disaster risk communication in the national education curriculum. The current curriculum focuses on general disasters that happen around the world but are not local to Thailand." (R.04, male)</i>	5

Dimension	Challenges	Examples of responses	Number of participants (n=10)
	2.2 Lenient implementation of the FRM plans (i.e. FRM was usually not operated as planned)	<i>"[FRM] plans have been developed, but they've not been rigorously implemented. Sometimes, they have been altered to support specific groups of people... [For example,] lands that were previously designated as floodways have now become Suvarnabhumi Airport... In some flood-prone locations, the private sector is free to buy and build... Rich ones could put up barriers to avoid floods, but those barriers would increase flood risk for their neighbours."</i> (R.01, male)	2
3. <u>Technical</u> (4 participants)	3.1 Limited capacity of the flood prevention systems to cope with increasing flood risks	<i>"Another challenge is that the drainage system's capacity is limited, while urbanisation is continuously expanding. The areas that could naturally absorb water, such as rice fields, were replaced by modern buildings and concrete. Hence, all rainwater goes into the drainage system. It was designed to cope with 60% of the total rainfall. Now, about 80–90% of rainwater goes into the system."</i> (A.02, male) <i>"Water runs from high to low. Our area [Bangkok] is flat, water cannot flow naturally; we need to pump it out... [Due to the sea-level rise,] out of 100% of rainwater, nowadays, we can drain only 50-60%."</i> (A.01, male)	4

Remark: ^a Their flood animations are exhibited online at https://www.youtube.com/channel/UCEpl9nmlU-0rS7eAbu_GhVw

Three participant FRM key actors further argued that the inadequate public information and communication is a result of two reasons: (1) public engagement in FRM, particularly at the management level, has not yet being prioritised by key workers in FRM governance, and (2) powerholders (e.g. politicians) often prefer visible structural flood protections over educating people to deal with flood threats (for political reasons):

“I think it’s a lack of knowledgeable people working at the management level. So, the state authorities aren’t aware of the importance of enhancing the public’s capacity to deal with floods... [Besides,] based on my experience, politicians like physical flood protections with their names inscribed. If we educate people to adapt, people won’t remember their names. People won’t elect them.”

(R.01, male)

“[In powerholders’ views,] the results of public education projects are imperceptible. Here [at the Bangkok Flood Control Centre], they prioritise initiatives that result in zero floods... educating the public about flood risks and adaptation [to live with floods] has not been agreed upon to be implemented.”

(A.01, male)

It is clear from these data that all participant FRM key actors agreed that effective public engagement is a significant challenge that needs to be addressed to improve FRM in Thailand. In the following section I discuss how the participant FRM key actors would like the public to engage with FRM.

7.3 FRM Key actors’ expectations of engagement by the public

In this section I will discuss the data generated from the participant FRM key actors’ interviews to address RQ3.2:

If any, in which ways do FRM key actors expect the public to engage with FRM?

Similar to the analysis of the participant Thai public visitors’ engagement practices in FRM (section 5.2), the participant FRM key actors’ responses about their expectations of engagement from the public were analysed using Stern’s (2000) types of citizen engagement in addressing environmental issues. Table 7.3 displays the participant FRM key actors’ responses.

Table 7.3 Participant FRM key actors' expectations of support from the public towards improving FRM

Note: Expectations of support from the public were categorised using Stern's (2000) types of citizen engagement in addressing environmental issues. Some participants mentioned more than one expected action.

Expectations of engagement in FRM from the public	Examples of responses	Number of participants (n=10)
1. Take no action		N/A
2. Actions in the private sphere		10
2.1 <u>Reduce flood causes</u> (i.e. managing waste and wastewater properly, being cautious about their land development, and preparing household rainwater containers)	<p><i>"At least, the easiest action, I would like the public to dispose of their trash properly. Nowadays, public waste management counteracts the flood management system."</i> (A.04, male)</p> <p><i>"I'm thinking about city planning. I feel that in the past, people understood floods. We wouldn't build our houses on waterways. But nowadays, people construct buildings wherever they want... So, flood problem occurs... We need to be more cautious about it [city planning]"</i> (E.03, female)</p> <p><i>"Focusing on Bangkok, we [the flood control centre] are afraid of rain. Rainwater needs places to go. Everyone doesn't allow it to be stored in their houses; it all goes to the drainage system immediately, which accelerates floods. Every household can help by storing some rainwater. It can be any kind of water tank or pond if you have space."</i> (A.01, male)</p> <p><i>"I only wish they'd follow the city's regulations... Apart from littering, direct discharges from street food shops [oily wastewater] to drainage systems are another significant problem for FRM... According to the regulations, buildings [in Bangkok] need to have grease traps to initially clean their wastewater before discharging... You may see for yourself that most houses don't install it... because they need to pay maintenance costs."</i> (A.02, male)</p>	9

Expectations of engagement in FRM from the public	Examples of their responses	Number of participants (n=10)
<p>2.2 <u>Adapt to living with floods</u></p>	<p><i>“[Thai people] need to stop thinking that the government will help or stop waiting for help... If they live in Bangkok, at least, they need to know that there is a chance of being flooded and that there are flood impacts. What they need to know, for example, is where to cut off the electronic circuits when it floods. Many people were killed by electrocution and diseases that come with floods. As I said, floods [in urban areas] don’t suddenly happen. There are warnings, so it can be prepared for.” (R.01, male)</i></p> <p><i>“We cannot always avoid flooding; the central region of Thailand is lowland. Nevertheless, we can mitigate its impacts... If we actively follow the news and seek information, like from the Meteorology Department, we will know when floods will arrive. We should be able to prepare.” (E.01, female)</i></p> <p><i>“Thai people need to adapt to living with water. For example, in some areas of Ayutthaya province, people live in stilt houses. When floods come, they can still live there. It also allows floodwater to drain through the area quickly.” (E.02, female)</i></p>	<p>4</p>
<p>3. Non-activist action in the public sphere</p>		<p>6</p>
<p>3.1 <u>Actively participate in collective flood preparation and response initiatives</u> (i.e. collecting local information, sharing knowledge and ideas for flood adaptation, and offering help to flood victims)</p>	<p><i>“In reality, government agencies have no in-depth information about each community. It’s hard to know where to help first. Therefore, if the community’ members collaborate to collect and provide their communities’ information, such as how many vulnerable people there are and where they are, it will enable the state to help faster and more effectively.” (R.02, female)</i></p> <p><i>“Those who have not been affected [by floods] should initiate help for those who have been. That’s our main aim, to build a sense of voluntarism in the general public. Not just for flooding issues, but for other social issues as well.” (E.03, female)</i></p>	<p>6</p>

Expectations of engagement in FRM from the public	Examples of their responses	Number of participants (n=10)
3.2 Participate in decision-making on FRM policies and plans	<p><i>“I think people in Bangkok have more resources, more social capital, and more educational opportunities [than people who live in other areas of Thailand]. So, they can do more than just donate clothes and food to flood-affected people. They could use their resources, such as knowledge and ideas, to suggest or implement long-term flood adaptation for those who encounter floods.” (E.01, female)</i></p> <p><i>“Their [the public’s] participation is critical for planning the country’s development, as well as preparing for and adapting to floods... They need to see that they can influence [the development of FRM policies and plans], not just sit still, and their participation is so powerful.” (R.01, male)</i></p>	2
4. Activism (Social/political leadership) action		N/A

The data show that all participant FRM key actors expected the public to act more to support FRM. Nonetheless, as illustrated in the above table, they only referred to actions in the private sphere and non-activist actions in the public sphere. Focusing on the non-activist actions, only two participant FRM key actors mentioned expecting the public to participate in decision-making in FRM policies and plans.

7.4 FRM Key actors' views on challenges and how to promote public engagement in flood risk management

In this section I discuss the data generated from the participant FRM key actors' interviews to address RQ3.3:

From FRM key actors' perspectives, if any, what are the barriers hindering the public from engaging with FRM? What are their suggestions to promote public engagement in FRM in Thailand?

I will start the discussion with the participant FRM key actors' perspectives about challenges in promoting public engagement in FRM in Thailand.

7.4.1 Challenges

Table 7.4 demonstrates the participant FRM key actors' answers about challenges in promoting public engagement in FRM. Corresponding with their previous answers about challenges in improving FRM in Thailand (section 7.2), the participant FRM key actors argued that the challenges come from both the public ('personal factors') and the context of FRM in Thailand ('situational factors'). Nonetheless, the challenges posed by the public were mentioned by most of the participant FRM key actors. Only half of the participants mentioned the situational challenges.

Table 7.4 Challenges in promoting public engagement in FRM from the participant FRM key actors' perspectives

Note: Some participant FRM key actors mentioned more than one challenge.

Challenges	Examples of responses	Number of participants (n=10)
1. Posed by the public		10
1.1 The public has limited awareness of flood risks to themselves and others	<p><i>“People think that disastrous floods do not occur frequently. So, they think, why do they have to know about it?” (R.01, male)</i></p> <p><i>“They [the public] have in their minds that if we have flood tunnels, there will be no flood [which, in his opinion, is not true]. So, they do nothing but wait for the problems to be solved by us [the state].” (A.02, male)</i></p> <p><i>“I think people in Bangkok know too little about the impacts that others have to encounter to keep Bangkok safe [from flooding]. So, they don’t feel connected to the issues... For example, the communities I spoke with [were determined by the government to be flood reservoirs to prevent flooding in central Bangkok]... If I’d not been there [and talked to them about flood impacts], I would have had no idea that they could produce rice only twice a year. They have to cancel the third season and let their fields be flooded in order to reduce flood likelihood in Bangkok.” (E.01, female)</i></p>	8
1.2 The public perceives that FRM is not laypeople’s responsibility	<p><i>“Like, they don’t think that it is their business. They think that it is the responsibility of others or the government to resolve the problem, rather than their own... What is it called? Perspective? When they have a problem, for example, they always look for help. They never try to deal with the problems themselves. They like to blame everything but themselves.” (E.03, female)</i></p> <p><i>“Secondly, they think that it’s not their responsibility to solve flood problems, it’s the state... They blame the government, like... in 2011 ... They see no connection between their vulnerabilities and their risk of flooding... So, they don’t understand why they have to act [to address FRM].” (R.01, male)</i></p>	6

Challenges	Examples of responses	Number of participants (n=10)
2. Posed by the context of FRM in Thailand		5
2.1 Inadequacy of comprehensive flood risk information for the public	<p><i>“As I said before [that the public sees no relationship with FRM], our society is never informed about crises, not only in the environmental but also in the economic aspects, for example. We prioritise pro-growth policies [considering economic growth instead of building national resilience] ... When it comes to climate change, they [the public] see no connection because we use the polar bear framework [to educate the public] ... polar bears will no longer have ice to live on, so what? Local decision-makers and residents are not informed about impacts on themselves, like the sea-level rise... There is no connection to their way of life.” (R.03, female)</i></p> <p><i>“Accessing information about FRM is very difficult here [in Thailand]. It is dispersed throughout several national organisations... I experienced such difficulty myself when I was doing my PhD... Some websites had stopped working... When I contacted the organisations to request information, I was told that the person who collected the data did not work there anymore.” (R.01, male)</i></p>	5
2.2 Fading of flood memories in the Bangkok Metropolitan Region (BMR)	<p><i>“The community that hasn’t been flooded for a long time, for generations, will have none of the [flood] knowledge. If we look at the history of flooding in flood-prone areas, there are always chances of flooding despite having various approaches to prevent floods, maybe every five or ten years. For example, in Bangkok, before 2011, it had been decades since people experienced floods. If we ask whether Bangkok has ever been flooded, the answer is yes. But it was for generations. So, it’s no longer in people’s consciousness... Therefore, before engaging [with FRM], they need to know their risks.” (R.02, female)</i></p>	3

Those who mentioned the inadequacy of comprehensive flood risk information for the public and fading of flood memories in the Bangkok Metropolitan Region (BMR) viewed these factors as the root cause of the public's limited flood risk awareness and the public's perception that FRM is not laypeople's responsibility (for example, see R.03's responses in Table 7.4 above). Following the challenges in promoting public engagement in FRM, I asked the participant FRM key actors to suggest ways to improve the engagement.

7.4.2 How to promote public engagement in flood risk management

The data revealed that all participant FRM key actors suggested improving public understanding of flooding issues and FRM as the key to promoting public engagement in FRM; the phrases "*people need to know*" and "*society needs to be able to [e.g. read hazard maps]*" were consistently identified in their responses. Table 7.5 displays the participant FRM key actors' responses about types of understanding that should be promoted to the public.

Table 7.5 Types of understanding that should be promoted to the public from the participant FRM key actors' perspectives

Note: Some participant FRM key actors mentioned more than one sort of understanding.

Types of public understanding that should be improved	Examples of responses	Number of participants (n=10)
<p>1. <u>Flood risks in the BMR^a</u> (i.e the flood-prone nature of BMR; sea-level rise effects; limitations of flood protection systems)</p>	<p><i>“People need to know that Bangkok is a lowland city and sea levels are rising... Some people may have heard on social media that Bangkok will sink in 50 years. I can tell you that we won’t have to wait 50 years. We are now sinking. The reason we can still go around with dry feet is that we can still pump rainwater out.” (A.01, male)</i></p> <p><i>“The first thing that people need to know is the characteristics of flood in their area... In Bangkok, people need to pay attention to news about how to evacuate or what to do in the event of a disaster.” (R.01, male)</i></p> <p><i>“I think at least the society needs to be able to read [flood] hazard maps. However, in Thailand, there is still a lack of development in hazard mapping. These risk maps are crucial for determining where cities should be built and permitting building construction. For example, what types of buildings can be built in which locations to reduce flood risks?... Where is it safe to live?” (R.04, male)</i></p>	5
<p>2. <u>How the public contributes to the causes of flooding</u> (i.e. deforestation and littering)</p>	<p><i>“Personally, as I said before, I believe that flooding is caused by human living practices...like, deforestation and littering. It’s about how we overconsume and only take advantage of nature. We see flooding as a natural disaster, but in reality, it’s also a result of human activity. So, I think it is important that people acknowledge this point.” (E.03, female)</i></p> <p><i>“Actually, littering is one of the main causes of flooding in Bangkok. We can see in the news that although we’ve got giant drainage tunnels, what you usually found [in the drainage systems] are sofas and mattresses... But people are unconcerned that floods happen because of their littering habits. This [lack of awareness of the consequences of littering issues] needs to be fixed.” (E.02, female)</i></p>	4

Types of public understanding that should be improved	Examples of responses	Number of participants (n=10)
3. <u>Impacts of technological flood protection systems on other people and the environment</u>	<p><i>“Sometimes, we don’t realise that some communities are flooded to protect us... The majority of people think that’s okay; there is flooding, and people might have no food or clothes. Okay, I will donate. But in reality, there are more impacts than that. I believe that if people realise the actual impacts, Bangkokians are powerful [to help], even in terms of politics.” (E.01, female)</i></p> <p><i>“People should be aware that... floodwalls can reduce flooding risk on one side of the walls while increasing it on the other. Floodwalls designed to defend Bangkok, for example, increase the likelihood and severity of flooding in towns outside the walls. People in such areas might experience floods that they have never encountered before.” (R.01, male)</i></p> <p><i>“They [the public] need to know that... like the Netherlands, we could build dams between the land and the sea. For Bangkok, we would need to build dams close to the Gulf of Thailand [to prevent flooding caused by high tides]. The city will no longer flood. But it will affect the ecological system around the area. Nothing [aquatic animals] will be able to live in that area because of the accumulation of wastewater.” (A.01, male)</i></p> <p><i>“I think they need to understand that...we could completely eliminate flooding in Bangkok, but it would cost a significant amount of money, which instead could be used for other significant things like education and health care.” (A.02, male)</i></p>	4
4. <u>How the public can live with floods</u> (i.e. Thai traditional ways to live with floods)	<p><i>“In the past, in Thailand, we lived with water and adapted to it...People used to build stilt houses. When floods came, they could live with floodwater by using boats. Even in Bangkok, there used to be so many canals. As the city has been modernised, the canals have been altered into roadways...No way to let the water run through...This ability [to live with floods] should be brought back to our society.” (E.02, female)</i></p>	3

Types of public understanding that should be improved	Examples of responses	Number of participants (n=10)
	<p><i>“In the past, people understood the behaviour of floodwater. We would not build anything that might obstruct waterways. People nowadays build without understanding the condition of the environment...They build where they want to. So, water could not run to rivers or seas as usual. It then becomes an issue. I think people need to be aware of this more.” (E.04, male)</i></p>	

Remark: ^a Bangkok Metropolitan Region, the study area of this research

While most of the participant FRM key actors did not suggest a practical approach to promoting the sorts of public understanding that they had mentioned, E.01 shared her experience of running a workshop with undergraduate students. She argued that offering opportunities for her students to witness the consequences of installing flood protection systems to protect Bangkok had motivated several of her students to help the designated-to-be-flood-catchment communities:

“Through my workshop, I discovered that having opportunities to know that other people are suffering from floods could inspire several undergraduate students to help flood-affected communities... [After talking with flood victims,] the students reflected that they had never known that many people were suffering from flooding. Actually, this was not what I expected as the outcome of the workshop. Very surprised and glad to see such reflections from them... Some even want to put their ideas into practice [which is beyond the scope of the workshop].”

(E.01, female)

Two state authorities reflected that their attempts to promote public understanding of flooding issues and FRM have been inhibited by two reasons: (1) their lack of capacity to translate the technical information into a comprehensible version for the public, and (2) informing the public is not a priority for the state powerholders:

“As I said, our information is technical, like raw data. No one helps us interpret them for laypeople. For example, if it rains at this volume, which locations need to be cautious [about flooding]? Technical information is hard for the general public to understand... We still lack the interpreted version.”

(A.01, male)

“It’s a part of our [the government’s] fault [that the public sees FRM as none of their business] because when we advertised our policies, we guaranteed zero floods, for example, if flood tunnels were built. But we didn’t specify that it wouldn’t flood only in some districts [not the whole area of Bangkok] as politicians expect zero floods. This [not telling the whole truth] doesn’t help [improve public engagement in FRM] ... Many years ago, I found that we [the Flood Control Centre] used to publish comic books to inform the public about FRM in Bangkok, which I proposed republishing them... But they didn’t approve. The outcome was not as expected by the centre... They expect to get the zero-flood result.”

(A.02, male)

7.5 FRM Key actors' expectations of support from science museums

I now discuss the data generated from the participant FRM key actors' interviews to address RQ3.4:

If any, in what ways do FRM key actors see the roles of non-formal education organisations, particularly science museums, in supporting FRM in Thailand?

My aim in asking this question was to understand the participant FRM key actors' expectations of support from science museums in improving FRM in Thailand. The interview data reflected both the participant FRM key actors' expectations of support from science museums and their doubtfulness about the institutions' potential to support FRM.

7.5.1 Expected support from science museums

In accordance with their notions of how to promote public engagement in FRM (section 7.4.2 above), all participant FRM key actors agreed that science museums could potentially help support the improvement of FRM in Thailand by promoting public understanding of three topics, as presented in Table 7.6 below.

Table 7.6 Types of public understanding that science museums should promote from the participant FRM key actors' perspectives

Note: Some participant FRM key actors mentioned more than one sort of understanding.

Types of public understanding that science museums should promote	Examples of responses	Number of participants (n=10)
1. Choices of methods that laypeople can adopt to mitigate flood risks	<p><i>"I think museums can reach out to flood-affected communities...use their knowledge to support those who are affected." (E.01, female)</i></p> <p><i>"People tend to fear [encountering floods] less if they have solutions. Therefore, museums should provide knowledge of various solutions. It might be simulations of flood scenarios in which people can try to apply different solutions." (R.03, female)</i></p> <p><i>"As I said, these things [floods] do not just suddenly happen. There are warnings. People could be better prepared and adapted. Museums, for example, can create flood scenarios ... like mockups of flood events, and educate people on how to prepare... because devastating floods did not occur only in 2011, but several times in the past. It will undoubtedly happen again in the future." (R.01, male)</i></p>	7
2. Laypeople's significance in improving FRM	<p><i>"To let them engage, to make them see their significance in designing the country's plans to cope and adapt [with floods]. To show them what they can do and how important their role is, rather than just sitting still... make them understand that their engagement is powerful." (R.01, male)</i></p> <p><i>"Communication... in order to successfully implement state strategies, it must relate to them [the public]. Don't simply say to them that the global temperature is increasing, please turn off the light. That's okay, but how is it related to them? If they do, what will they get in return? If they do, how will their lives get better? The communication [for risk mitigation] has to tell people how it's related to them and how they could help." (R.02, female)</i></p>	6

Types of public understanding that science museums should promote	Examples of responses	Number of participants (n=10)
3. The seriousness of flooding issues in Thailand	<p><i>“If museums could make educational media, presenting this [information about the flood prevention system and its limitations] in physical models. Like, if water comes, where does it go? Make it easier to understand. I don’t focus much on adults but children ... If they understand that littering can block drainage systems and causes floods, then, we can teach them to manage their waste properly. I believe this type of education has the potential to bring about significant change [in FRM].” (A.01, male)</i></p> <p><i>“Let’s talk about flood risk forecasts. People can’t see how severe floods will be, and how often floods can happen. They need to feel that it is threatening them. So, models, or something like that. It could be VR [Virtual Reality] technology... I think we could use this technology to simulate [flood] situations to make people really understand it, straightforward. [Make] an immediate impact on people’s perceptions... raise public concern.” (R.03, female)</i></p> <p><i>“In my opinion, museums can provide not only hard knowledge but also emotional engagement with the issues for those who come to visit... I mean, not just saying this is flooding. The museums must communicate in terms of emotion... It needs to make people feel that there are people who suffer from floods. Like, oh! It’s really this severe.” (E.01, female)</i></p>	6

Due to the lack of an information hub for FRM in Thailand, one participant argued that science museums can support FRM by establishing themselves as a hub of FRM information for all stakeholders (e.g. the public and researchers) to access:

“In terms of disaster or climate change management, many organisations have their information, but there is no platform to gather it together. If museums can establish such a platform, you [science museums] could draw in people who are serious about this issue, such as researchers and workers in this field... [Museums] can become an archive centre... At least, tell people where to get further information... It could be as simple as a small room with computers to access collected information and areas for people to roam around and learn about FRM... I think people [who work in FRM] will contact the museums themselves... For example, now I would like to run my city planning game with the public, but I’m not ready; I don’t have enough manpower. I can’t handle it. If other organisations that are responsible for public education are interested in my workshop, I really would love to cooperate. We will approach you [the museums].”

(R.03, female)

R.03 was the only one who expressed her interest in working corporately with science museums.

7.5.2 Doubtfulness of the potential of science museums

Despite their agreement that science museums can help support the improvement of FRM, two participant FRM key actors mentioned doubts about how effectively science museums can help promote public understanding of flooding issues and FRM. They argued that visiting science museums has not yet been a part of Thai culture:

“We’re not yet talking about effective or not, but more about active or not, in terms of the ability to draw people into museums. Strangely, Thai people don’t go to museums, except when they have kids. I have nieces, so I intend to visit museums more often. People usually go to the cinema and eat out with their families, friends, and partners. Very few people choose to visit museums.”

(R.02, female)

7.6 Discussion and implications for promoting public engagement in flood risk management

This chapter explores the participant FRM key actors' perspectives on public engagement in Thailand. Early on in this chapter, I reported, from the participant FRM key actors' perspectives, challenges in improving FRM in Thailand; expectations of support from the public; challenges in promoting public engagement in FRM; suggestions on how to promote such engagement; and expectations of support from science museums in improving FRM in the nation. While the limitations of this investigation need to be acknowledged (i.e. due to the use of snowball sampling, the participant FRM key actors tended to be recruited from the circle of those actors who are already interested in promoting public engagement in FRM), this investigation, which was inspired by a multi-layered (CR) perspective (discussed earlier in chapters 3 and 4), allowed me to explore the complex realities of promoting public engagement in Thailand.

The main findings from this investigation revealed that although all the participant FRM key actors agreed with the need for better public engagement in FRM in Thailand, they expected the public to take only private actions (i.e. taking pro-environmental behaviours and making flood adaptations) and non-activist actions in the public sphere (i.e. cooperating with flood preparation and response initiatives) to address FRM. Since FRM key actors play a significant role in determining how to promote public engagement in FRM, especially in terms of strategies (e.g. education plans) (Wehn et al., 2015), it seems rather unlikely that activism actions (social and political leadership actions), a tool that enables citizens to exercise their rights to influence the development of policies and plans in the context of a democratic nation (Stern, 2000), will be included in their recommended strategies.

The investigation results also show that the participant FRM key actors' arguments on challenges in promoting public engagement in FRM are aligned with findings from other research studies and some of my findings from the investigation of the participant Thai public visitors (chapters 5 and 6). The congruent argument is that the gap between the public and FRM in Thailand is the result of the interaction of multiple factors in personal and situational

dimensions. The factors that were mentioned by the participant FRM key actors include (sections 7.2 and 7.4):

In the personal dimension

(1) The public's limited awareness of flood risks to themselves and others

All participant FRM key actors argued that the lack of flood risk awareness among the Thai public is one of the main challenges in improving public engagement in FRM in Thailand. From the participant FRM key actors' perspectives, the limited flood risk awareness among the Thai public is a result of the public's (1) limited understanding of the complexity and seriousness of flooding issues in the BMR (the study area), (2) overvaluing of structural flood protection systems, and (3) limited understanding of how technological flood protection systems affect other people and the environment (e.g. those who live outside floodwalls and ecological degradation caused by installing a large dam).

(2) The public's perception that FRM is not laypeople's responsibility

The participant FRM key actors argued that the Thai public's perception that FRM is not laypeople's responsibility is a result of the public's limited understanding of their contribution to the causes of flooding and how to adapt to living with floods.

In the situational dimension

(1) Inadequate public communication about flood risk and FRM information

Half of the participant FRM key actors underlined that inadequate public communication about flood risk and FRM information in Thailand is another significant limiting factor that prevents the public from engaging with FRM. In accordance with McEwen et al. (2017), they argued that it is a root cause of the limited awareness of flood risks and the perception that FRM is not laypeople's responsibility among the Thai public. Similar to Phanthuwongpakdee (2016) and Singkran (2017), based on their experiences working in FRM, two participant

FRM key actors pointed out that this issue of inadequate public communication about flood risk and FRM information is a result of the fact that the state powerholders (e.g. politicians and policymakers) have no interest in empowering the public to engage with FRM. Indeed, the issue was also underlined as a significant barrier to the promotion of public engagement in FRM in other national contexts (e.g. Brazil and the EU nations) (Da-Silva-Rosa et al., 2015; Evers, 2012; Wehn et al., 2015).

(2) Diminishing flood memories and traditional knowledge about living with floods from Thailand

In accordance with Phanthuwongpakdee (2016), three participant FRM key actors cited that the diminishing flood memories and traditional knowledge about living with floods from Thai society inhibit the Thai public's engagement with flood risk mitigation. The participants argued, similar to Ludy & Kondolf (2012) and McEwen et al. (2017), that diminishing flood memories and traditional knowledge about living with floods from society causes the public's limited flood risk awareness and ability to reduce their vulnerability to flooding circumstances. Future generations therefore tend to be uninformed about their risk of flooding and how to mitigate the potential flood effects. According to the findings, I am arguing here that to improve public engagement in Thailand effectively, the aforementioned limiting factors need to be addressed.

In addition, the investigation also highlights some practical approaches to promote public engagement in FRM in Thailand. First, the investigation underlines the need for establishing hubs of knowledge and information about flooding issues and FRM for all stakeholders (e.g. the public and researchers) to access (section 7.5). Second, building connections between citizens and people who experienced flooding issues is another interesting approach, as suggested by one FRM key actor (section 7.4.2). This is similar to several researchers' arguments that opportunities to explore narratives of science, technology, social, and environmental (STSE) issues from people who have been affected by the issues help individuals develop an in-depth knowledge about the impact of such issues (Boyer & Roth, 2006; Lee & Roth, 2001; McEwen & Jones, 2012; McNamara & Rooke, 2008). Such knowledge is a fundamental element for building individuals' willingness to address the issues (Keller, 2016).

When comparing the findings from the two investigations in this study—i.e., the participant Thai public visitors (reported in chapters 5 and 6) and the participant FRM key actors (reported in this chapter)—there are also some dissimilarities in terms of factors that inhibit public engagement in FRM in Thailand. Given this, as mentioned in chapter 4, I therefore opted to reinterpret the two investigations' findings together using a cross-investigation analysis. This was to generate a better understanding of the scenario of public engagement in FRM in Thailand. Findings from the cross-investigation analysis are presented in the following chapter.

Chapter 8: Discussion (cross-investigation analyses)

In this chapter, I will summarise the findings from both Thai public visitors and FRM key actors and will further discuss the findings together to re-address the overarching aims of this study: to acquire insights into how Thai public visitors to a large science museum engage with flood risk management (FRM) in Thailand and what must be addressed to enhance such engagement. In section 8.1 I will look more closely into each investigation, drawing conclusions about the investigation process and key findings relevant to possibilities for and barriers to promoting public engagement in FRM.

In section 8.2 I will then discuss my (re)interpretation of the findings of each investigation together by using an adapted version of Stake's (2006) framework for cross-case analysis. This process has merged findings across the investigations (when possible) and identified special findings that emerged from considering findings from the two investigations together. Then, I will summarise all limiting factors discovered in this study that inhibit public engagement in FRM. In accordance with the limiting factors, theory building around how to promote public engagement in FRM in Thailand will be addressed in section 8.3; thoughts about ways to empower the public and shift FRM key actors' views on the public will be explored.

Lastly, in Section 8.4 I will offer a critique of this study, re-examining some of my methodological choices and limitations of the research.

8.1 Summarising the investigations of the participant Thai public visitors and the participant FRM key actors

Before presenting the summary of my findings from both investigations, it is important to remind readers once again that I discuss my assumptions based on my agreement with the notion of Environmental Citizenship (EC); that is, humans are citizens of this ecologically interdependent world who have rights and responsibilities to mitigate and prevent environmental risks towards themselves and others through taking actions in the private and public spheres (Dobson, 2010, 2003; ENEC, 2018; Hadjichambis & Reis, 2020). In this light, I therefore believe in Thai citizens' rights and responsibilities to influence the improvement

of FRM in Thailand through their actions in both the private (i.e. taking flood adaptations and pro-environmental behaviours to reduce flood causes) and public spheres (i.e. take non-activist social and political actions and activism actions) (Stern, 2000). Underpinned by this notion, as described in chapter 4, I opted to use types of environmental actions defined by Stern (2000) to assess how the public engages with FRM in Thailand from the perspectives of two participant groups (i.e. the participant Thai public visitors and the participant FRM key actors).

8.1.1 Thai public visitors' investigation

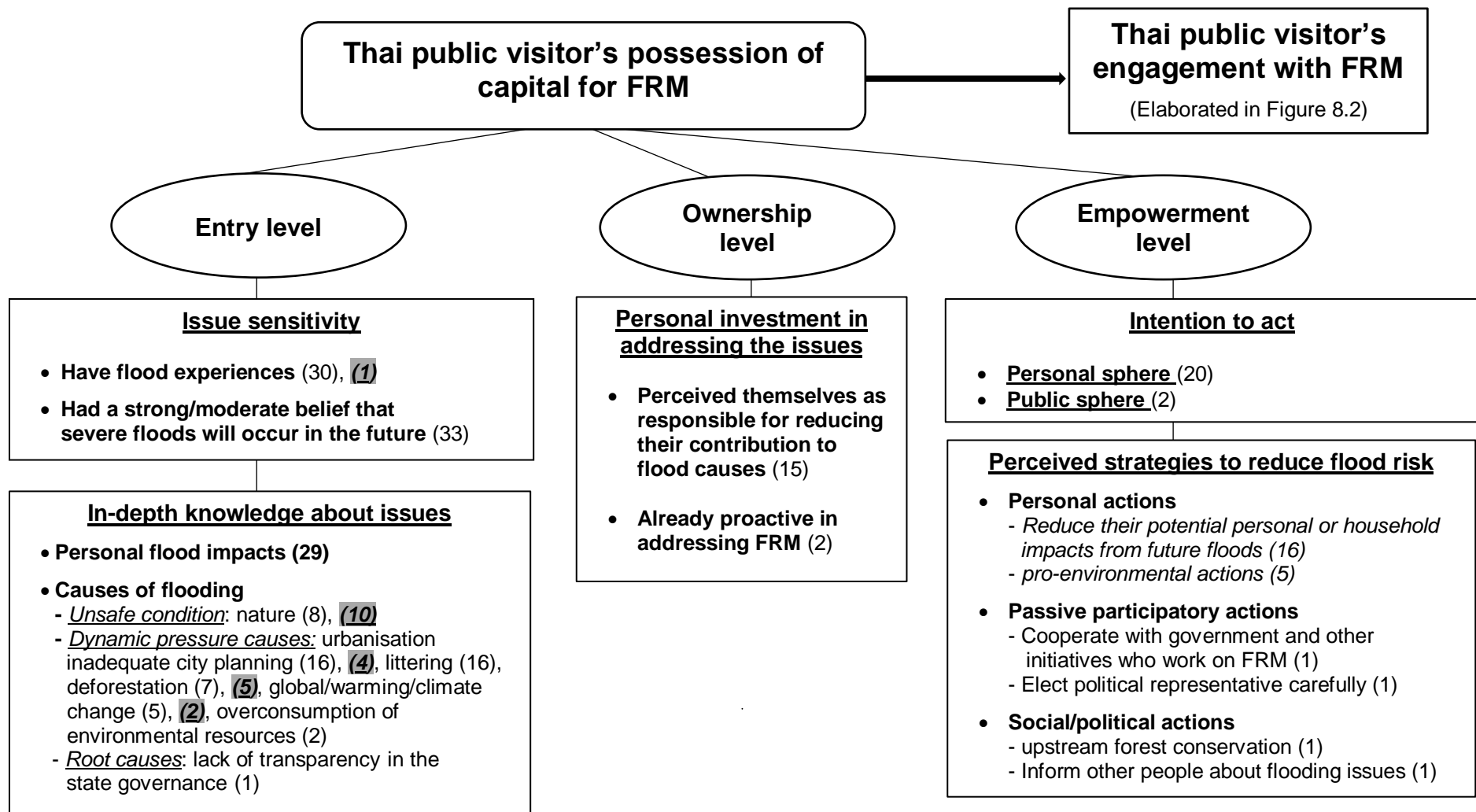
My goal with the Thai public visitor's investigation was to gain a better understanding of the realities of Thai public engagement in FRM through the perspectives of Thai visitors to science museums—the target audience of museum-based flood education programmes. This investigation offered the public's voices to support educators and other FRM key actors (e.g. policymakers) to develop more effective educational (and other supporting) interventions to promote public engagement in FRM in Thailand ('bottom-up') (Dufty, 2008). Two research questions (developed according to a holistic framework for evaluating public engagement in FRM proposed in section 2.3.3):

RQ1 – *What is the Thai public visitors' possession of capital at the entry-level - issue sensitivity (flood experiences, flood risk perception, and empathetic perspectives toward flood victims); and in-depth knowledge about issues (understanding of the causes of flooding issues)?*

RQ2 – *What is the Thai public visitors' possession of capital at the ownership and empowerment levels - their perceived responsibility for flood risk management (FRM), intention to act, perceived strategies to mitigate flooding issues, and locus of control?*

were explored based on the data generated from the participant Thai public visitors: drawings and the drawing explanations generated from 18 child visitors

(aged 5-12 years old); and flood personal meaning maps (PMMs) and interviews generated from 38 adult visitors (aged 13 years old and above). Based on the findings reported in chapters 5 and 6, I can summarise the participant Thai public visitors' possession of capital for addressing FRM and their engagement with FRM as Figure 8.1 and Figure 8.2, respectively.



Meaning of the figure symbols

(n) = number of participant adult visitors who possess the capital (total n = 38)

(n) = number of participant child visitors who possess the capital (total n = 18)

Figure 8.1 Overview of participant Thai public visitor's possession of capital for addressing FRM

Note: the figure was depicted based on the research findings reported in chapters 5 and 6.

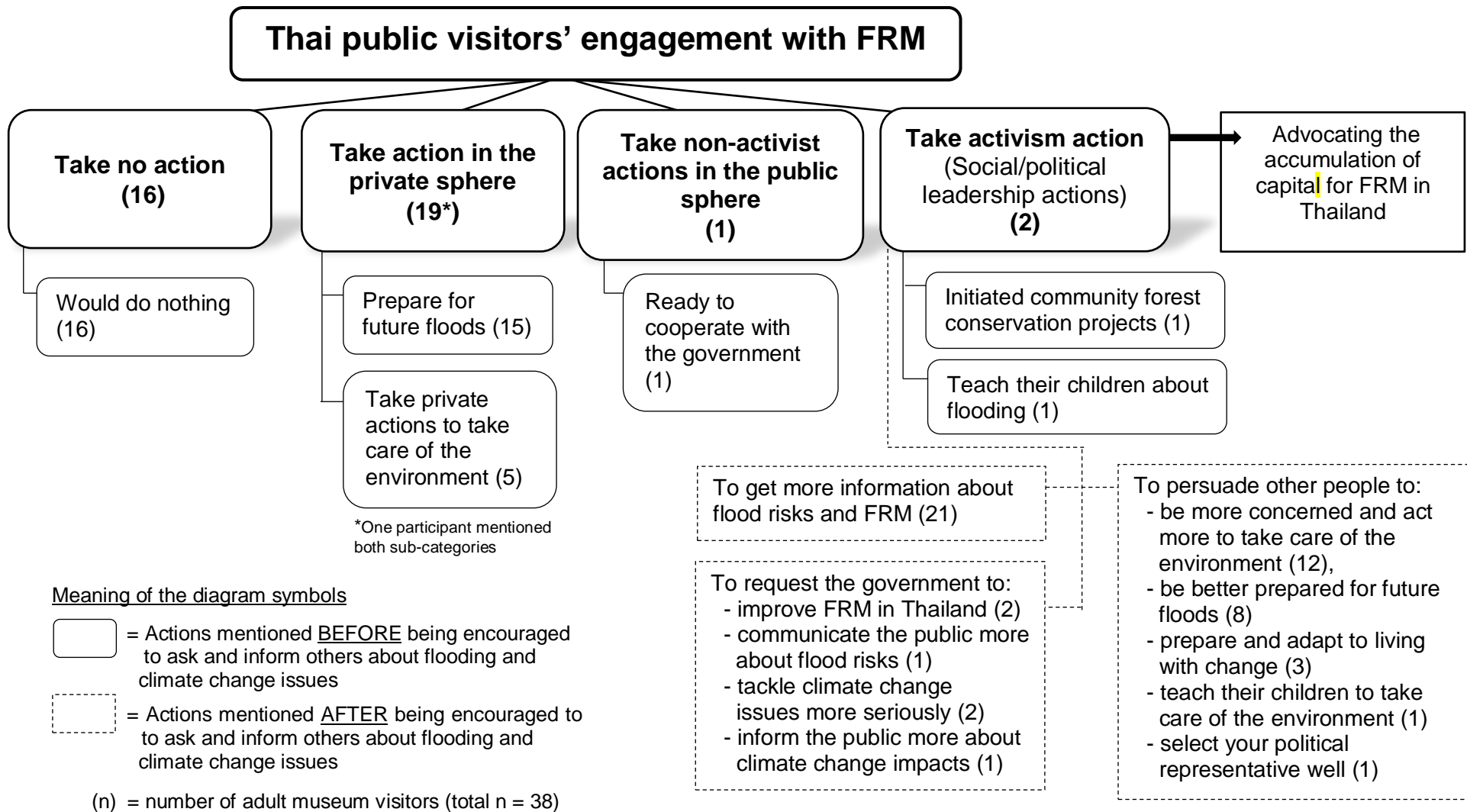


Figure 8.2 Overview of participant Thai public visitors' engagement in FRM

Note: the figure was depicted based on the research findings reported in chapter 6 (sections 6.2, 6.3, and 6.4)

As shown in Figure 8.2, the main findings from the participant Thai public visitors alluded to a restricted engagement in FRM among the participants. While most of the participant Thai (adult) public visitors (more than two-thirds) already possess capital that fosters collective FRM at the entry-level (i.e. flood experiences, knowledge of negative flood impacts at the personal level, strong or moderate beliefs of future flood likelihood, and understanding that local environmental issues (particularly urbanisation/ inadequate city planning, and littering) cause flooding issues in Thailand) (see Figure 8.1), the majority of the adult visitors reported taking no action towards the issues or taking private action (preparing) to reduce personal and household flood risks (see actions mentioned BEFORE being encouraged to ask or share with others in Figure 8.2). In other words, although they possess several sorts of capital that are useful for improving FRM, which makes them a significant contributor, the majority of them were inactive towards mitigating flooding issues in the public sphere (e.g. impelling a better FRM).

However, when they were encouraged directly to ask or inform others about flooding and climate change, more than half of the participant adult visitors expressed their curiosity about flooding issues, climate change, and solutions for the issues (see actions mentioned AFTER being encouraged to ask or share with others in Figure 8.2). And to a lesser extent, they also wanted to persuade other people and request the government to help address the issues.

By interpreting the findings from the investigation of Thai public visitors through the holistic framework²⁹ for evaluating individuals' engagement with FRM (proposed in section 2.3.3), I was able to identify several positive and limiting factors that influence public engagement in FRM in Thailand, which are summarised as follows:

Positive factors:

- According to their possession of capital for FRM revealed in this study, the public is a potential contributor to FRM.

²⁹ As described in section 2.3.3, the framework is considered to be holistic as it underlines factors that influence individuals' engagement in FRM in both personal and situational dimensions.

- 'Learning' (either for themselves or their children) is the main purpose for the public to visit the science museum.

Limiting factors:

- From the personal ('psychological') aspect, the limiting factors that were identified include the public's limited awareness of flood risks to themselves and others, the public's limited understanding of the causes of flooding issues, the public's perception that FRM is not laypeople's responsibility, the public's not recognising the significance of laypeople in FRM, and the public's limited knowledge of flood risk mitigation strategies.

- From a situational aspect, the limiting factors that were identified include inadequate public communication about flood risk and FRM information, diminishing flood memories and traditional knowledge about living with floods from Thai society, and limited opportunities and encouragement for the public to take social and political actions.

8.1.2 FRM key actors' investigation

My aim in adding the FRM key actors' investigation to my case study was to better understand the situational influences of the scenario of public engagement in FRM in Thailand. In doing so, a research question:

RQ3 – How do FRM key actors perceive public engagement in FRM in Thailand?

was explored based on the interview data generated from ten FRM key actors (four researchers involved in disaster risk reduction, four volunteer educators involved in education for enhancing collective actions in solving society's problems (flooding issues were one of their concerns), and two state authorities from the Bangkok Flood Control Department). As I discussed in chapter 7, the main findings from this investigation alluded to the FRM key actors' agreement on the importance of promoting public engagement in FRM; a lack of public engagement is a major barrier to FRM in their perspectives.

The limiting factors that prevent the public from engaging with FRM in Thailand from the participant FRM key actors' perspectives include:

- the personal ('psychological') aspect (argued by most of the participant FRM key actors), the public's limited awareness of flood risks to themselves and others, and the public's perception that FRM is not laypeople's responsibility.

- the situational aspect (argued by a few participant FRM key actors), inadequate public communication about flood risk and FRM information, diminishing flood memories and traditional knowledge about living with floods from Thai society, and state powerholders' not prioritising public engagement in FRM.

Apart from their direct suggestions on the limiting factors, the discussion with the participant FRM key actors also revealed some possibilities for promoting public engagement in FRM in Thailand:

- All the participant FRM key actors viewed public engagement as essential for FRM (even though most of their expectations were still limited to altering the public's behaviours to mitigate flood risks and cooperate with state regulations ('actions in the private sphere' and 'non-activist actions in the public sphere') I will discuss this point further in section 8.2).

- Most of the participant FRM key actors, even to a limited extent (i.e. visiting science museums has yet to become part of Thai culture), recognised the potential role of science museums in supporting the promotion of public engagement in FRM in Thailand. A few of them also expressed enthusiasm to collaborate with science museums to promote public engagement in mitigating flooding issues (e.g. sharing their expertise and educational activities).

According to the findings from both investigations, I acknowledged both similarities and differences in terms of factors that influence public engagement in FRM between my discovery from the public themselves (i.e. the participant Thai public visitors) and the participant FRM key actors' perspectives. I therefore performed a cross-investigation analysis (section 4.3), which helped me visualise the findings of each investigation together to deepen my understanding of the mechanisms behind the scenario of public engagement in FRM in Thailand. The cross-investigation findings will be discussed in the following section.

8.2 Cross-investigation findings: FRM key actors' deficit views on the public

I adapted Stake's (2006) cross-case analysis to reinterpret the findings from the two investigations in this study (i.e. the investigations of the participant Thai public visitors and the participant FRM key actors). (See section 4.3 for more details on the reinterpretation process.) In Table 8.1, the findings of the two investigations are compared. Each finding is marked with its level of significance (low, medium, or high), which is identified by the number of participants who mentioned the finding. The demonstration of these findings in the same table allowed me to merge the findings and identify special findings from the two investigations, as shown in Table 8.2.

Table 8.1 Comparing the findings from the two investigations (Thai public visitors vs. FRM key actors)

Note: Letters were used to indicate the significance of the findings: L = Low, M = Medium, and H = High, which, respectively, indicate that the finding was mentioned by < 1/3, between 1/3 - 2/3, and > 2/3 of the participants. The idea was adapted from Stake (2006).

Mechanisms	Findings from the participant Thai public visitors (chapters 5 and 6)	Findings from the participant FRM key actors (chapter 7)
<u>Possibilities for promoting public engagement in FRM</u>		
Personal aspect	<ul style="list-style-type: none"> • The public is a potential contributor to FRM in both the private and public spheres (H) • ‘Learning’ is the main purpose for the public to visit the science museum (H) 	<ul style="list-style-type: none"> • The participant FRM key actors perceived that the public is a potential contributor to FRM in both the private and public spheres (L)
Situational aspect	N/A	<ul style="list-style-type: none"> • The participant FRM key actors perceived that public engagement is essential in improving FRM, especially that the public should alter their behaviour to mitigate flood risks (e.g. adopt flood adaptation) and cooperate with state regulations) (H) • The participant FRM key actors perceived that it is essential for the public to influence decision-making in the development of policies and plans (L) • The participant FRM key actors expressed enthusiasm to collaborate with science museums to promote public engagement in mitigating flooding issues (L)

Mechanisms	Findings from the participant Thai public visitors (chapters 5 and 6)	Findings from the participant FRM key actors (chapter 7)
<u>Limiting factors inhibiting public engagement in FRM</u>		
Personal aspect	<ul style="list-style-type: none"> • The public had limited awareness of flood risks to themselves (L) • The public had limited awareness of flood risks to others (H) • The public had a limited understanding of the causes of flooding issues (M) • The public perceived that FRM is not laypeople's responsibility (M) • The public did not recognise the significance of laypeople in FRM (H) • The public had limited knowledge of flood risk mitigation strategies (H) <p style="text-align: center;">N/A</p>	<ul style="list-style-type: none"> • The public had limited awareness of flood risks to themselves (H) • The public had limited awareness of flood risks to others (H) • The public had a limited understanding of the causes of flooding issues (H) • The public perceived that FRM is not laypeople's responsibility (H) <p style="text-align: center;">N/A</p> <ul style="list-style-type: none"> • The public had limited knowledge of risk mitigation strategies (L) • Visiting science museums has yet to become part of Thai culture (L)
Situational aspect	<ul style="list-style-type: none"> • Inadequate public communication about flood risk and FRM information (L) • Diminishing of flood memories and traditional knowledge about living with floods from Thai society (H) • Limited opportunity and encouragement for the public to take social and political actions (M) <p style="text-align: center;">N/A</p>	<ul style="list-style-type: none"> • Inadequate public communication about flood risk and FRM information (M) • Diminishing of flood memories and traditional knowledge about living with floods from Thai society (L) <p style="text-align: center;">N/A</p> <ul style="list-style-type: none"> • State powerholders' not prioritising public engagement in FRM (M)

Table 8.2 Matrix of merged and special findings

Note: Merged findings mean the factors were mentioned either in one or both investigation(s) and special findings mean the factors emerged from reinterpreting the two investigations together.

Possibilities for and barriers to promoting public engagement in FRM in Thailand	Merged findings	Special findings
<u>Possibilities</u>		
Personal aspect		
• According to their possession of capital for FRM, the public is a potential contributor to FRM	x	
• ‘Learning’ is the main purpose for the public to visit the science museum	x	
Situational aspect		
• Despite their limited perspective on the public’s roles in FRM, FRM key actors have recognised the importance of public engagement in FRM	x	
<u>Limiting factors</u>		
Personal aspect		
• The public’s limited awareness of flood risks to themselves and others	x	
• The public’s limited understanding of the causes of flooding issues	x	
• The public’s perception that FRM is not laypeople’s responsibility.	x	
• The public’s not recognising the significance of laypeople in FRM	x	
• The public’s limited knowledge of flood risk mitigation strategies	x	
Situational aspect		
• Inadequacy of public communication about flood risk and FRM information	x	
• Diminishing flood memories and traditional knowledge about living with floods from Thai society	x	
• A limited opportunity and encouragement for the public to take social and political actions	x	
• FRM key actors’ deficit view on the public		x

The main finding from the cross-investigation analysis highlighted that the majority of the FRM key actors had deficit views on the public. According to Davis and Museus (2019), the term ‘deficit view’ refers to the idea that a person’s traits are ‘the cause’ of their failures. With deficit thinking, those who consider themselves as ‘experts’ (e.g. scientific experts) construe personal traits as ‘the

only source' of non-experts' failures in achieving something (e.g. educational outcomes, improving their wellbeing, and bringing change to environmental circumstances). They ignore systemic influences that shape disparities in individuals' social achievements (Davis & Museus, 2019).

In this study, meanwhile, I found that the public's limited engagement in FRM tended to be about their feelings of powerlessness in influencing change in FRM (e.g. the public did not recognise the significance of laypeople in FRM), which is caused by several situational factors (e.g. the inadequate public communication about flood risk and FRM information), more than about the public's ignorance of the issues (i.e. the public had limited awareness of flood risks to themselves). Most of the participant FRM key actors viewed the public's ignorance as a primary reason for the public's lack of engagement in FRM; only a few participant FRM key actors mentioned situational barriers.

In addition, while all participant FRM key actors in Thailand agreed on the importance of public engagement in FRM, for most of them, public engagement is limited to the public taking action in the 'private sphere' and cooperating with state regulations and plans (a 'non-activist action in the public sphere'). They, especially the state authorities, tended to believe that if the public has a better understanding of the issues' complexity, the public will cooperate more with them and complain less about their work. These experts' deficit views on the public seem to be another significant situational barrier that prevents the public from engaging with FRM in Thailand, as I will discuss below.

Several researchers in the field of public engagement in addressing issues related to science, technology, society, and the environment (STSE) (e.g. Beck, 1995; Davis & Museus, 2019; Levinson, 2010) have found that experts' deficit perspectives on the public often result in greater tension between experts and non-experts. The perspectives usually direct experts to approach other stakeholders ('non-experts') with a 'they-know-better' attitude (Beck, 1995), which narrows the experts' focus down to fixing laypeople (non-experts) instead of addressing situational causes of the issues (Davis & Museus, 2019) and searching for genuine collaboration to solve the complex issues (Levinson, 2010). Considering that these experts' suggestions dominantly inform the development of FRM policies and plans, therefore there is a significant chance that limiting factors in the situational dimension are left unattended.

For example, if this research was underpinned by a deficit perspective on the public (which I had at the very beginning of my PhD research), I could overlook situational influences that obstruct the public from engaging with FRM. This seems to explain why some studies on FRM in the context of Thailand that I have reviewed (e.g. Thanvisitthpon et al., 2018) often call for better public education to promote Thai public engagement in FRM, but not a change in FRM governance (e.g. offering more opportunities for the public to engage). Similar to this study, Phanthuwongpakdee's study (2016) on flood adaptation practices in four flood-affected communities highlights the issue of having deficit views on the public among local FRM authorities in Thailand. The author argues that although several locals acknowledged problems with state flood protection plans (e.g. installing flood walls), they were less likely to inform local authorities about the problems because their concerns and needs used to be treated as unimportant.

Apart from having deficit perspectives on the public, several participant FRM key actors also had deficit views on the potential of science museums in supporting the improvement of FRM in Thailand. As previously discussed in section 7.5, they were sceptical of the effectiveness of science museum contributions to FRM because, in their opinion, science museums in Thailand have yet to successfully attract the public. Once again, considering that the development of FRM policies and plans is predominantly informed by experts' suggestions, this seems to explain why science museums—a significant non-formal education institution in Thailand—were left excluded from the recent national disaster risk management plan (DDPM, 2015). Thus, I am arguing here that the FRM key actors' deficit views on other stakeholders (i.e. the public and science museums in this study) are another barrier to the promotion of public engagement in FRM in Thailand.

Drawing on findings from each investigation and the cross-investigation analysis, I can summarise several factors in both personal and situational dimensions that obstruct public engagement in FRM in Thailand as in Figure 8.3. In order to effectively encourage the public to engage with FRM in the private and public spheres, I argue that these limiting factors need to be addressed. In the following section, I discuss how to promote better public engagement in FRM in Thailand regarding these limiting factors.

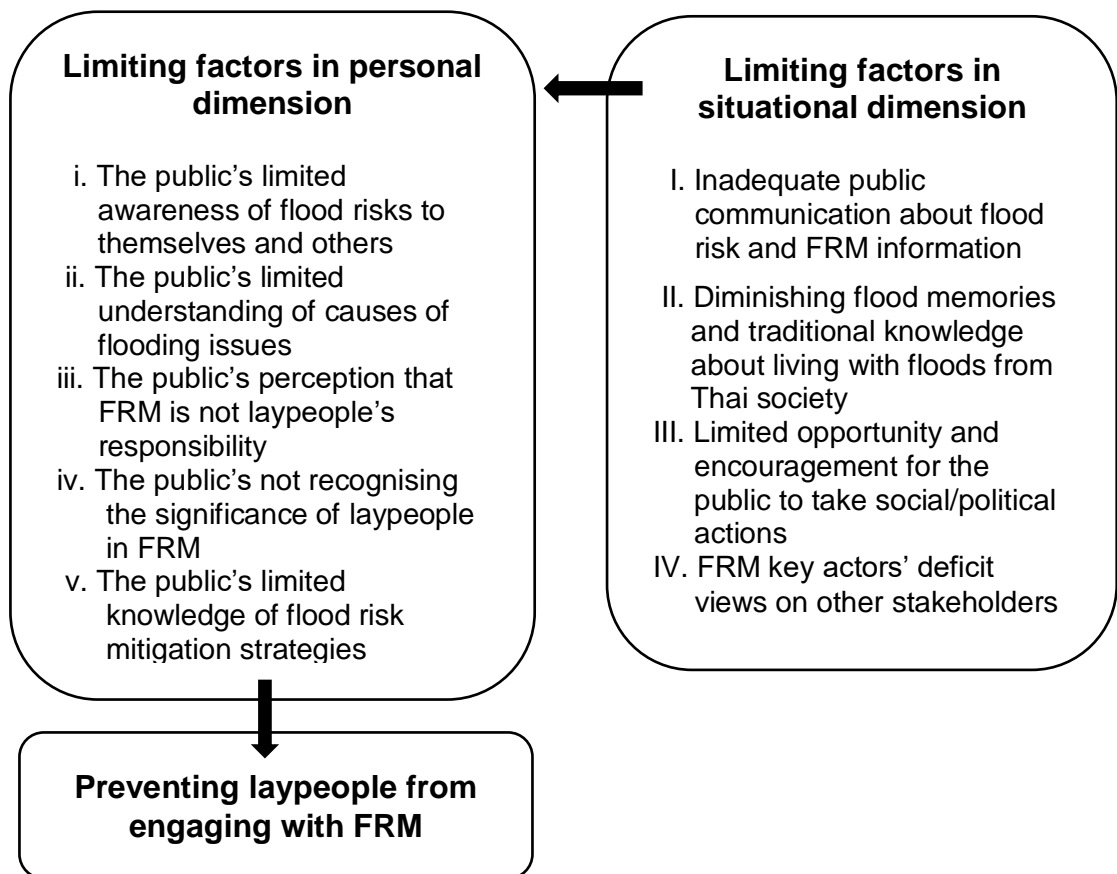


Figure 8.3 Summary of factors inhibiting public engagement in FRM

8.3 Discussion: How to promote better public engagement in flood risk management in Thailand

In this section, I return to address the initial question that motivated me to conduct this research about how to promote better public engagement in FRM in Thailand and some challenges that need to be considered. While I may not have complete answers to this question, especially considering the small-scale nature of this study, I believe that the findings throughout this research offer useful answers to the question. According to the identified limiting factors (see Figure 8.3), I argue that to facilitate the public to use their rights and potential to improve flooding circumstances fully, what is needed is not just a change in the public's knowledge and awareness about the issues, but also a change in their 'engagement reality and opportunities' (Cross, 2013; Da-Silva-Rosa et al., 2015; Horton, 2003; Levinson, 2010). In doing so, we need to work on two significant matters concurrently: empowering the public and shifting FRM key actors' views

on other stakeholders, which I will discuss below using the Bangkok Metropolitan Region (the community of interest in this study) as the centre of the discussion.

8.3.1 Empower the public

Considering this case study as an ‘instrument’ to understanding the scenario of public engagement in FRM in Thailand provides empirical evidence that several factors (see Figure 8.3) have caused the Thai public to be unaware of and feel powerless and hopeless to mitigate flooding issues. Empowering the public to believe in their significance and ability to influence FRM is therefore essential. In doing so, I argue that two interventions need to be implemented: offering more sources of reliable and updated knowledge about flooding issues and FRM for the public to access and offering safe spaces for the public to connect and exercise their social and political actions towards the improvement of FRM with other stakeholders.

Offering more sources of reliable and updated knowledge for the public

According to the participant Thai public visitors (especially those who were already concerned about flooding issues), being able to access more information is important for them to make informed decisions about FRM. Indeed, some of them argued that having an educational medium for communicating such information will help them, as parents, talk about flooding issues with their children easier³⁰. While disseminating information (‘deficit model’) alone is not sufficient when it comes to enacting laypeople to take actions to mitigate socio-environmental issues (Codreanu et al., 2014; Eilks, 2015; Johnson et al., 2014; Levinson, 2010; Shaw et al., 2004; Shiwaku et al., 2007; Wachinger et al., 2013), knowledge is still useful for people when it is relevant, robust, and timely with agential agendas, competencies, and values (Dickson, 2000; Levinson, 2010;

³⁰ For example, MV.08 stated (chapter 6): “One thing that I could think of now after talking with you [the interviewer] is that I have to teach this one [points at her son] to prepare for his future. But it’s hard to make him know what flooding looks like, like what I actually experienced. It would be nice if [...] they make something...like...models that children can visualise about flood events through”.

Smederevac-Lalic et al., 2020). In a democratic context, ‘robust knowledge³¹’ plays a significant role in empowering citizen deliberation and participation (Levinson, 2010). It enables individuals’ capacity to understand and form questions and arguments about their issues of interest (i.e. FRM in this research) (Navas-Iannini & Pedretti, 2017).

Based on the participant Thai public visitors’ want-to-know knowledge and the participant FRM key actors’ want-laypeople-to-know knowledge, I can outline the sorts of knowledge that must be made available for the public to access as follows:

- (1) All causes of flooding issues in the local area (‘the BMR’)
- (2) The limitations of technological flood protection systems: how they affect other people and the environment, and their political use
- (3) Historical flood events in the local area (‘the BMR’), and their impacts and flood experiences from affected locals
- (4) Roles of laypeople in addressing FRM (rights and responsibilities) in democratic nations
- (5) Evidence of successful cases of public engagement in FRM
- (6) All possible choices of actions that laypeople can take to mitigate flood risks (i.e. preparation for flood response, long-term adaptation, and actions in the private and public spheres to mitigate causes of flooding issues) and limitations of each action.

For those who have not yet been aware of flooding issues, knowledge (1), (2), and (3) would introduce the public to flood risks, both towards themselves and others. Hopefully, the fact that the BMR is naturally flood-prone and several flood events have occurred previously in the area (discussed earlier in section 2.1) will increase the “*watery sense of places*”—the understanding that floods are a typical occurrence in the areas (McEwen & Jones, 2012), —among the BMR residents. Visual evidence of local flood events (e.g. epigraphic marks of floodwater and video clips of local flood events) helps improve expert and local awareness of the frequency and magnitude of extreme events (McEwen & Jones, 2012).

³¹ According to Seijger et al. (2016, p. 393), robust knowledge is archived when “knowledge is credible, salient, and produced in a legitimate way.” It is the knowledge that is relevant and accepted by actors in the context of its applications (e.g. knowledge produced through research studies and local experiences/observations).

Knowledge of all causes that increase flooding issues in the BMR might establish individuals' understanding of their responsibility towards flood risk mitigation (Rees et al., 2015); that is, it would facilitate individuals' recognition of their involvement with flooding issues, particularly as a cause of the issues, which eventually may increase their judgement of responsibility towards FRM (Marjanovic et al., 2012; Smederevac-Lalic et al., 2020). In addition, Norris et al. (2008) have argued that knowledge about local floods and their impact helps people make better decisions on how to respond to upcoming flood events.

For those who are less aware of flood risks due to their optimistic viewpoints of technological flood protection systems (section 5.5), the knowledge (1) and (2) could challenge their existing perspectives, which hopefully result in increasing their 'sense of complexity' in dealing with flooding issues. That is, the issues cannot be solved simply by installing technological flood protection systems (Gray & Colucci-Gray, 2014; Hodson, 2003; Levinson et al., 2020), and by doing so, it impacts other people and the environment (see e.g. Herschy, 1998; Kondolf, 1997; Phanthuwongpakdee, 2016; Ravetz, 2005; Singkran, 2017; Speller, 2015).

Agreeing with Gray & Colucci-Gray (2014), Hodson (2003) and Levinson (2010), I argue that the basic understanding of how science and technology are influenced by and have influenced the sociopolitical environment (e.g. why technological flood protection systems are a politically preferable choice for powerholders, even if they are proved ineffective in building sustainably flood-resilient communities) will enable citizens to be critical about pros and cons of using science and technology. Acknowledging the impact of floods and flood protection systems on others is a significant foundation of empathetic feelings toward others, which is another important factor that motivates individuals to mitigate flooding issues (Harmon-Jones et al., 2003; Keller, 2016; Marjanovic et al., 2012; Zhou et al., 2003). The acknowledgement could develop moral and political anger – the kind of anger felt when we see an injustice being committed and the kinds of political values that underpin such injustice (Levinson, 2010),

For knowledge (4), (5), and (6), I argue that they are critical for those who have not yet recognised their roles and potential in FRM and those who feel insignificant ('powerless and hopeless') in improving the flooding circumstances. Knowledge about the roles of laypeople in addressing FRM, evidence of successful cases of public engagement in FRM, and all possible actions that

laypeople can take to mitigate flood risks is an important component in improving individuals' feelings of significance, power, and hopefulness—a significant factor that encourages people to engage with FRM (Bourn, 2021; Hicks, 2018; Hines et al., 1987; Honneth, 1992; Hungerford & Volk, 1990).

As discussed in section 2.3.2, the feelings of powerlessness and hopelessness in dealing with environmental circumstances are invertedly related to individuals' possession of 'perceived self-efficacy'—individuals' beliefs in the effectiveness of their actions to influence situational outcomes (Hines et al., 1987; Honneth, 1992; Hungerford & Volk, 1990). The more 'perceived self-efficacy' an individual possesses, the more powerful and hopeful they feel and the more motivated they are to take action to change their situation. Perceived self-efficacy is high when individuals possess high self-confidence, self-respect, self-esteem, and belief that the issues of their interest can be improved (Bourn, 2021; Hicks, 2018; Honneth, 1992; Newman et al., 2005; Paton, 2006; Speller, 2015; Speller & Ravenscroft, 2005).

Thus, if we want to build self-confidence, self-respect, self-esteem, and belief that the issues can be improved among the public, (realistic) hopeful content about improving the environmental situation is essential to be promoted in public education, as reflected by curators and facilitators at Science World (Vancouver, British Columbia) (Navas Iannini & Pedretti, 2022). They argued that when exhibitions about sustainability are preoccupied with hopeless content (e.g. climate change impacts), it yields feelings of depression (e.g. "*We're all going to die!*" in their terms), which results in losing audiences' interest to 'exciting' exhibitions (e.g. cool physics lessons). They therefore argued for adding more 'hopeful content' (e.g. stories of 'green heroes' and sustainable 'actions taken by others') to improve audience engagement in exhibitions for sustainability.

In addition, recent research in environmental behaviours claims that when compared to knowledge about environmental problems or how to address environmental problems, social norms and culture tend to have a stronger effect on individuals' decisions on whether or not to take pro-environmental actions (Cross, 2013). Witnessing others take pro-environmental actions significantly motivates individuals to adopt more pro-environmental behaviours (Cross, 2013). In light of the foregoing, I contend that efforts to educate the public about their significance (rights and responsibilities) in influencing FRM, as well as successful

cases of public engagement in FRM, and to broaden their perceived action options (particularly actions that people can take without making their lives more difficult), are critical to promoting public engagement in FRM in Thailand (Bourn, 2021; Hines et al., 1987; Honneth, 1992; Hungerford and Volk, 1990; Levinson et al., 2020; Smederevac-Lalic et al., 2020; Sutoris, 2022).

Importantly, it is essential to promote the examples of successful cases and the choices of action, along with their challenges and limitations. This is to prevent creating ‘false hope’ for the public. For example, green consumption is not sufficient enough to compensate for unsustainable environmental circumstances (Sörqvist & Langeborg, 2019), and making political protests on climate change (e.g. Greta Thunberg’s protests) does not easily bring about changes in national and international work on addressing the issues. Improving environmental situations takes time, effort, and commitment from the collectives (Bourn, 2021).

The key practical and strategic question raised here is: *While expert knowledge is often materialised and publicised, how can ‘local’ knowledge and needs be captured and publicised?*

Offering safe spaces for the public to exercise social and political actions

The limited opportunity to act in the public sphere is another situational factor that must be addressed to promote public engagement in FRM in Thailand (section 8.2). In doing so, I argue that offering more ‘safe spaces’ for the public to exercise social and political actions—connect and exchange their knowledge, concerns, ideas, and resources; and collaborate with other stakeholders (e.g. FRM working groups in Thailand, other public groups, state authorities)—is essential (Choi & Pak, 2006; Hicks, 2018; Levinson, 2010; Stapleton, 2015).

Safe spaces in my meaning refer to places where every opinion and concern are carefully listened to and discussed without feeling that their expressions will be criticised, laughed at, or undervalued (Hicks, 2018; Levinson, 2010); and cause no negative consequences to individuals (e.g. legal or social effects). This is because the discussion of social issues (especially politics) in Thailand, due to the cultural and political context of the nation, can result in several negative consequences, ranging from general social conflicts to legal consequences.

In terms of culture, valuing hierarchy – a distance of power according to different social positions (e.g. expert-laypeople and children-elders) - and social harmony among the majority of Thai people tend to be a main barrier to public expressions for social and political changes (Bogart, 2012; Deveney, 2005; Hallinger & Kantamara, 2010; Hofstede et al., 2010; Pimpa, 2012). For instance, Thai students do not like to ask or answer questions in classrooms because they are taught to be respectful, non-aggressive, accepting, tolerant, and non-confrontational team players toward teachers (Bogart, 2012; Deveney, 2005). In workplaces, Thais tend to avoid disagreement or criticism when communicating with others, particularly those who are in higher positions (Holmes et al., 2003). Kamolpattana (2016) found explainers in science museums in Thailand tend to avoid interacting with their visitors because of similar reasons.

In terms of political structure, although Thailand is an officially democratic country, the nation has been classified as a 'flawed democracy' by the Democracy Index 2015 due to issues of media freedom infringement and minor suppression of political opposition and critics (The Economist Intelligence Unit, 2016). Politics, as discussed earlier in Section 1.2, has been perceived as inappropriate and unwelcomed to discuss in the country, even in the family or educational settings (Fry, 2002; Sasipornkarn, 2020). Since Thailand's military coup d'état in 2014, the Thai military has dominated Thai politics in an authoritarian manner, which has worsened the nation's democratic process.

According to the latest national education scheme (2017-2036), enhancing citizens' ability to take social and political actions is not an agenda in the educational plan (Office of the Education Council, 2017). In addition, the Computer Crimes Act has been enacted in 2021 to prevent harm from fake news on social media platforms, which has also been used by the government to expand their control over citizens' criticism of their governance (Bugher, 2021; Ganjanakhundee, 2020). Given this, in agreement with Hicks (2018) and Levinson (2010), I argue that offering spaces for the public to work with other stakeholders, especially FRM working groups, in a non-hierarchical manner and safe from serious negative consequences is a crucial way to empower the public to take more action in the public sphere.

In retrospect, my experience discussing FRM with the participant Thai public visitors in this study suggests that reciprocal exchange between the Thai public

(the participant Thai public visitors) and researchers (me) is possible. The majority of the Thai public visitors who participated in this study seemed eager to share their thoughts with me, and I was able to share scientific information with them about sea-level rise and the increasing likelihood of floods in Thailand with them simultaneously. As a result, while I learned a lot more about the scenario and mechanism of public engagement in FRM Thailand from their perspective, several of the participant Thai public visitors have expanded their knowledge of the relationship between climate change and flood risks in Thailand (discussed earlier in section 6.6).

I believed that the high degree of their enthusiasm was partly a result of my attempt to consistently inform them of the value of their thoughts in improving (education for) FRM in Thailand, that I did not know better than them, and that their participation in this research would not cause them any negative effects. Thus, in order to effectively establish safe spaces, a shift in the FRM key actors' views on the public is also required (considering that the FRM key actors have deficit views on the public, as evidenced by this study), which will be discussed further in the following section.

In addition, Cross (2013) and Horton (2003) have argued that individuals tend to be motivated to take pro-environmental actions when they can constantly witness other people take action on addressing environmental issues. In this light, I have a strong assumption that providing an opportunity for the public to connect with FRM working groups and witness their work will expand their knowledge of action choices for mitigating flood issues and foster public engagement with FRM.

By the time I am finishing this thesis, the most recent Bangkok governor, *Chadchart Sittipunt* (elected in May 2022), has launched a digital platform ('Traffy Fondue³²') to encourage Bangkok's residents to report issues that need to be addressed in the city. Within a month after the launch, there were more than 50,000 issues reported, and 35% of the issues were solved, including the maintenance of flood draining system. The attempt to listen to locals and instantaneously respond to solve the issues results in a significant increase in lay engagement in city improvement—41 times greater than the monthly average before the launch (SPRiNG, 2022). This seems to indicate that the increase in

³² For more information, visit: <https://www.thaipbsworld.com/traffy-fondue-nothing-to-do-with-cheese-but-melting-away-bangkokians-problems/>

opportunities to engage in society's management motivates citizens to take more action to address societal issues. It also highlights the importance of state authorities' perspectives on the public, which is discussed further in the following section.

A key practical and strategic question is: *How can safe spaces for the public to exercise taking social and political action be established and expanded to a wider public (e.g. those who have limited access to digital platforms)?*

8.3.2 Shift FRM key actors' views on other stakeholders

This study found FRM key actors' deficit views on the public, which appears to be a main barrier preventing the public to engage with FRM, especially in the public sphere (section 8.2). For example, in the UK, the public's voices have begun to be seriously included in the development of FRM policies and plans only when state agencies, local authorities, and other bodies recognise the value of lay knowledge and needs (McEwen & Jones, 2012). This is similar to the case of Bangkok I raised in the above section. As a result, unless FRM key actors perceive other stakeholders (for example, the public and science museums) as significant contributors (with essential capital for improving FRM), opportunities for varied stakeholders to collaboratively engage with improving FRM, particularly in the development of FRM policies and plans, will be scarce.

Key practical and strategic questions are: *How can we foster the development of anti-deficit views among FRM key actors in Thailand? How can we sustain the anti-deficit perspectives in our society?*

8.3.3 Some challenges

While offering safe spaces for the public to connect reciprocally with FRM working groups is a significant way to empower the public to take action in the public sphere, the deliberative tool (encouraging the exchange of knowledge and opinions about social issue management between stakeholders) does not simply lead to actions. It potentially leads to greater conflicts (Levinson, 2010; McEwen & Jones, 2012), especially when each participating party contends to use the dialogic approach as an instrument to win their argument rather than promote the

moral purposes of democratic deliberation, the common good, or striving to attain consensus (Young, 2000). In the field of FRM, clashes between 'expert knowledge' and 'local knowledge' are evident when attempts are made to 'integrate' them (McEwen & Jones 2012). Even when there are citizen forums, the most powerful parties are usually still the ones who have the most say in how policies and plans are made (Levinson, 2010). In other words, results from citizen forums usually will not be included in the development of policies and plans if they do not advocate the interests of powerful parties.

This poses an important question about how to manage conflicts that might arise from the connection-building between FRM stakeholders (e.g. FRM key actors and the public).

8.4 A critique of the study

In retrospect, the research strategy used in this study to investigate the scenario of public engagement in FRM in Thailand appears to work well. It allowed me to examine diverse perceptions and practices regarding flooding issues and FRM from the target audience of the museum-based flood education I endeavour to develop in the future. More specifically, as discussed earlier in chapters 3 and 4, the use of a case study approach in conjunction with a critical realist (CR) strategy to structure this study enables me (instead of exploring the Thai public in general) to focus on examining my target group of members of the Thai public (the Thai public visitors at an exhibition in a particular science museum) in detail ('the case') and also expand the layer of investigation to public engagement in FRM from the FRM key actors ('the context of the case').

As mentioned in chapter 4, the case study approach entails the exploration of a specific phenomenon to provide an in-depth account of one (or a few) instance(s) of a particular phenomenon of interest (Denscombe, 2010; Punch, 2009; Yin, 2013, 2003). In this research project, this in-depth and intensive characteristic of this methodology was not only significant to the identification of patterns and dissonances of Thai public engagement practices towards FRM but also to the exploration, at least partially, of the realities (mechanisms) behind these cases. That is, more than simply facilitating my efforts to pragmatically organise and identify patterns and dissonances in the 'case' investigated, the

case study methodology also allowed me to understand why the case happened that way from the perspectives of the public themselves (e.g. particular beliefs and constraints).

In conjunction with a case study approach, as discussed earlier in chapters 3 and 4, the critical realist (CR) strategy has allowed me to add a layer of investigation (public engagement in FRM from the FRM key actors) to the case study. This strategy seems to have advanced the knowledge production in this study beyond case-based knowledge. That is, the study did not just provide the case description (i.e. Thai public visitors' engagement with FRM) but also offered an explanation of how the case interacted with its context (i.e. the situation of FRM in Thailand). Thus, in this scenario, the choice of using CR and its multi-layered approach to investigate social phenomena was particularly useful to my understanding of the different levels of complexity of the scenario of public engagement in FRM in Thailand. That is, the engagement is influenced by the interplay among several agential and contextual factors.

While the use of different methods to generate data from two participant groups did not always lead to triangulation of the findings in a strict sense (i.e. did not use the same research questions in both investigations), interconnecting data generated from the two investigations certainly helped me to cross-check my own interpretations with different perspectives (i.e. Thai public visitors and FRM key actors) and to explore more nuanced ideas and explanations related to the topic being investigated.

In addition, I cannot assume that all interpretations and connections established between data collected from the Thai public visitors and the FRM key actors are a complete representation of the case explored throughout this study, especially since the study adopted an interpretive position (knowledge is socially constructed). Nonetheless, the use of a CR perspective and its 'judgemental rationality' approach provided me with a pathway to strengthen my interpretations. That is, the inferences made in this study are not solely done by employing a multi-layered perspective on the case being examined, as stated above, but also by consistently connecting findings between this study and other research in the fields related to Education for Sustainability (EfS) ('theoretical redescription'). I hope that the use of 'judgemental rationality' has developed a certain degree of trustworthiness in my answers to RQs.

Despite these positive experiences with the use of a case study and CR as methodological choices, some limitations can be identified, mainly in relation to the sampling process and size, and the data generation methods. I need to acknowledge that they are not perfect, and therefore, they could not have possibly captured all the views and practices linked to my research topics. I will first focus on the investigation of the participant Thai public visitors.

It can be said that investigating a small number of Thai public visitors (18 children and 38 adults) recruited through a convenience sampling approach could limit me from producing knowledge regarding the topic of my investigation (i.e. public engagement in FRM) that represents the Thai public visitors to this large science museum. Even so, the in-depth and instant responses collected from those who attended the Climate Change Exhibition in varied forms of data (drawings and their explanations, flood PMMs, questionnaires, and interviews) have provided me with a richness of viewpoints about their engagement with FRM. This range of viewpoints helped me identify relevant patterns (e.g. their actions to mitigate flood risks) and mechanisms (e.g. possession of capital that fosters FRM, and personal and situational constraints) behind the case being studied. My decision to stop recruiting the participant Thai visitors after a month of having no novel pattern and mechanism emerged from later recruited visitors ('data saturation') also helped me to overcome, to some extent, the limitations of my small sample size.

Obstacles also emerged from my goal to include young children in my investigation. According to my pilot fieldwork at the science museum, traditional in-depth interviews (about 30 minutes-long) were ineffective with young children (less than 13 years old): since they were surrounded by the exciting museum environment, attracting and keeping the children to talk to a stranger (me) about serious issue appeared impossible. Instead of calling off my initial intention, I opted to use a draw-and-explain approach to generate data from the child visitors. The drawing alone appeared to have worked well in terms of attracting and keeping the child visitors focused on expressing their thoughts about the complicated topic (i.e. flooding); that is, the approach effectively assisted me in attracting and keeping the participant child visitors (aged 5-12 years old) participating in the research tasks and generating rich data from the children.

The drawing approach also had limitations, especially with its interpretations. Since interpretations of drawings can be considerably influenced by the interpreters, asking the participant child visitors to explain their drawings right after finishing them facilitated strengthening the child visitors' own voices in the interpretation process. I also opted for a cross-check analysis approach (I cross-checked my initial interpretations with my supervisors' and six PhD colleagues' opinions, as discussed in chapter 4) which helped me critique, confirm, and explore more nuanced ideas and explanations related to the child visitors' realities. Nevertheless, I had to accept that not all aspects of the topic being investigated (e.g. flood risk perceptions, intention to act on flooding issues) can be generated from the draw-and-explain approach.

Interviews also had a negative side. The approach tended to place many participants, particularly the Thai public visitors, in a position where they had to talk to a stranger; at the beginning of the interviews, many participants seemed to hesitate to express themselves openly about their views. My choice of being clear with them about the research purpose and consistently informing them that there is no right or wrong answer helped me partly overcome this challenge; that is, I believed that in doing so, the participants felt more comfortable expressing their genuine thoughts.

In relation to the personal meaning mapping (PMM) approach, the choice of using the PMMs before and after the interviews appeared to pay off in terms of getting the interviewees to concentrate on the topic being investigated (i.e. flooding) and assessing the influence of interview discussions on the interviewees' perceptions about the topic. However, as discussed in chapter 4, several words/phrases added to the post-interview PMMs require more explanation from the participants. (While the words/phrases mentioned in the pre-interview PMMs were discussed during the interviews, which allowed me to establish a broader understanding of words/phrases from the participants' perspectives. I did not ask them to discuss post-interview words/phrases). Thus, my choice to overcome this limitation that emerged from the lack of the validation step was to exclude a few random words/phrases (e.g. polar bear, feeling) from the study finding report, since their meanings were unclear.

I now move onto discuss the investigation of the participant FRM key actors. The fact that I was an outsider to the FRM professional working groups obstructed

my chance to recruit them to my study. To overcome this hindrance, I opted for a snowball sampling method to recruit this participant group. Regardless of the criticism that the snowball sampling method cannot ensure the total sample population's representativeness (Bhardwaj, 2019), the approach appeared to have worked well in terms of providing me with an opportunity to recruit participant FRM key actors who were beyond my initial recognition. Considering the fact that FRM key actors are difficult to contact directly, the approach seemed to increase the extent of the FRM key actors' acceptance to participate in my study because they knew that they were introduced by other key actors in their connections.

In relation to the participant FRM key actors' interviews, there was a challenge in terms of keeping the interviews concise while having several in-depth questions to discuss with the participants. I therefore opted to send (through e-mail) the list of interview questions, the consent form and the introduction of my research to the participant FRM key actors a few days before the actual interviews. The procedure appeared to work well in terms of reducing my research introductory time and getting the discussion right to the topic being investigated. Apart from our discussion, several participants had prepared and offered me additional data that they considered to be useful for my research (e.g. documents from their research projects).

Lastly, being a cross-cultural study (the data were generated in Thai) was also a challenge in relation to data analysis and presentation of the study. Since English is my second language, during the research process I encountered low confidence in translating the research instruments from English to Thai and the generated data from Thai to English, and in writing to present my research in English. The employment of a proof translation by a Thai-English professional translator, as described in chapter 4, and English proofreading by English native speakers helped me overcome this language barrier.

8.5 Concluding thoughts

When I started this research, my effort was to understand the 'reality' of public engagement in FRM in Thailand that went beyond what can be actually seen or heard directly from the collected data about the topic. One of my primary

concerns was how I could analyse the two different investigations—in terms of the participants and research questions—together to acquire (in-depth) insights into the ‘reality’ of the issue being investigated. In this chapter, to overcome the challenge, I adapted Stake’s (2006) cross-case analysis approach to analyse the two investigations together.

Through searching for commonalities and differences between what I discovered from the participant Thai public visitors and the participant FRM key actors’ views, I was able to merge and identify special findings from the two investigations. The process allowed me to build theories around mechanisms (both supportive and limiting factors) that influence public engagement in FRM in Thailand and make evidence-based assumptions on how to promote better public engagement in FRM in Thailand. In the following chapter, I will discuss the research implications for the science museum practice and the wider context.

Chapter 9: Research implications

In this chapter I will offer the research implications for science museum practitioners, focusing on how science museums can support the improvement of FRM in Thailand, and for practitioners and researchers in a wider context.

9.1 Implications for science museum practice

9.1.1 Potential roles and recommended practices

In this section, I specifically offer an answer to science museum practitioners who may have a similar curiosity to mine - *how can science museums support the improvement of FRM in Thailand?* While I may not have the complete answer to the question, especially considering the small-scale nature of this study and my research scope on promoting public engagement in FRM, I believe that the study informs potential roles and recommended practices for science museums to help foster public engagement in mitigating environmental risks in Thailand. Before carrying on the discussion about the potential roles and recommended practices, two significant points need to be made explicit.

First, while the debate about museums' social and political roles between the old museology (collection-based education) and the contemporary (more accountable for the needs of society), I advocate the notion that museums have the potential to foster sustainability of society (Cameron & Deslandes, 2011; Lane et al., 2007; Newman et al., 2005; Pedretti & Navas Iannini, 2020). The institutions already have a connection with the public who value learning (as evidenced in Chen's (2015), Subhamitr & Chen's (2013) and this studies), and when compared to the formal education sector, they are more flexible to adapt to local circumstances and can select which issues to focus on (Hadjichambis et al., 2019; Navas Iannini & Pedretti, 2022).

Second, based on my own experiences as a resident of two big cities (i.e. Bangkok/Thailand and London/England), I agree with the notion that education for sustainable societies needs to encourage and empower citizens to take action

in both the private (e.g. reducing environmental resource consumption) and public spheres (e.g. impel change of social structures and norms) (Chater & Loewenstein, 2022; Hadjichambis & Reis, 2020; Levinson et al., 2020). Thus, the implications for science museums I offer below are underpinned by these notions.

Based on the theoretical assumptions on how to promote better public engagement in FRM in Thailand (section 8.3), there are two roles that science museums can work on to support Thailand to be flood resilient: (role 1) being a source of reliable and updated knowledge about flooding issues and FRM for the public to access; (role 2) being a safe space for the public to exercise their participation in conversations, deliberations and collective actions toward improving FRM. To incorporate these roles, I suggest science museums adopt 'critical and agential' exhibition approaches (Pedretti, 2002; Pedretti & Navas Iannini, 2020), which are underpinned by the four frameworks of science communication for democratic participation (i.e. deficit, dialogic and deliberative, participation, and dissent and conflicts/actions) (Levinson, 2010). Details of each role and how the roles can be fulfilled are discussed as follows.

Role 1: Being a source of reliable and updated knowledge about flooding issues and FRM for the public to access (the basic role)

Given that science museums have developed their professionalism in the areas of preserving, recording, and disseminating knowledge for decades (Friedman, 2010; Hooper-Greenhill, 1995; McManus, 1992b; Tressel, 1980), science museums in Thailand can develop their institutions to become a source of reliable and updated knowledge about flooding issues and FRM for the public to access (Cameron & Deslandes, 2011). Importantly, the knowledge that science museums must archive and make available to the public has to cover beyond scientific knowledge about flooding issues. The sort of knowledge that must be promoted includes:

- (1) All causes of flooding issues in the local area ('the Bangkok Metropolitan Region (BMR)')
- (2) The limitations of technical flood protection systems: how they affect other people and the environment, and their political use

(3) Historical flood events in the local area ('the BMR'), and their impacts and flood experiences from affected locals

(4) Roles of laypeople in addressing FRM (rights and responsibilities) in democratic nations

(5) Evidence of successful cases of public engagement in FRM

(6) All possible choices of actions that laypeople can take to mitigate flood risks (i.e. preparation for flood response, long-term adaptation, and actions in the private and public spheres to mitigate causes of flooding issues) and limitations of each action.

While 'expert knowledge' is often materialised and publicised, the question raised in terms of the science museum practice is how 'local or lay knowledge' can be captured.

To capture local flood knowledge, McEwen & Jones (2012) have suggested using a 'citizen science' model (Cooper et al., 2007), establishing channels (e.g. through social media platforms or public outreach projects) to invite laypeople to co-create knowledge archives. Lay knowledge could include (but is not limited to) photographs and videos of local flood events, newspapers, personal stories of local flood experiences and impacts, and local and traditional knowledge of flood adaptation, their opinions and needs with addressing flooding issues (McEwen & Jones, 2012). As evident in this study, these types of knowledge exist among several members of the Thai public who visited a large science museum in BRM, Thailand. Many of them were willing to contribute to the development of flood education. In this spirit, inviting their audience to co-create archives for museum-based public flood education tends to be a prior step that the science museum can do.

To make the knowledge available to the public, science museums can use traditional (hands-off and hands-on) knowledge transmission approaches ('deficit model') (Wellington, 1998). They can select key contents to display through various types of communication methods, such as exhibitions of objects, visual and model information; storytelling in verbal, written and video forms; walk-through exhibits; and scenario-building, and they can set up a digital library where everyone can have access to their archive when it is wanted or needed. Importantly, all choices of actions should be communicated to the public in the sense of giving recommendations, not commands (Cameron & Deslandes,

2011). Crucially, science museums should have impartial facilitators who can help the public visitors understand the knowledge, especially scientific knowledge.

From my acknowledgement, the Watersnoodmuseum³³ in the Netherlands appears to be a good example of how a museum has been established to be a hub of knowledge for educating their citizens about flooding issues and FRM. The museum was designated and designed to be the 'national knowledge and memorial Centre' for the Netherlands' remarkable flood event in 1953. Their exhibitions are divided into four sections: *Facts* (the flood event and its background), *Emotions* (the story of the victims, the impact on the survivors, and the vigour of the people during flood recovery), *Reconstruction* (the redevelopment of devastated dykes, landscape, villages and towns), and *Future* (how the Netherlands lives with water). The exhibitions display historical footage, books, newspapers, names and personal stories of flood victims, and reality-based games that are relevant to the flood event and strategies to live with water. Nonetheless, there is still limited research on how these museum practices affect their audience and wider society, especially their influences on audience engagement with FRM.

Role 2: Being a safe space for the public to exercise their participation in conversations, deliberations and collective actions toward improving FRM (the advanced role)

Apart from being a hub of knowledge, science museums can also provide 'safe spaces' for the public to exercise their participation in conversations and deliberations, and collective actions toward improving FRM. Offering spaces for the audience to participate in conversations and deliberation with subject matter situated at the intersection of Science, Technology, Society and Environment (STSE) is a significant component of the 'agential exhibition' approach (Pedretti & Navas Iannini, 2020). In doing so, science museums can set up:

³³ More information about Watersnoodmuseum and their flood education programmes can be found at <https://watersnoodmuseum.nl/en/> and <https://en.wikipedia.org/wiki/Watersnoodmuseum>

- ‘write-and-share’ spaces (see examples in figures 9.1 and 9.2) where visitors can share their views about the issues of interest and access others’ points of view,

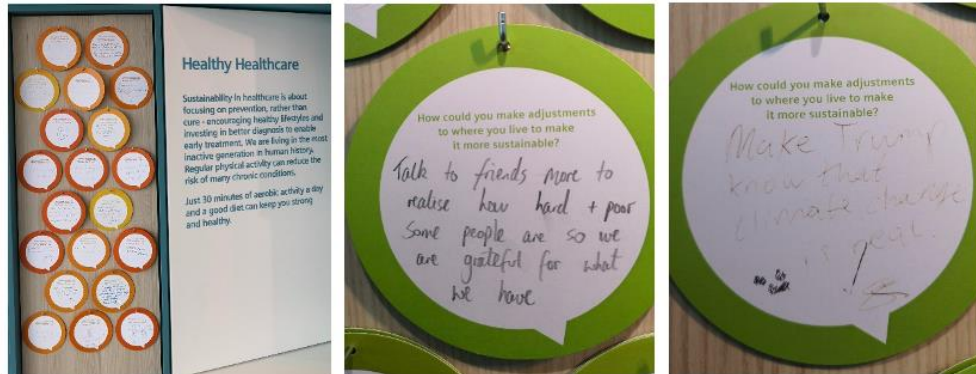


Figure 9.1 Write-and-share spaces at The Crystal³⁴



Figure 9.2 Write-and-share spaces at the Bangkok Art and Culture Centre (BACC)³⁵

- closed online platforms (e.g. Facebook and YouTube) to facilitate the exchange of knowledge and experiences, building connections between the public and FRM working groups (Lane et al., 2007; Wilde et al., 2021)

³⁴ A museum of sustainable innovation in London, UK. More information about The Crystal can be found at <https://www.thecrystal.org/>

³⁵ More information about The Bangkok Art and Culture Centre can be found at <https://en.bacc.or.th/>

- face-to-face meetings between FRM working groups and the public in science museum settings (e.g. talks, forums and conferences) in which topics to discuss are selected by the public audience

While exhibitions, talks, forums, and conferences about FRM in science museums settings could play a role to attract and motivate the public to engage with FRM, closed online platforms may help sustain the connection between the interested parties (Horton, 2003; Lane et al., 2007; Wilde et al., 2021).

Importantly, science museums need to ensure that the connection is built in a non-hierarchical and respectful manner – the FRM key actors are willing to listen to the public and value their voices as equal partners (Cameron & Deslandes, 2011; Hicks, 2018; Levinson, 2010; McEwen & Jones, 2012) – to facilitate genuine sharing of knowledge and collaboration. People’s willingness to collaborate tends to decline when they are approached with a deficit attitude (Levinson, 2010). In this light, having trained facilitators who can handle the conflicts that might arise from deliberative discourses among stakeholders is important.

Integrating these novel roles into science museum practice is possible but cannot be achieved by a straightforward translation of the innovative ideas into their existing practices (‘top down’) (Fullan, 2007; Penuel et al., 2015). That is, despite the possibilities (i.e. that science museums already have a connection with the public who value learning and are flexible to select which issues to include in their educational practices), several potential challenges still need to be considered in order to integrate these novel roles into the science museum practice. In the following section, I discuss challenges that adopting the recommended roles into science museum practice might encounter.

9.1.2 Challenges to be considered

My aim in pointing out challenges in adopting the recommended roles is not to discourage educators and researchers from incorporating these roles into their work. Instead, I aim to give them precautions and call for ideas to help overcome the challenges. Details of potential challenges are discussed below.

The first challenge is relevant to the culture of science museums that determine their practices: their professional views of their institutions, their

financiers' priorities, and social and political cultures in the context of their services. Similar to school contexts (e.g. Flutter & Rudduck, 2004), science museum professionals are a significant influence on science museum practices. The extent to which professionals incorporate their audience's perspectives into their practices is determined by the strength of their beliefs in the values of the audience's perspectives. Thus, as argued by Rennie and Williams (2006), their traditional views of science museums as providers of impersonal and trustworthy information appear to be a significant barrier for science museums to adopt civic forms of practices that are relevant to sensitive information, opinions, points of view, criticality and action. Moreover, in Thailand, encouraging public dialogues on societal issues can be more challenging than in some other nations due to the culture that values hierarchy and social harmony (Bogart, 2012; Hallinger & Kantamara, 2010; Pimpa, 2012; Thapatiwong, 2011), and the current political culture – flawed democracy (The Economist Intelligence Unit, 2016). This could prevent science museums from getting involved with controversial issues.

In addition, since science museums are very much dependent on funding from external sources, financiers' priorities (e.g. the government and the corporate sector) are another factor determining science museum development practice (Cameron & Deslandes, 2011b; Hadjichambis et al., 2019; Navas Iannini & Pedretti, 2022). As such, museums are usually not intended for straightforward input into informing and monitoring state governance (Cameron & Deslandes, 2011). For example, the National Science Museum (NSM) in Thailand is funded and operated by the Thai government (National Science Museum, 2019). Thus, undeniably, the government plays a significant role in determining the museum practices; the level of their support for the museum to adopt civic forms of practices tends to be low (section 8.3.1). In this light, in order to begin integrating the roles of promoting public engagement in FRM, the specific culture of each science museum need to be taken into account.

In agreement with Navas Iannini and Pedretti (2022), questions to be asked at the beginning of incorporating these recommended roles into science museums' practice are: *Would it be possible (and desirable) for science museums to be radical about communicating the insufficiency of science (i.e. technological flood protection system in the case of FRM)? Would it be possible (and desirable) for science museums to create exhibitions that invite small groups*

of public visitors and FRM working groups to explore flooding issues together (in a non-hierarchical way)? Would it be possible (and desirable) for science museums' curators to share their authority in creating exhibitions/activities with their public audience? If so (and if not so), from the science museum perspective, what are the possibilities and challenges of including promoting public engagement in FRM into their practices?

The second challenge pertains to FRM key actors' perspective on the public and science museums in supporting the improvement of FRM. To provide opportunities for the public to exercise their actions with FRM working groups, science museums need support and collaboration from these key actors, particularly their willingness to work with the public as equal partners. Still, as found in this study, many FRM key actors in the context of Thailand have deficit views on the public (i.e. seeing the public as ignorant towards addressing flooding issues) and have yet acknowledged science museum roles in supporting FRM (section 8.2).

In this light, for science museums to promote public engagement in FRM, the gap between FRM key actors, the public, and science museums needs to be taken into account; questions to be asked are: *Could (and how could) we bridge the gap between FRM key actors, the public, and science museums? Could (and how could) groups of visitors be included in FRM key actors' and science museums' works that imply pondering positions about FRM concerns and outlining plans for action (e.g. designing an exhibition to promote the improvement of FRM with science museums)?*

The last challenge is relevant to the nature of conversations and deliberation about societal issues between stakeholders, which does not simply lead to collective actions for environmental justice (section 8.3.2). In contrast, it potentially leads to greater conflicts and distance between stakeholders (Levinson, 2010; McEwen & Jones, 2012). Given this, educators and researchers need to keep in mind that conflicts could occur through attempts to build a connection between stakeholders. It requires great effort to include the public's voices in the development of FRM policies, plans, and implementations within a 'complex adaptive system' (Chapman, 2004, p.51). Therefore, science museums should not pressure themselves with expectations to produce successful solutions for the issues with a few attempts (e.g. by providing an exhibition or

hosting a few public forums) (Cameron & Deslandes, 2011), but rather learn from their trial and error.

The question to be asked therefore is: *How can science museums handle the potential conflicts to minimise creating a greater distance between the public and FRM key actors?*

As a final thought, it is undeniable that integrating the novel roles to promote public engagement in FRM into science museum practices will require great effort from researchers and educators who are interested in doing so. Nonetheless, I argue that addressing these challenges is an essential part of enabling science museums to support building 'flood resilience' in Thailand.

9.2 Implications for a wider context

Throughout this thesis I have been arguing about how to promote public engagement in FRM in Thailand effectively and about how science museums can support this process. The study has implications for various social actors, including professionals involved in the science museum landscape (i.e. science museum curators and educators, and researchers) who are willing to incorporate promoting public engagement in FRM (or other societal issues of interest) into their practice, as well as FRM policymakers, state authorities, and FRM working groups. Apart from direct implications for science museum practices, as discussed in the above section, the study can also inform researchers and scholars in a wider context, including the fields of Education for Sustainability (EfS), Disaster Risk Reduction Education (DRRE), Science Education (SE), and Museum Studies. The implications are summarised below.

Implications for professionals

- For the development of FRM in Thailand in general, I hope the findings presented and analysis developed in my empirical chapters have provided some insights into the scenario of public engagement in FRM in Thailand; barriers that need to be addressed to promote a better engagement; and possibilities and challenges for science museums to support improving FRM in Thailand. Professionals in the field of FRM in Thailand (e.g. FRM

policymakers) therefore can use findings from this study as empirical evidence to support their decision-making on FRM policies and plans.

- For professionals in science museums:

1) In the context of Thailand, where the development of the practical strategy to support non-formal education institutions to help promote public engagement with disaster risk reduction (DRR) has yet to be developed, this study provides a practical guideline to the institutions to promote public engagement in FRM in Thailand.

2) Still specific to Thailand, as individuals tend to develop an understanding and awareness about environmental issues more successfully when the introduction of knowledge is linked with their experiences (e.g. experienced flood events) (Berkowitz & Lutterman, 1968; Hadjichambis & Reis, 2020; Schild, 2016), the robust relationship between climate change and flooding issues in Thailand presented in this study therefore can be a useful component that science museums can integrate into their practice to increase awareness of climate change in Thai society.

3) For more than a decade, researchers in museum development have argued about the benefit of including stakeholders' voices in museum practices to address societal issues (Diamond et al., 2016; Navas Iannini & Pedretti, 2022; Newman et al., 2005). Still, this shared authority approach has yet to be widely used by museum curators, at least in the science museum where I carried out my study. Thus, apart from offering insights into how science museums can support the improvement of FRM, from a science museum curator's perspective, I hope my research experiences can offer encouragement and a pathway to other curators to (1) engage and respond more to the needs of people and societies, (2) work collaboratively with other stakeholders (e.g. the general public, and working groups, affected communities, and other museums) to address societal issues, and (3) examine their capacity and limitations regarding support addressing societal issues (e.g. FRM) and how to overcome such limitations.

Implications for researchers and scholars

- For the field of SE for a sustainable future (e.g. Funtowicz & Ravetz (1997), Gray & Colucci-Gray (2014) and Levinson (2010)): in relation to FRM, my findings provided empirical evidence from the voices of two groups of stakeholders (i.e. the public and FRM key actors) that advocate the need for SE to radically address awareness of the ways in which science and technology are used for the benefit of certain groups (e.g. political reputation and support from the business sector) at the price of other social and environmental well-being (e.g. installing floodwalls to protect industrial areas). The traditional approach of SE for a sustainable future appears to overemphasise the values of science and technology (e.g. 'green technology') as the solution to environmental problems and ignore the consequences of science and technological developments on the planet (Gray & Colucci-Gray, 2014).
- For the field of EfS, of which DRRE is an integral part (Shaw, 2014; United Nations, 2016):
 - 1) My exploratory interactions with the Thai public visitors provide empirical evidence that the public is not always ignorant when comes to dealing with environmental crises, but rather a significant contributor. As the capital for dealing with socio-environmental issues is distributed (Levinson, 2010), rather than asking what should be taught to the public, the development of interventions to strengthen the collective movement for a better environmental situation should begin by openly exploring the issues with them. As demonstrated in this study, providing places for the public's voices in the development of educational interventions appears to not only help inform how to design the intervention but also foster a sense of genuine collaboration between the public and educational sectors;
 - 2) My findings provided empirical evidence that EfS should promote more hope for solving environmental problems to the public (Bourn, 2021; Hicks, 2018). As shown in this study, not witnessing any positive outcome of the effort that humans have put in to address environmental problems generates doubt

among people about whether they should continue to help address environmental issues.

3) In relation to research methodologies, the study offered:

- in an attempt to expand research methods to investigate people's engagement with DRR from a holistic perspective, the use of the holistic framework to facilitate the visualisation of individual engagement practice with DRR and all factors that influence their practice (chapter 2). The framework offered me the ability to unravel the connections between personal and situational factors that influence the ways in which laypeople engage with FRM, and all types of action that laypeople can take to mitigate flooding issues.

- the use of Bourdieu's theory of practice, particularly the concept of capital, to inform how society deals with collective risks. The concept provided me with a lens to perceive all stakeholders as important partners in solving environmental problems. My view of the public as a significant contributor to FRM (anti-deficit) helped me approach the public with the intention to learn from them, which resulted in acquiring an understanding of the scenario of public engagement in FRM Thailand that I had not yet anticipated before discussing with the public:

- the use of the drawing-and-explain approach to examine children's perceptions of complicated issues (i.e. in this case study, flooding issues). The approach offered me the opportunity to attract and keep children engaged with my research task in a stimulating environment (i.e. in a science museum) and obtain rich data about children's understanding of flooding, which I believe I cannot obtain from using the traditional interview approach. However, as evident in this study, the approach's effectiveness appears to be limited with children younger than five due to their drawing ability;

- the use of the personal meaning mapping (PMM) approach to assist interviews. While the method was usually applied to personal conceptual, attitudinal, and emotional understanding of particular topics (Falk et al., 1998; Kelly, 2007), I found that by applying it prior to and after research interventions (in this study, interviews), the approach worked well to measure the participants' conceptual change that the research interventions may have caused. However, my experience recommends that the approach should not

be used alone and that asking for the following explanations of what has been put on PMMs should be done for the benefit of data analysis;

- the use of a critical realist (CR) stance in the design of this study, involved not only adopting a multi-method strategy for data generation but, more importantly, a multi-layered approach to the organisation of this research design (i.e. the establishment of links between agential, structural, and locally-specific findings) and the theoretical concept of 'judgemental rationality' to inform the approach to data validity and reliability throughout my analysis;

- in an attempt to acquire a comprehensive view of the scenario of public engagement in FRM in Thailand, the adapted use of Stake's multiple case study analysis approach (2006) to facilitate the cross-investigation analysis of findings from the two distinct participant groups (i.e. the participant Thai public visitors and the participant FRM key actors). The approach offered me a second level of analysis to merge the findings and identify special findings that remain hidden when analysing each investigation separately.

Chapter 10: Conclusion and recommendations

In the closing chapter of this research endeavour I provide the thesis conclusion and recommendations for future research and underline my intention to work forward from this thesis.

10.1 Conclusion

Responding to the rising flood risk in Thailand (Kulp & Strauss, 2019; Marome, 2016; OECD, 2007), the education sector has been called to help support the national flood risk management (FRM) plan by promoting public engagement in risk mitigation (DDPM, 2015; Phanthuwongpakdee, 2016; Singkran, 2017; Tanwattana & Toyoda, 2018; Thanvisitthpon et al., 2018). From a science museum educator's perspective, I therefore wondered how science museums, a significant non-formal education institution in Thailand, can help address this concern.

When I started this research, I initially sought to address voices from the public - a critical stakeholder in community risk management, but usually neglected from the policy and plan development process - in the development of public flood education to promote public engagement in FRM ('bottom-up') (Dufty, 2008). The intention inspired me to obtain more insights into how Thai public visitors to a large science museum (the target audience of museum-based flood education) engage with FRM in Thailand; and if there are any factors in both personal and situational dimensions that must be addressed to enhance their engagement. By taking a recommendation from the Critical Realists, I also investigated the situation of public engagement in FRM in Thailand from the FRM key actors' perspectives to acquire a better understanding of the situational influences on public engagement practices.

In order to achieve my aims, the following research questions were developed to guide this research investigation (chapter 3). (1) *What is the Thai public visitors' possession of capital at the entry-level: issue sensitivity (flood experiences, flood risk perception, and empathetic perspectives toward flood victims); and in-depth knowledge about issues (causes of flooding issues)?* (2) *What is the Thai public visitors' possession of capital at the ownership and*

empowerment levels: their perceived responsibility for FRM, intention to act, perceived strategies to mitigate flooding issues, and locus of control? (3) How do FRM key actors perceive public engagement in FRM in Thailand?

In revisiting these questions with the empirical data generated from fifty-six Thai public visitors who visited a large science museum in Thailand (18 children and 38 adults, aged 5-12 years old and 13 years old and above, respectively) and ten FRM key actors (chapter 4), I concluded that the Thai public visitors were heterogeneous in terms of their possessions of capital for FRM and their engagement with FRM. Within the context of a democratic country (Thailand's official governance system) where citizens are supposed to have rights and responsibilities for deciding the development of policies and plans, the findings showed that the majority of the participant Thai public visitors' engagement with FRM was limited to taking 'no action' to taking action in the 'private sphere' to reduce their 'personal or household' flood risks (chapter 6).

The discussion with both the public (chapters 5 and 6) and FRM key actors (chapter 7) yielded key knowledge to inform the promotion of public engagement in FRM in Thailand; that is, the limited public engagement in FRM in Thailand is not always the result of the public ignorance about the issues. Instead, it is a result of a range of factors in both personal and situational dimensions (chapter 8). The personal limiting factors, which vary from one individual to another, include the public's (i) limited awareness of flood risks to themselves and others, (ii) limited understanding of causes of flooding issues, (iii) perception that FRM is not laypeople's responsibility, (iv) not recognising the significance of laypeople in FRM and (v) limited knowledge of flood risk mitigation strategies.

The personal limiting factors, as stated above, appeared to be the result of four situational factors: (1) inadequate public communication about flood risk and FRM information, (2) diminishing flood memories and traditional knowledge about living with floods from Thai society, (3) limited opportunities and encouragement for the public to take social/political actions, (4) FRM key actors' deficit views on other stakeholders. According to these findings, the study suggests that to facilitate the public to utilise their rights and potential to improve flooding circumstances fully, what is needed is not just a change in the public's knowledge and awareness about the issues, but also a change in their 'engagement with

reality and opportunities' (Cross, 2013; Da-Silva-Rosa et al., 2015; Horton, 2003; Levinson, 2010).

In doing so, the study argues two significant matters that need to be addressed concurrently: empowering the public and shifting FRM key actors' views on other stakeholders (to see other stakeholders as equal partners). To empower the public, the study suggests that Thai society needs to (1) provide more sources of essential knowledge about flooding issues and choices of action to mitigate the issues for the public to access, and (2) provide more 'safe spaces' for the public to exercise social and political actions. The study also poses several key questions regarding strategies for empowering the public and shifting FRM key actors' views on other stakeholders that the field of public engagement in FRM in Thailand needs to work toward (chapter 8).

Based on the theoretical contribution on how to promote better public engagement in FRM in Thailand, the thesis provides direct implications for science museums' practices (chapter 9). To support the improvement of FRM in Thailand, I argue that science museums can adopt two roles: (role 1) being a source of reliable and updated knowledge about flooding issues and FRM for the public to access, and (role 2) being a safe space for the public to exercise their participation in conversations, deliberations, and collective actions toward improving FRM.

In the following section, regarding the critique of the study (chapter 8) and the research implications (chapter 9), I will outline recommendations for future research and practices in relation to advancing public engagement in FRM and science museums' practices to support such engagement.

10.2 Recommendations

First, given that the "bottom-up" approach is more effective than the "top-down" approach in promoting public engagement in FRM (Dufty, 2008), voices from broader groups of the public in Thailand in relation to FRM are critical for improving FRM in Thailand. This study solely yielded insights into how the Thai public engaged in FRM and what inhibits them to advance their engagement from a small group of the Thai public (i.e. those who visited a large science museum in Thailand). Prior to this study, there was limited research (Phanthuwongpakdee,

2016; Thanvisitthpon et al., 2018) that focused on exploring Thai public engagement with FRM. The research studies investigated flood adaptation strategies of four local communities in Thailand (Phanthuwongpakdee, 2016) and surveyed the public's satisfaction with the state FRM from 400 residents in Bangkok, the capital of Thailand (Thanvisitthpon et al., 2018).

In this regard, I suggest that future research could (and should) pay attention to accentuating the voices of various groups of the public in the improvement of FRM in Thailand (e.g. audiences of other non-formal education settings, school students, university students, low-income and flood-affected communities, and communities that are able to cope with floods). Furthermore, my experience conducting this study showed that the public possesses knowledge, perspectives, and actions regarding flooding issues and FRM beyond my prior assumptions. I therefore call upon future research to investigate the public's engagement with FRM in an open manner. RQs (chapter 3) and methodological approaches (chapters 3 and 4) could be used to explore public engagement with FRM with other groups of the Thai public. It could also be adapted to explore the public's voices in other contexts (e.g. other countries with similar issues) and with other issues.

Second, a better understanding of how individuals develop and maintain their environmental citizenship lifestyles – that is, taking private and public actions to bring social and political change in the direction of sustainability – is important knowledge to inform the development of education for environmental citizenship (Horton, 2003). In this study, I found that there are already Thai citizens who are proactive towards addressing FRM in Thailand, especially in the social dimension (e.g. initiating community-based upstream forest conservation and promoting public awareness of collective actions to address flooding issues). These active citizens appear to demonstrate a distinctive, important, and potentially replicable form of environmental citizenship in regard to flooding issues. Thus, a better understanding of these citizens tends to play an important role in the development of education for environmental citizenship. *What does environmental citizenship in relation to FRM look like? How might such citizenship be produced? How might such citizenship be maintained or manifested?* Tied to these reflections and questions is my call upon future research to specifically study these active citizens.

Third, Fullan (2007) argues that educational innovative ideas cannot be successfully implemented by a straightforward translation to practice ('top down'). This front-end study could only offer a 'precondition for success' – informing how science museums can support the promotion of public engagement in FRM in Thailand. The translation of these theoretical contributions into actual practices might encounter several contextual challenges (section 9.1.2). The development and improvement of science museum practices also require formative and summative evaluation along the practical practice development (Diamond et al., 2016; Rennie & Williams, 2006). According to Fullan (2007, p. 41), "*ownership (...) is more of an outcome of a quality change process than it is a precondition for success.*" Therefore, future research arising from this study should be about exploring the translation of these theoretical contributions (i.e. the new roles for science museums to promote public engagement in FRM) into actual practices.

In doing so, I recommend that researchers should work collaboratively with educators and curators of science museums to unfold how science museums can adopt these innovative ideas into their practices (Fullan, 2007). *Are science museum professionals interested in adopting these roles in their practices? How are these proactive roles established? What are the outcomes of these practices? What are the possibilities and challenges of translating these roles into actual practices?* In Thailand, despite having a few museum exhibitions attempted to promote public concern about flooding issues, such as the *Always Prepare: Living with Changes Exhibition*³⁶ (2012-2013), there is no research conducted to find out how these exhibitions were developed and to evaluate their outcomes and challenges. I therefore believe that documenting and sharing the development of these practices will fill the gap in the research literature on how non-formal education settings can promote public engagement in addressing environmental risks (what does work and what does not).

Lastly, the work of facilitators (also known as 'explainers') in science museum spaces is also significant for activating criticality and engagement toward the issues being exhibited (Navas Iannini, 2018). My experience discussing with the Thai public audience offered evidence that the public audience (although not all) possesses interests, curiosities, and intentions to

³⁶ A temporary exhibition hosted by the Thailand Creative & Design Center; for more information, see: <https://www.thaitravelblogs.com/2012/09/always-prepare-living-with-changes-exhibition/>

inform others about their local socio-environmental issues. Nonetheless, in order to express their curiosities and actually inform others about the issues, the public audience needs to be facilitated and encouraged (e.g. being invited to discuss). In addition, some information (e.g. the scientific information about the impact of rising sea levels in the Bangkok Metropolitan Region that I introduced to the participant Thai public visitors in this study) can be difficult to understand by the public as it is not their area of expertise. Hence, it seems like having facilitators is important to encourage the public audience to share their knowledge, opinions, and concerns, and to be critical and able to engage more with the displayed content.

Tied to these reflections is my recommendation to consider the participation and intervention of front-house facilitators involved in the programmes. *Can facilitators create safe spaces for conversations and debates to unravel different positions and points of view within the programmes? Can these professionals help elicit visitors' personal narratives as a way to promote meaningful connections with issues being exhibited? Can facilitators manage dissents and conflicts that may emerge from conversations among multiple stakeholders (e.g. the public and key actors)?* In agreement with Navas Iannini (2018), I suggest that trained personnel in the area of psychology or counselling are essential for creating safe and trusting environments in science museums to approach difficult and sensitive issues together with their visitors and to help manage dissent and conflicts that may emerge from conversations among multiple stakeholders.

10.3 Final thoughts

“Museums offer us a way to see different ways to live and be productive, by showing us how different cultures have lived in the past [and live now], by inspiring creativity, or offering opportunities to do voluntary work or information learning”

(McKenzie, 2010)

My passion for working in science museums brought me the opportunity to do this PhD research. Based on my experiences with science museum development (as both a researcher and a visitor to several science museums), I undoubtedly agree with Bridget McKenzie, as stated above, that science museums are public education avenues that can partly impact the way in which

people (particularly their audience) understand and act in their daily practice. They have the potential to support society in their services to deal with socio-environmental issues that matter, that are relevant, and that impact our own and environmental well-being.

For more than ten years, since I was impacted by the severe flood event in 2011 and witnessed flood impacts on others in Thailand (my homeland), I have been concerned about what laypeople like me can do to mitigate flooding issues. My work with these Thai public visitors to a large science museum and FRM key actors in Thailand theoretically opened up a space to study the ways in which science museums can take place to support Thai society to be flood resilient. It also underlined potential challenges that they need to overcome in order to successfully adopt these roles. The work can be seen as an invitation to ponder how science museums can take a step forward and consider integrating the aforementioned ways into their existing practice.

In this context, I hope that my opportunity to work with the Science Museum (where this research was conducted) after completing this PhD programme will provide me with opportunities to bridge theory and practice. That is, I could work collaboratively with the science museum's curators to develop museum-based flood education exhibitions and activities, as well as carry out action research throughout the practice's development.

References

- Achiam, M. & Sølberg, J. (2017). Nine meta-functions for science museums and science centres. *Museum Management and Curatorship*, 32 (2), pp. 123–143.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, pp. 179–211.
- Al Naser, F. & Sandman, M. (2000). Evaluating resilience factors in the face of traumatic events in Kuwait. *Sultan Qaboos University Medical Journal*, 2 (2), pp. 111–116.
- Aldrich, D.P. (2012). *Building resilience: Social capital in post-disaster recovery*. Chicago: The University of Chicago Press.
- Alerby, E. (2000). A way of visualising children's and young people's thoughts about the environment: A study of drawings. *Environmental Education Research*, 6 (3), pp. 205–222.
- Amodio, L. (2013). Science communication at glance. In A.-M. Bruyas & M. Riccio (Eds.), *Science centres and science events: A science communication handbook*. Milan; Heidelberg; New York; Dordrecht; London: Springer, pp. 27–48.
- Archer, L., Dawson, E., DeWitt, J., Seakins, A. & Wong, B. (2015). "Science capital": A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts: SCIENCE CAPITAL. *Journal of Research in Science Teaching*, 52 (7), pp. 922–948.
- Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2012). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal*, 49 (5), pp. 881–908.
- Arnstein, S.R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35 (4), pp. 216–224.
- Arunotai, N. (2008). Saved by an old legend and a keen observation: The case of Moken sea nomads in Thailand. In R. Shaw, N. Uy & J. Baumwoll (Eds.), *Indigenous knowledge for disaster risk reduction: Good practices and lessons learned from experiences in the Asia-Pacific Region*. Bangkok: UNISDR Asia Pacific, pp. 73–78.

- Baggini, J. (2019). *How the world thinks: A global history of philosophy*. London: Granta Books.
- Baldassare, M. & Katz, C. (1992). The personal threat of environmental problems as predictor of environmental practices. *Environment and Behavior*, 24 (5), pp. 602–616.
- Bandelli, A. & Konijn, E.A. (2012). Science centers and public participation: Methods, strategies, and barriers. *Science Communication*, 35 (4), pp. 419–448.
- Barrett, M.J. & Sutter, G.C. (2006). A youth forum on sustainability meets the human factor: Challenging cultural narratives in schools and museums. *Canadian Journal of Science, Mathematics and Technology Education*, 6 (1), pp. 9–23.
- Bazeley, P. (2013). *Qualitative data analysis: Practical strategies*. London: SAGE.
- BBC News (2020). *Greta Thunberg: Who is she and what does she want?* Retrieved May 05, 2020, from <https://www.bbc.co.uk/news/world-europe-49918719>
- Beck, U. (1995). *Ecological Enlightenment: Essays on the politics of the risk society*. London: Polity Press.
- Becker, G., Aerts, J.C.J.H. & Huitema, D. (2014). Influence of flood risk perception and other factors on risk-reducing behaviour: A survey of municipalities along the Rhine. *Journal of Flood Risk Management*, 7 (1), pp. 16–30.
- Bekkers, R. (2006). Traditional and health-related philanthropy: The role of resources and personality. *Social Psychology Quarterly*, 69 (4), pp. 349–366.
- Bell, L. (2008). Engaging the public in technology policy: A new role for science museums. *Science Communication*, 29 (3), pp. 386–398.
- Bell, P., Lewenstein, B., Shouse, A.W. & Feder, M.A. (Eds.) (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, D.C.: National Academies Press.
- Bellomo, K.S. (2014). *Constructing biology curriculum for a diverse student population: Opportunities for the integration of STSE education and issues of social justice*. PhD Thesis. Toronto: University of Toronto.

- Bennett, T. (1995). *The birth of the museum: History, theory, politics*. London: Routledge.
- BERA (British Educational Research Association) (2018). *Ethical guidelines for education research*. 4th edn. London: BERA.
- Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards*, 41 (2), pp. 283–295.
- Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology*, 18 (3), pp. 621–630.
- Berkes, F. (2000). Indigenous knowledge and resource management system in the Canadian subarctic. In F. Berkes & C. Folke (Eds.), *Linking social and ecological systems: Management practices and social mechanisms for building resilience*. Cambridge: Cambridge University Press, pp. 98–128.
- Berkowitz, L. & Lutterman, K. (1968). The traditional socially responsible personality. *The Public Opinion Quarterly*, 32 (2), pp. 169–185.
- Bezemer, J., Diamantopoulou, S., Jewitt, C., Kress, G. & Mavers, D. (2012). *Using a social semiotic approach to multimodality: Researching learning in schools, museums, and hospitals*. National Centre for Research Methods. Retrieved June 18, 2019, from https://www.researchgate.net/publication/279503879_Using_a_Social_Semiotic_Approach_to_Multimodality_Researching_Learning_in_Schools_Museums_and_Hospitals
- Bhaskar, R. (2017). *The order of natural necessity: A kind of introduction to critical realism*. London: Gary Hawke.
- Bhaskar, R. (2008). *Dialectic: The pulse of freedom*. London; New York: Routledge.
- Bickerstaff, K. (2004). Risk perception research: Socio-cultural perspectives on the public experience of air pollution. *Environment International*, 30 (6), pp. 827–840.
- Birkholz, S. & Jeffrey, P. (2013). Exploring protection motivation in Wilhelmsburg (Hamburg): Is the threat 'real' to the people of the Elbe-Insel. *Conference presentation, International Conference on Flood Resilience Experiences in Asia and Europe 2013*. Retrieved January 5, 2020, from http://icfr2013.ex.ac.uk/papers/A4_Birkholz.pdf

- Bodmer, W. (2010). Public Understanding of Science: The BA, the Royal Society and COPUS. *Notes and Records of the Royal Society*, 64, pp. S151-S161.
- Bogart, V.W. (2012). Child development issues related to Thailand's tablet computer policy within the ASEAN community. *Conference presentation, The ASEAN Scenario 2015-2020 Conference*, Bangkok, Thailand. Retrieved March 29, 2020, from <https://pt.slideshare.net/vandebogart/childevelopmentipad?smtNoRedir=1>
- Boholm, A. (2003). The cultural nature of risk: Can there be an anthropology of uncertainty? *Ethnos*, 68 (2), pp. 159–178.
- Bosschaart, A., Kuiper, W. & van der Schee, J. (2015). Students' mental models with respect to flood risk in the Netherlands. *International Research in Geographical and Environmental Education*, 24 (2), pp. 131–147.
- Bosschaart, A., Kuiper, W., van der Schee, J. & Schoonenboom, J. (2013). The role of knowledge in students' flood-risk perception. *Natural Hazards*, 69 (3), pp. 1661–1680.
- Bosschaart, A., van der Schee, J. & Kuiper, W. (2016). Designing a flood-risk education program in the Netherlands. *The Journal of Environmental Education*, 47 (4), pp. 271–286.
- Bourdieu, P. (1986). Forms of capital. In J.G. Richardson (Ed.), *Handbook of theory and research for the sociology of education*. Westport, Conn: Greenwood Press, pp. 241–258.
- Bourdieu, P. (1984). *Distinction: A social critique of the judgement of taste, Reprint 1984*. Cambridge, Mass: Harvard University Press.
- Bourn, D. (2021). Pedagogy of hope: Global learning and the future of education. *International Journal of Development Education and Global Learning*, 13 (2), pp. 65–78
- Boyer, L. & Roth, W.-M. (2006). Learning and teaching as emergent features of informal settings: An ethnographic study in an environmental action group. *Science Education*, 90 (6), pp. 1028–1049.
- Brooks, J., McCluskey, S., Turley, E. & King, N. (2015). The utility of template analysis in qualitative psychology research. *Qualitative Research in Psychology*, 12 (2), pp. 202–222.

- Brown, K., Adger, W.N., Devine-Wright, P., Anderies, J.M., Barr, S., Bousquet, F., Butler, C., Evans, L., Marshall, N. & Quinn, T. (2019). Empathy, place and identity interactions for sustainability. *Global Environmental Change* 56 (2), pp. 11–17.
- Bryman, A. (2012). *Social research methods*. 4th edn. Oxford; New York: Oxford University Press.
- Bubeck, P., Botzen, W.J.W. & Aerts, J.C.J.H. (2012). A review of risk perceptions and other factors that influence flood mitigation behavior. *Risk Analysis*, 32 (9), pp. 1481–1495.
- Bubela, T., Nisbet, M.C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., Geller, G., Gupta, A., Hampel, J., Hyde-Lay, R., Jandciu, E.W., Jones, S.A., Kolopack, P., Lane, S., Lougheed, T., Nerlich, B., Ogbogu, U., O’Riordan, K., Ouellette, C., Spear, M., Strauss, S., Thavaratnam, T., Willemse, L. & Caulfield, T. (2009). Science communication reconsidered. *Nature Biotechnology*, 27 (6), pp. 514–518.
- Bucchi, M. (2008). Of deficits, deviations and dialogues: Theories of public communication of science. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology*, Routledge International Handbooks. London; New York: Routledge, pp. 57–76.
- Bugher, M. (2021). *Thailand: Proposed initiatives to combat ‘fake news’ undermine freedom of expression*. Article 19. Retrieved July 25, 2020, from <https://www.article19.org/resources/thailand-fake-news-undermine-freedom-of-expression/>
- Burton, I., Kates, R.W. & White, G.F. (1993). *The environment as hazard*. 2nd edn. New York: Guilford Press.
- Burton, I., Kates, R.W. & White, G.F. (1978). *The environment as hazard*. New York: Oxford University Press.
- Cameron, D.F. (1971). The museum, a temple or the forum. *Curator: The Museum Journal*, 14 (1), pp. 11–24.
- Cameron, F. & Deslandes, A. (2011). Museums and science centres as sites for deliberative democracy on climate change. *Museum and Society*, 9 (2), pp. 136–153.
- Canda, E.R. & Furman, L.D. (2010). *Spiritual diversity in social work practice: The heart of helping*. 2nd edn. Oxford; New York: Oxford University Press.

- Cannon, T. (1994). Vulnerability analysis and the explanation of 'natural' disasters. In A. Varley (Ed.), *Disasters, development and environment*. Chichester; New York: J. Wiley, pp. 13-31.
- Cardona, O.D. (2004). The need for rethinking the concepts of vulnerability and risk from a holistic perspective: A need review and criticism for effective risk management. In G. Bankoff, G. Frerks & T. Hilhorst (Eds.), *Mapping vulnerability: Disasters, development, and people*. London; Sterling, VA: Earthscan Publications, pp. 37–51.
- Caulton, T. (1998). *Hands-on exhibitions: Managing interactive museums and science centres*. London; New York: Routledge.
- Chadwick, A.F. & Stannett, A. (Eds.) (2000). *Museums and adults learning: Perspectives from Europe*. Leicester: NIACE.
- Chapman, J. (2004). *System failure: Why governments must learn to think differently*. London: Demos.
- Chater, N. & Loewenstein, G.F. (2022). The i-frame and the s-frame: How focusing on the individual-level solutions has led behavioral public policy astray. *SSRN Electronic Journal*, pp. 1-41.
- Chawla, L. & Cushing, D.F. (2007). Education for strategic environmental behavior. *Environmental Education Research*, 13 (4), pp. 437–452.
- Chen, K.T.N. (2015). The motivations of visitors for visiting museums: A comparative study of museum visitors in Western countries, Malaysia and Thailand. *APHEIT Journal*, 4 (2), pp. 100–114.
- Cheung, W. & Feldman, D. (2019). Can citizen science promote flood risk communication? *Water*, 11 (10), pp. 1-9.
- Chilvers, J. (2012). Reflexive engagement? Actors, learning, and reflexivity in public dialogue on science and technology. *Science Communication*, 35 (3), pp. 283–310.
- Choi, B.C.K. & Pak, A.W.P. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and Investigative Medicine*, 29 (6), pp. 351–364.
- Christensen, J.H., Bønnelycke, J., Mygind, L. & Bentsen, P. (2016). Museums and science centres for health: From scientific literacy to health promotion. *Museum Management and Curatorship*, 31 (1), pp. 17–47.

- Christensen, P. & Prout, A. (2002). Working with ethical symmetry in social research with children. *Childhood*, 9 (4), pp. 477–497.
- Codreanu, T.A., Celenza, A. & Jacobs, I. (2014). Does disaster education of teenagers translate into better survival knowledge, knowledge of skills, and adaptive behavioral change? A systematic literature review. *Prehospital and Disaster Medicine*. 29 (6), pp. 629–642.
- Colding, J., Elmqvist, T. & Olsson, P. (2003). Living with disturbance: Building resilience in social-ecological systems. In F. Berkes, J. Colding & C. Folke (Eds.), *Navigating social-ecological systems: Building resilience for complexity and change*. Cambridge; New York: Cambridge University Press, pp. 163–186.
- Coles, E. & Buckle, P. (2004). Developing community resilience as a foundation for effective disaster recovery. *The Australian Journal of Emergency Management*, 19 (4), pp. 6–15.
- Collado, S., Rosa, C.D. & Corraliza, J.A. (2020). The effect of a nature-based environmental education program on children's environmental attitudes and behaviors: A randomized experiment with primary schools. *Sustainability*, 12 (17), pp. 1-12.
- Commission of the European Communities (2007). *Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the Assessment and Management of Flood Risk*. Retrieved April 29, 2021, from <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:en:PDF>
- Cooper, C.B., Dickinson, J., Philips, T. & Bonney, R. (2007). Citizen science as a tool for conservation in residential ecosystems. *Ecology and Society*, 12 (2).
- Cottrell, A. (2006). Weathering the storm: women's preparedness as a form of resilience to weather-related hazards in Northern Australia. In D. Paton & D.M. Johnston (Eds.), *Disaster resilience: An integrated approach*. Springfield: Charles C Thomas, pp. 128–142.
- Creswell, J.W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. 3rd edn. Los Angeles: SAGE Publications.

- Creswell, J.W. & Creswell, J.D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. 5th edn. Los Angeles: SAGE.
- Cross, J. (2013). *Three myths of behavior change - What you think you know that you don't [Online]*. Presented at TEDx Talks. Retrieved May 20, 2021, from <https://www.youtube.com/watch?app=desktop&v=I5d8GW6GdR0>
- Da-Silva-Rosa, T., Mendonça, M.B., Monteiro, T.G., Souza, R.M.D. & Lucena, R. (2015). Environmental education as a strategy for reduction of socio-environmental risk. *Ambiente & Sociedade*, 8 (3), pp. 209–228.
- Davis, I. & Hall, N. (1999). Ways to measure community vulnerability. In J. Ingleton (Ed.), *Natural disaster management: A presentation to commemorate the International Decade for Natural Disaster Reduction (IDNDR), 1990 - 2000*. Leicester: Tudor Rose, pp. 87–89.
- Davis, L.P. & Museus, S.D. (2019). What is deficit thinking? An analysis of conceptualizations of deficit thinking and implications for scholarly research. *NCID Currents*, 1 (1). pp. 118-130.
- DDPM (Department of Disaster Prevention and Mitigation) (2015). *National Disaster Risk Management Plan (2015)*. Bangkok: Research and international cooperation bureau. Retrieved September 13, 2018, from https://www.disaster.go.th/upload/download/file_attach/584115d64fcee.pdf
- de Man, A. & Simpson-Housley, P. (1988). Correlates of responses to two potential hazards. *The Journal of Social Psychology*, 128 (3), pp. 385–391.
- Delgado-Serrano, M. del M., Mistry, J., Matzdorf, B. & Leclerc, G. (2017). Community-based management of environmental challenges in Latin America and the Caribbean. *Ecology and Society*, 22 (1).
- Delicado, A. (2009). Scientific controversies in museums: Notes from a semi-peripheral country. *Public Understanding of Science*, 18 (6), pp. 759–767.
- DellaSala, D.A. & Goldstein, M.I. (Eds.) (2018). *Encyclopedia of the Anthropocene*. Oxford: Oliver Walter.
- Denscombe, M. (2010). *The good research guide: For small-scale social research projects*. 4th edn. Maidenhead: Open University Press.
- Denzin, N.K. & Lincoln, Y.S. (2003). Introduction: The discipline and practice of qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *The landscape*

- of qualitative research: Theories and issues*. Thousand Oaks: SAGE, pp. 1–45.
- Deveney, B. (2005). An investigation into aspects of Thai culture and its impact on Thai students in an international school in Thailand. *Journal of Research in International Education*, 4 (2), pp. 153–171.
- Dey, I. (1993). *Qualitative Data Analysis: A user-friendly guide for social scientists*. London: Routledge.
- Dhakal, S. & Shrestha, A. (2016). Bangkok, Thailand. In S. Bartlett & D. Satterthwaite (Eds.), *Cities on a finite planet: Towards transformative responses to climate change*. London; New York: Routledge, Taylor & Francis Group, pp. 63–80.
- Di Leo, J.H. (1983). *Interpreting children's drawings*. New York: Brunner/Mazel.
- Diamond, J., Horn, M. & Uttal, D.H. (2016). *Practical evaluation guide: Tools for museums and other informal educational settings*. 3rd edn. Lanham: Rowman & Littlefield.
- Dickson, D. (2000). Science and its public: the need for a 'third way'. *Social Studies of Science*, 30 (6), pp. 917–923.
- Dilli, R. (2016). Conducting museum education activities within the context of developing a nature culture in primary school students: MTA natural history. *International Journal of Environmental & Science Education*, 11 (2), pp. 75–84.
- Dobson, A. (2003). *Citizenship and the environment*. Oxford; New York: Oxford University Press.
- Douglas, M. (1966). *Purity and danger: An analysis of the concepts of pollution and taboo*. London: Routledge.
- Dresner, M., Handelman, C., Braun, S. & Rollwagen-Bollens, G. (2015). Environmental identity, pro-environmental behaviors, and civic engagement of volunteer stewards in Portland area parks. *Environmental Education Research*, 21 (7), pp. 991–1010.
- Du Pisani, J.A. (2006). Sustainable development – historical roots of the concept. *Environmental Sciences*, 3 (2), pp. 83–96.
- Dufty, N. (2008). A new approach to community flood education. *The Australian Journal of Emergency Management*, 23 (2), pp. 4–8.

- Durant, J. (1992). *Museums and the Public Understanding of Science*. London: Science Museum.
- Easton, G. (2010). Critical realism in case study research. *Industrial Marketing Management*, 39 (1), pp. 118–128.
- Edwards, C.H. (2013). *Environmental Identity and Education among Older Adults: An interpretative phenomenological analysis*. PhD Thesis. Oregon: Pacific University.
- Egeru, A. (2012). Role of indigenous knowledge in climate change adaptation: A case study of the Teso sub-region, Eastern Uganda. *Indian Journal of Traditional Knowledge*, 11 (2), pp. 217–224.
- Eilks, I. (2015). Science Education and Education for Sustainable Development – Justifications, models, practices and perspectives. *EURASIA Journal of Mathematics, Science and Technology Education*, 11 (1), pp. 149-158.
- Eisenberg, N. & Miller, P.A. (1987). The relation of empathy to prosocial and related behaviors. *Psychological Bulletin*, 101 (1), pp. 91–119.
- Ellenbogen, K.M., Luke, J.J. & Dierking, L.D. (2007). Family learning in museums: perspectives on a decade of research. In J.H. Falk, L.D. Dierking & S. Foutz (Eds.), *In principle, in practice: Museums as learning institutions, learning innovations series*. Lanham: AltaMira Press, pp. 17-30.
- Elliott, R. & Timulak, L. (2005). Descriptive and interpretive approaches to qualitative research. In J. Miles & P. Gilbert (Eds.), *A handbook of research methods for clinical and health psychology*. New York: Oxford University Press, pp. 147–159.
- Enterprising Science (2016). Science Capital. *Science Capital*. Retrieved September 25, 2017, from <http://www.kcl.ac.uk/sspp/departments/education/research/cppr/Research/curentpro/Enterprising-Science/01Science-Capital.aspx>
- Evers, M. (2012). *Participation in flood risk management: An introduction and recommendations for implementation*. Karlstad: Centrum för klimat och säkerhet, Karlstads universitet.
- Falk, J.H. & Dierking, L.D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Lanham: AltaMira Press.

- Falk, J.H., Moussouri, T. & Coulson, D. (1998). The effect of visitors' agendas on museum learning. *Curator: The Museum Journal*, 41 (2), pp. 107–120.
- Faria, C., Boaventura, D. & Guilherme, E. (2020). Personal meaning maps as an assessment tool for a planetarium session: A study with primary school children. *Education, 3-13*, 48 (1), pp. 66–75.
- Federal Emergency Management Agency (2020). *Hazard mitigation planning*. Risk Management [online]. Retrieved September 15, 2019, from <https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning>
- Fereday, J. & Muir-Cochrane, E. (2006). Demonstrating rigour using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5 (1), pp. 80–92
- Fletcher, A.J. (2017). Applying critical realism in qualitative research: Methodology meets method. *International Journal of Social Research Methodology*, 20 (2), pp. 181–194.
- Fletcher, S.M., Thiessen, J., Gero, A., Rumsey, M., Kuruppu & N., Willetts, J. (2013). Traditional coping strategies and disaster response: Examples from the South Pacific Region. *Journal of Environmental and Public Health* 2013, pp. 1–9.
- Floke, C. (2004). Traditional knowledge in social–ecological systems. *Ecology and Society*, 9 (3).
- Flutter, J. & Rudduck, J. (2004). *Consulting Pupils: What's in it for schools?* London; New York: RoutledgeFalmer.
- Fortner, R.W., Lee, J.-Y., Corney, J.R., Romanello, S., Bonnell, J., Luthy, B., Figuerido, C. & Ntsiko, N. (2000). Public understanding of climate change: Certainty and willingness to act. *Environmental Education Research*, 6 (2), pp. 127–141.
- Friedman, A.J. (2010). The evolution of the science museum. *Physics Today*, 63 (10), pp. 45–51.
- Fry, G.W. (2002). The evaluation of educational reform in Thailand. *Paper presented at the Second International Forum on Education Reform: Key Factors in Effective Implementation September 2-5, 2002, Thailand*, pp. 1–46.

- Fullan, M. (2007). *The new meaning of educational change*. 4th edn. New York: Teachers College Press.
- Funtowicz, S. & Ravetz, J. (2003). Post-Normal Science. *International Society for Ecological Economics, Internet Encyclopaedia of Ecological Economics*, pp. 1-10.
- Funtowicz, S. & Ravetz, J. (1997). Environmental problems, post normal-science, and extended peer communities. *Études et Recherches sur les Systèmes Agraires et le Développement, INRA*, pp. 169–175.
- Fusch, P.I. & Ness, L.R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report*, 20 (9), pp. 1408–1416.
- Gagnon, M., Jacob, J.D. & McCabe, J. (2015). Locating the qualitative interview: Reflecting on space and place in nursing research. *Journal of Research in Nursing*, 20 (3), pp. 203–215.
- Gale, E.L. & Saunders, M.A. (2013). The 2011 Thailand flood: Climate causes and return periods. *Weather*, 68 (9), pp. 233–237.
- Gandolfi, H.E. (2019). *Exploring and implementing an intercultural model of history of science to teach about nature of science*. PhD Thesis. London: University College London.
- Ganjanakhundee, S. (2020). *Social media and Thailand's struggle over public space*. Singapore: ISEAS-Yusof Ishak Institute, pp. 1-10.
- Ge, Y., Yang, G., Wang, X., Dou, W., Lu, X. & Mao, J. (2021). Understanding risk perception from floods: A case study from China. *Natural Hazards*, 105, pp. 3119–3140.
- Ghaderi, Z., Mat Som, A.P. & Henderson, J.C. (2015). When disaster strikes: The Thai floods of 2011 and tourism industry response and resilience. *Asia Pacific Journal of Tourism Research*, 20 (4), pp. 399–415.
- Given, L. (2008). Critical Realism. In *The SAGE encyclopedia of qualitative research methods*. Thousand Oaks: SAGE Publications, Inc., pp. 168–170.
- Gorski, P.S. (2013). "What is Critical Realism? And why should you care?" *Contemporary Sociology*, 42 (5), pp. 658–670.
- Gray, D. & Colucci-Gray, L. (2014). Globalisation and the Anthropocene: The reconfiguration of science education for a sustainable future. *Sisyphus - Journal of Education*, 2 (3), pp. 14-31.

- Grothmann, T. & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15 (3), pp. 199–213.
- Grothmann, T. & Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards*, 38 (1-2), pp. 101–120.
- Guha-Sapir, D., Vos, F., Below, R. & Ponserre Sylvain (2012). *Annual disaster statistical review 2011: The numbers and trends*. Brussels, Belgium: Centre for Research on the Epidemiology of Disasters (CRED). Retrieved May 29, 2019, from http://www.cred.be/sites/default/files/ADSR_2011.pdf
- Guillemin, M. & Gillam, L. (2004). Ethics, reflexivity, and “ethically important moments” in research. *Qualitative Inquiry*, 10 (2), pp. 261–280.
- Güney, B. (2012). Museum concept from past to present and importance of museums as centers of art education. *Procedia - Social and Behavioral Sciences*, 55, pp. 1250–1258.
- Gunter, B. & Wober, M. (1983). Television viewing and public perceptions of hazards to life. *Journal of Environmental Psychology*, 3, pp. 325–335.
- Gutwill, J.P. & Allen, S. (2010). Facilitating family group inquiry at science museum exhibits. *Science Education*, 94 (4), pp. 710–742.
- Hadjichambis, A. Ch. & Reis, P. (2020). Introduction to the conceptualisation of Environmental Citizenship for twenty first century education. In A. Ch., Hadjichambis, P., Reis, D., Paraskeva-Hadjichambi, J., Činčera, J., Boeve-de Pauw, N., Gericke & M. -C. Knippels, (Eds.), *Conceptualizing Environmental Citizenship for 21st century education, environmental discourses in Science Education*. Cham: Springer International Publishing, pp. 1-14.
- Hadjichambis, A.Ch., Reis & P., Paraskeva-Hadjichambi, D. (Eds.) (2019). *ENEC cost action report: European SWOT analysis on Education for Environmental Citizenship*. Lisbon: Institute of Education – University of Lisbon, Cyprus Centre for Environmental Research and Education & European Network for Environmental Citizenship – ENEC Cost Action.
- Hall, J.W., Dawson, R.J., Sayers, P.B., Rosu, C., Chatterton, J.B. & Deakin, R. (2003). A methodology for national-scale flood risk assessment.

- Proceedings of the Institution of Civil Engineers - Water and Maritime Engineering*, 156 (3), pp. 235–247.
- Hallinger, P. & Kantamara, P. (2010). Educational change in Thailand: Opening a window onto leadership as a cultural process. *School Leadership & Management*, 20 (2), pp. 189–205.
- Hancock, D.R. & Algozzine, R. (2016). *Doing case study research: A practical guide for beginning researchers*. 3rd edn. New York: Teachers College Press.
- Hansson, R.O., Noulles, D. & Bellovich, S.J. (1982). Knowledge, warning, and stress: A study of comparative roles in an urban floodplain. *Environment and Behavior*, 14 (2), pp. 171–185.
- Haraway, D. (1991). *Simians, cyborgs, and women: The reinvention of nature*. Abingdon, Oxon: Routledge, Taylor & Francis Group.
- Harding, S.G. (1991). *Whose science? Whose knowledge? Thinking from women's lives*. New York: Cornell University Press.
- Harmon-Jones, E., Peterson, H. & Vaughn, K. (2003). The dissonance-inducing effects of an inconsistency between experienced empathy and knowledge of past failures to help: Support for the action-based model of dissonance. *Basic and Applied Social Psychology*, 25 (1), pp. 69-78.
- Hawthorne, M. & Alabaster, T. (1999). Citizen 2000: Development of a model of environmental citizenship. *Global Environmental Change*, 9, pp. 25–43.
- Henriksen, E.K. & Frøyland, M. (2000). The contribution of museums to scientific literacy: Views from audience and museum professionals. *Public Understanding of Science*, 9 (4), pp. 393–415.
- Herschy, R.W. (1998). Population displacement due to dam construction. In *Encyclopedia of hydrology and lakes, Encyclopedia of Earth Science*. Netherlands: Springer, pp. 523–524.
- Hesse-Biber, S.N. & Leavy, P. (2010). *The practice of qualitative research*. 2nd edn. London: SAGE Publications.
- Hewitt, K. (1983). The idea of calamity in a technocratic age. In K. Hewitt (Ed.), *Interpretations of calamity from the viewpoint of human ecology, The risks & hazards series*. Boston: Allen & Unwin, pp. 3–32.
- Hicks, D. (2018). Why we still need a geography of hope. *Geography*, 103 (2), pp. 78–85.

- Hine, A. & Medvecky, F. (2015). Unfinished science in museums: A push for critical science literacy. *Journal of Science Communication*, 14 (02), pp. 1-14.
- Hines, J.M., Hungerford, H.R. & Tomera, A.N. (1987). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. *The Journal of Environmental Education*, 18 (2), pp. 1–8.
- Ho, M.-C., Shaw, D., Lin, S. & Chiu, Y.-C. (2008). How do disaster characteristics influence risk perception? *Risk Analysis*, 28 (3), pp. 635–643.
- Hodder, P. (2010). Out of the laboratory and into the knowledge economy: A context for the evolution of New Zealand science centres. *Public Understanding of Science*, 19 (3), pp. 335–354.
- Hodson, D. (2003). Time for action: Science education for an alternative future. *International Journal of Science Education*, 25 (6), pp. 645–670.
- Hofstede, G.H., Hofstede, G.J. & Minkov, M. (2010). *Cultures and organizations: Software of the mind: intercultural cooperation and its importance for survival*. 3rd edn. New York: McGraw-Hill.
- Holmes, H., Tangtongtavy, S. & Tomizawa, R. (2003). *Working with the Thais: A guide to managing in Thailand*. Bangkok: White Lotus Press.
- Honneth, A. (1992). *Kampt um anerkennung*. 1st edn. Suhrkamp, Frankfurt am Main: Suhrkamp-Taschenbuch Wissenschaft.
- Hooge, M. (2001). “Not for our kind of people”: The sour grapes phenomenon as a causal mechanism for political passivity. In P. Dekker & E. Uslander (Eds.), *Social capital and participation in everyday life*. London: Routledge, pp. 162–175.
- Hooper-Greenhill, E. (Ed.) (1995). *Museum, media, message, museums: New visions, new approaches*. London; New York: Routledge.
- Hoover, S.M., Strapp, C.M., Ito, A., Foster, K. & Roth, K. (2018). Teaching qualitative research interviewer skills: A developmental framework for social justice psychological research teams. *Qualitative Psychology*, 5 (2), pp. 300–318.
- Horton, D. (2003). Demonstrating environmental citizenship? A study of everyday life among green activists. *Presented at the Citizenship and the*

- Environment Workshop Environmental Politics Conference*, University of Newcastle, pp. 1–16.
- Horton, D. (2005). Demonstrating environmental citizenship? A study of everyday life among green activists. In A. Dobson & D. Bell (Eds.), *Environmental Citizenship*. Cambridge: The MIT Press.
- House of Lords (2000). *Science and technology - Third report*. Retrieved June 18, 2022, from <https://publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm>
- Hsieh, H.-F. & Shannon, S.E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15 (9), pp. 1277–1288.
- Huckle, J. (2014). Education for sustainability citizenship in Europe. *Open Citizenship*, 5 (1), pp. 32–47.
- Hudson, K. (1977). *Museums for the 1980s: A survey of world trends*. London: Macmillan.
- Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge; New York: Cambridge University Press.
- Hungerford, H.R. & Volk, T.L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21 (3), pp. 8–21.
- Hungspreug, S., Khao-uppatum, W. & Thanopanuwat, S. (2000). Flood management in Chao Phraya River basin. Presented at the International Conference, Bangkok: Kasetsart University.
- Impact Forecasting LLC (2011). *2011 Thailand floods event recap report*. Chicago: AON Benfield. Retrieved March 16, 2020, from http://thoughtleadership.aonbenfield.com/Documents/20120314_impact_forecasting_thailand_flood_event_recap.pdf
- International Council of Museums (2007). *ICOM definition of a museum*. Retrieved August 06, 2019, from <https://icom.museum/en/resources/standards-guidelines/museum-definition/>
- IPCC (2018). *Principles governing IPCC work*. Retrieved January 22, 2018, from <https://www.ipcc.ch/site/assets/uploads/2018/09/ipcc-principles.pdf>

- Janes, R.R. (2009). *Museums in a troubled world: Renewal, irrelevance or collapse?* Museum meanings. London: Routledge.
- Jang, L. & Wang, J. (2009). Disaster resilience in a Hakka community in Taiwan. *Journal of Pacific Rim Psychology*, 3 (2), pp. 55–65.
- Jenkins, E. (2000). Science for all': Time for a paradigm shift? In R. Millar, J. Leach & J. Osborne (Eds.), *Improving science education: The contribution of research*. Buckingham; Philadelphia: Open University Press, pp. 207–226.
- Joffe, H. (2003). Risk: from perception to social representation. *British Journal of Social Psychology*, 42 (1), pp. 55–73.
- Johnson, V.A., Ronan, K.R., Johnston, D.M. & Peace, R. (2014). Evaluations of disaster education programs for children: A methodological review. *International Journal of Disaster Risk Reduction*, 9 (2), pp. 107–123.
- Johnson, L. & Morris, P. (2010). Towards a framework for critical citizenship education. *The Curriculum Journal*, 21 (1), pp. 77-96.
- Kamolpattana, S. (2016). *Science museum explainer training: Exploring factors that influence visitor-explainer interaction*. PhD Thesis. Bristol: University of West of England.
- Kates, R.W. (1971). Natural hazard in human ecological perspective: hypotheses and models. *Economic Geography*, 47 (3), pp. 438-451.
- Kato, H., Asukai, N., Miyake, Y., Minakawa, K. & Nishiyama, A. (1996). Post-traumatic symptoms among younger and elderly evacuees in the early stages following the 1995 Hanshin-Awaji earthquake in Japan. *Acta Psychiatrica Scandinavica*, 93 (6), pp. 477–481.
- Kaushik, R. (1997). Science education: Attitude development in science museums/centres. *Nova Scotian Institute of Science*, 41 (3), pp. 115–126.
- Kellens, W., Terpstra, T. & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research, *Risk Analysis*, 33 (1), pp. 24–49.
- Keller, R.S. (2016). Keeping disaster human: Empathy, systematization, and the law. *Minnesota Journal of Law, Science & Technology*, 17 (1). pp. 1-69.
- Kellert, S. R., Metah, J. N., Ebbin, S. A. & Lichtenfeld, L. L. (2000). Community natural resource management: Promise, rhetoric, and reality. *Society & Natural Resources*, 13 (8), pp. 705–715.

- Kelly, L. (2007). *The interrelationships between adult museum visitors' learning identities and their museum experiences*. PhD Thesis. Sydney: University of Technology.
- Knocke, E.T. & Kolivras, K.N. (2007). Flash flood awareness in Southwest Virginia. *Risk Analysis*, 27 (1), pp. 155–169.
- Kollmann, E., Reich, C., Bell, L. & Goss, J. (2010). Using provocative questions to address societal health issues. *Museums & Social Issues*, 5 (2), pp. 175–190.
- Kollmann, E.K., Reich, C., Bell, L. & Goss, J. (2013). Tackling tough topics: Using socio-scientific issues to help museum visitors participate in democratic dialogue and increase their understandings of current science and technology. *Journal of Museum Education*, 38 (2), pp. 174–186.
- Kondolf, G.M. (1997). Hungry water: Effects of dams and gravel mining on river channels. *Environmental Management*, 21 (4), pp. 533–551.
- Korstjens, I. & Moser, A. (2018). Trustworthiness and publishing (part 4 of The practical guidance to qualitative research series). *European Journal of General Practice*, 24(1), pp. 120–124.
- Krishtalka, L. & Humphrey, P.S. (2000). Can natural history museums capture the future? *BioScience*, 50 (7), pp. 611-617.
- Kulp, S.A. & Strauss, B.H. (2019). New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. *Nature Communications*, 10 (1), pp. 1-12.
- Kuroda, M., Uwasu, M., Bui, X.-T., Nguyen, P.-D. & Hara, K. (2021). Shifting the perception of water environment problems by introducing “imaginary future generations”—Evidence from participatory workshop in Ho Chi Minh City, Vietnam. *Futures*, 126, pp. 1–12.
- La Loubère, S. de (1693). *A new historical relation of the kingdom of Siam (Du Royaume de Siam)*. London: T. Horne.
- Lane, R., Vanclay, F., Wills, J. & Lucas, D. (2007). Museum outreach programs to promote community engagement in local environmental issues. *Australian Journal of Public Administration*, 66 (2), pp. 159–174.
- Lang, C., Reeve, J. & Woollard, V. (Eds.) (2006). *The responsive museum: Working with audiences in the twenty-first century*. Aldershot; Burlington: Ashgate.

- Larkin, P.J., Dierckx de Casterlé, B. & Schotsmans, P. (2007). Multilingual translation issues in qualitative research: Reflections on a metaphorical process. *Qualitative Health Research*, 17 (4), pp. 468–476.
- Laska, S.B. (1990). Homeowner adaptation to flooding: An application of the general hazards coping theory. *Environment and Behavior*, 22 (3), pp. 320–357.
- Lawrence, M. & Tinkler, A. (2015). What can you learn about science in a natural history museum? *School Science Review*, 97 (358), pp. 68–73.
- Layton, D. (1986). Revaluing science education. In P. Tomlinson & M. Quinton (Eds.), *Values across the curriculum*. London: Falmer, pp. 158–178.
- Layton, D., Jenkins, E., Macgill, S. & Davy, A. (1993). *Inarticulate science? Perspectives on the public understanding of science and some implications for Science Education*. Driffield: Studies in Education.
- Lebel, L., Sinh, B.T., Garden, P., Seng, S., Tuan, L.A. & Truc, D.V. (2009). The promise of flood protection: Dikes and dams, drains and diversions. In F. Molle, T. Foran, & M. Kakonen (Eds.), *Contested waterscapes in the Mekong Region: Hydropower, livelihoods and governance*. London; Sterling: Earthscan, pp. 283–306.
- Lechowska, E. (2018). What determines flood risk perception? A review of factors of flood risk perception and relations between its basic elements. *Natural Hazards*, 94 (3), pp. 1341–1366.
- Lee, S. & Roth, W.-M. (2001). How ditch and drain become a healthy creek: Representations, translations and agency during the re/design of a watershed. *Social Studies of Science*, 31 (3), pp. 315–356.
- Levinson, R. (2010). Science education and democratic participation: An uneasy congruence? *Studies in Science Education*, 46 (1), pp. 69–119.
- Levinson, R., Paraskeva-Hadjichambi, D., Bedsted, B., Manov, B., Hadjichambis, A. Ch. (2020). Political dimensions of Environmental Citizenship. In: A. Ch. Hadjichambis, P. Reis, D. Paraskeva-Hadjichambi, J. Činčera, J. Boeve-de Pauw, N. Gericke & M. -C. Knippels (Eds.), *Conceptualizing Environmental Citizenship for 21st century education, environmental discourses in Science Education*. Cham: Springer International Publishing, pp. 17-28.

- Li, H. (2017). Rethinking vulnerability in the age of Anthropocene: Toward ecologizing education. *Educational Theory*, 67 (4), pp. 435–451.
- Lincoln, Y.S. & Guba, E.G. (2003). Paradigmatic controversies, contradictions, and emerging confluences. In N.K. Denzin & Y.S. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues*. Thousand Oaks: SAGE, pp. 253–291.
- Liu, S.-C. & Lin, H. (2018). Envisioning preferred environmental futures: Exploring relationships between future-related views and environmental attitudes. *Environmental Education Research*, 24 (1), pp. 80–96.
- López-Marrero, T. (2010). An integrative approach to study and promote natural hazards adaptive capacity: A case study of two flood-prone communities in Puerto Rico. *Geographical Journal*, 176 (2), pp. 150–163.
- López-Marrero, T. & Yarnal, B. (2010). Putting adaptive capacity into the context of people's lives: A case study of two flood-prone communities in Puerto Rico. *Natural Hazards*, 52 (2), pp. 277–297.
- Lu, D. & Flavelle, C. (2019). Rising seas will erase more cities by 2050, new research shows. *The New York Times [online]*. Retrieved October 30, 2019, from <https://www.nytimes.com/interactive/2019/10/29/climate/coastal-cities-underwater.html?fbclid=IwAR2iJriRQKhkEs9gxMRKuPYd9pQ29EIlv4sxG5jB9r1cdEKvSbmjsKKDMLw>
- Ludy, J. & Kondolf, G.M. (2012). Flood risk perception in lands “protected” by 100-year levees. *Natural Hazards*, 61 (2), pp. 829–842.
- Macdonald, S. & Silverstone, R. (1992). Science on display: The representation of scientific controversy in museum exhibitions. *Public Understanding of Science*, 1 (1), pp. 69–87.
- MacPhail, A. & Kinchin, G. (2004). The use of drawings as an evaluative tool: Students' experiences of sport education. *Physical Education & Sport Pedagogy*, 9 (1), pp. 87–108.
- Maldonado, J. (2014). A multiple knowledge approach for adaptation to environmental change: Lessons learned from coastal Louisiana's tribal communities. *Journal of Political Ecology*, 21 (1), pp. 61-82.
- Manandhar, S., Pratoomchai, W., Ono, K., Kazama, S. & Komori, D. (2015). Local people's perceptions of climate change and related hazards in

- mountainous areas of northern Thailand. *International Journal of Disaster Risk Reduction*, 11, pp. 47–59.
- Manyena, S.B. (2006). The concept of resilience revisited: The concept of resilience revisited. *Disasters*, 30 (4), pp. 434–450.
- Marinetto, M. (2003). Who wants to be an active citizen?: The politics and practice of community involvement. *Sociology*, 37 (1), pp. 103–120.
- Marjanovic, Z., Struthers, C.W. & Greenglass, E.R. (2012). Who helps natural-disaster victims? Assessment of trait and situational predictors. *Analyses of Social Issues and Public Policy*, 12 (1), pp. 245–267.
- Marks, D. (2015). The urban political ecology of the 2011 floods in Bangkok: The creation of uneven vulnerabilities. *Pacific Affairs*, 88 (3), pp. 623–651.
- Marome, W., Pholcharoen, T. & Wongpeng, N. (2017). Developing and using a board game as a tool for urban and social resilience and flood management planning in the Bangkok Metropolitan Region. *Urbanisation*, 2 (1), pp. 28–37.
- Marome, W.A. (2016). Enhancing adaptation to climate change by impact assessment of the flood in Bangkok. *Journal of Architectural/Planning Research and Studies*, 13 (2), 31–40.
- Mazda, X. (2004). Dangerous ground? Public engagement with scientific controversy. In D. Chittenden, G. Farmelo & B.V. Lewenstein (Eds.), *Creating connections: Museums and the public understanding of current research*. Walnut Creek: AltaMira Press, pp. 127–144.
- McCall, V. & Gray, C. (2014). Museums and the ‘new museology’: Theory, practice and organisational change. *Museum Management and Curatorship*, 29 (1), pp. 19–35.
- McEwen, L., Garde-Hansen, J., Holmes, A., Jones, O. & Krause, F. (2017). Sustainable flood memories, lay knowledges and the development of community resilience to future flood risk. *Transactions of the Institute of British Geographers*, 42 (1), pp. 14–28.
- McEwen, L. & Jones, O. (2012). Building local/lay flood knowledges into community flood resilience planning after the July 2007 floods, Gloucestershire, UK. *Hydrology Research*, 43 (5), pp. 675–688.

- McKenzie, B. (2010). *The climate crisis and the happy museum, climate action in culture and heritage [online]*. Retrieved July 14, 2022, from <http://ecoch.wordpress.com/2010/05/17/despair-and-the-happy-museum/>
- McKinley, E. & Fletcher, S. (2012). Improving marine environmental health through marine citizenship: A call for debate. *Marine Policy*, 36 (3), pp. 839–843.
- McManus, P.M. (1992). Topics in museums and science education. *Studies in Science Education*, 20 (1), pp. 157–182.
- Merriam, S.B. (1998). *Qualitative research and case study applications in education*. 2nd edn. San Francisco: Jossey-Bass Publishers.
- Merriam, S.B. & Simpson, E.L. (2000). *A guide to research for educators and trainers of adults*. 2nd edn. Malabar: Krieger Pub. Co.
- Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation*, The Jossey-Bass higher and adult education series. San Francisco: Jossey-Bass.
- Message, K. (2006). *New museums and the making of culture*. New York: Berg.
- Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook*. 2nd edn. Thousand Oaks: SAGE Publications.
- Miles, R. & Tout, A. (1992). Exhibitions and the public understanding of science. In J. Durant (Ed.), *Museums and the public understanding of science*. London: Science Museum in association with the Committee on the Public Understanding of Science.
- Miles, S.H. & Craddock, S. (2018). Ethics for the Anthropocene epoch. In *Encyclopedia of the Anthropocene*. Oxford: Elsevier, pp. 21–27.
- Miles, S.R. (2015). *Understanding the family visitor experience: How family accommodate agendas during a visit to a local interactive science centre.*, London: The University of London.
- Miller, S. (2010). Deficit model. In S. Priest (Ed.), *Encyclopedia of science and technology communication*. Thousand Oaks: SAGE Publications, Inc., pp. 208–209.
- Ministry of Finance and World Bank (2012). Thai flood 2011: Rapid assessment for resilient recovery and reconstruction planning. Retrieved May 29, 2022, from https://www.gfdrr.org/sites/default/files/publication/Thai_Flood_2011_2.pdf

- Mitchell, J.K. (1999). Megacities and natural disasters: A comparative analysis. *GeoJournal*, 49 (2), pp. 137–142.
- Mitchell, J.K. (1990). Human dimensions of environmental hazards: Complexity, disparity, and the search for guidance. In A. Kirby (Ed.), *Nothing to fear: Risks and hazards in American society*. Tucson: University of Arizona Press, pp. 131–175.
- Mitchell, T., Haynes, K., Hall, N., Choong, W. & Oven, K. (2008). The roles of children and youth in communicating disaster risk. *Children, Youth and Environments*, 18 (1), pp. 254–279.
- Molino Stewart (2007). *Roles and responsibilities for VICSES in flood education*. Retrieved April 29, 2022, from <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.956.3960&rep=rep1&type=pdf#:~:text=Under%20the%20Victorian%20State%20Emergency,all%2Dhazards%20emergency%20management%20planning>.
- Monte, T. & Reis, P. (2021). Design of a pedagogical model of Education for Environmental Citizenship in primary education. *Sustainability*, 13 (11), pp. 1-13.
- Moseley, C., Desjean-Perrotta, B. & Utley, J. (2010). The Draw-An-Environment Test Rubric (DAET-R): Exploring pre-service teachers' mental models of the environment. *Environmental Education Research*, 16(2), pp. 189–208.
- Moussouri, T. (1997). *Family agendas and family learning in hands-on museums*. PhD Thesis. Leicester: University of Leicester.
- Museum of Tomorrow, 2021a. *About the museum [online]*. Retrieved September 08, 2022, from URL <https://museudoamanha.org.br/en/about-the-museum>
- Museum of Tomorrow, 2021b. *EXHIBITIONS [online]*. Retrieved September 08, 2022, from URL <https://museudoamanha.org.br/en/exhibitions>
- Mustafa, D. (2009). Natural hazards. In N. Castree, D. Liverman, D. Demeritt & B. Rhoads, B. (Eds.), *A companion to environmental geography*. Chichester; Malden: Wiley-Blackwell, pp. 461–475.
- Mustafa, D. (2013). Hydro-politics on the basin scale in the Indus. In D. Mustafa (Ed.), *Water resource management in a vulnerable world: The hydro-hazardscapes of climate change*. London: I.B. Tauris.

- Nakano, G. & Yamori, K. (2021). Disaster risk reduction education that enhances the proactive attitudes of learners: A bridge between knowledge and behavior. *International Journal of Disaster Risk Reduction*, 66, pp. 1-9.
- Nash, N., Capstick, S., Whitmarsh, L., Chaudhary, I. & Manandhar, R. (2019). Perceptions of local environmental issues and the relevance of climate change in Nepal's Terai: Perspectives from two communities. *Frontiers in Sociology*, 4, pp. 1–18.
- National Science Museum (2019). *About NSM [online]*. Retrieved January 20, 2020, from <https://www.nsm.or.th/en/about-us/aboutnsm.html>
- Navas Iannini, A.M. (2018). *Public engagement with critical exhibitions: Insights from a Brazilian and a Canadian science museum*. PhD Thesis. Toronto: University of Toronto.
- Navas Iannini, A.M. & Pedretti, E. (2022). Museum staff perspectives about a sustainability exhibition: What do they tell us about scientific literacy? *International Journal of Science Education, Part B*, 12 (1), pp. 1–21.
- Navas-Iannini, A.M. & Pedretti, E. (2017). Preventing youth pregnancy: Dialogue and deliberation in a science museum exhibit. *Canadian Journal of Science, Mathematics and Technology Education*, 17 (4), p. 271–287.
- Newman, A., McLean, F. & Urquhart, G. (2005). Museums and the active citizen: Tackling the problems of social exclusion. *Citizenship Studies*, 9 (1), pp. 41–57.
- Newmann, F.M. (Ed.) (1992). *Student engagement and achievement in American secondary schools*. New York: Teachers College Press.
- Nigg, J. (1996). *The social impacts of physical processes: How do we manage what we can't control? (Preliminary paper 238)*. Disaster Research Center. Newark: University of Delaware Newark.
- Norris, F.H., Friedman, M.J., Watson, P.J., Byrne, C.M., Diaz, E. & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry: Interpersonal and Biological Processes*, 65 (3), pp. 207–239.
- Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F. & Pfefferbaum, R.L., (2008). Community resilience as a metaphor, theory, set of capacities, and

- strategy for disaster readiness. *American Journal of Community Psychology*, 41 (1-2), pp. 127–150.
- NSO, 2010. *Population and housing census 2010 [online]*. National Statistic Office, Thailand. Retrieved December 12, 2019, from http://web.nso.go.th/en/census/poph/cen_poph_10.htm
- Ockwell, D., Whitmarsh, L. & O'Neill, S. (2009). Reorienting climate change communication for effective mitigation: Forcing people to be green or fostering grass-roots engagement? *Science Communication*, 30 (3), pp. 305–327.
- OECD (2015). *Green growth in Bangkok, Thailand, OECD green growth studies [online]*. OECD. Retrieved April 12, 2020, from https://www.oecd-ilibrary.org/urban-rural-and-regional-development/green-growth-in-bangkok-thailand_9789264237087-en
- OECD (2007). *Ranking of the world cities most exposed to coastal flooding today and in the future: Executive summary*. Retrieved April 12, 2020, from <https://www.oecd.org/env/cc/39721444.pdf>
- Office of the Education Council (2017). *The National Scheme of Education B.E. 2560-2579 (2017-2036) [in Thai]*.
- Parry, S. (2009). Stem cell scientists' discursive strategies for cognitive authority. *Science as Culture*, 18, 89–114.
- Paton, D. (2006). Disaster resilience: integrating individual, community, institutional, and environmental perspectives. In D. Paton & D.M. Johnston (Eds.), *Disaster resilience: An integrated approach*. Springfield: Charles C Thomas, pp. 3–10.
- Paton, D., Johnston, D., Smith, L. & Millar, M. (2001). Responding to hazard effects: Promoting resilience and adjustment options. *Australian Journal of Emergency Management*, pp. 47–52.
- Payne, R.J. & Pigram, J.J. (1981). Changing evaluations of flood plain hazard: The hunter river valley, Australia. *Environment and Behavior*, 13 (4), pp. 461–480.
- Peacock, W.G., Brody, S.D. & Highfield, W. (2005). Hurricane risk perceptions among Florida's single family homeowners. *Landscape and Urban Planning*, 73 (2-3), pp. 120–135.

- Pedretti, E. (2002). T. Kuhn meets T. Rex: Critical conversations and new directions in science centres and science museums. *Studies in Science Education*, 37 (1), pp. 1–41.
- Pedretti, E. & Navas Iannini, A.M. (2020). *Controversy in science museums: Re-imagining exhibition spaces and practice*. London; New York: Routledge, Taylor & Francis Group.
- Pelz, B. (2020). *Chapter 12 interpretive research*. Research methods for the social sciences [online]. Retrieved June 15, 2020, from <https://courses.lumenlearning.com/suny-hccc-research-methods/chapter/chapter-12-interpretive-research/>
- Penning-Rowsell, E.C. (1996). Flood-hazard response in Argentina. *Geographical Review*, 86 (1), 72-90.
- Penuel, W.R., Allen, A.-R., Coburn, C.E. & Farrell, C. (2015). Conceptualizing research–practice partnerships as joint work at boundaries. *Journal of Education for Students Placed at Risk (JESPAR)*, 20 (1-2), pp. 182–197.
- Phanthuwongpakdee, N. (2016). *Living with floods: Moving towards resilient local-level adaptation in Central Thailand*. PhD Thesis. King's College London & National University of Singapore.
- Pimpa, N. (2012). Learning problems in transnational business education and training: The case of the MBA in Thailand. *International Journal of Training and Development*, 13 (4), pp. 262–279.
- Pooley, J.A., Cohen, L. & O'Conner, M. (2006). Links between community and individual resilience: Evidence from cyclone effected communities in Northwest Australia. In D. Paton & D. M. Johnston, D.M. (Eds.), *Disaster resilience: An integrated approach*. Springfield: Charles C Thomas.
- Pouliot, C. (2009). Using the deficit Model, public debate model and co-production of knowledge models to interpret points of view of students concerning citizens' participation in socioscientific issues. *International Journal of Environmental & Science Education*, 4 (1), pp. 49–73.
- Prachachat Online (2020). "Anutin" said Covid is not a big deal. For sure, we can manage, no lockdown. Covid-19 [online]. Retrieved February 12, 2021, from <https://www.prachachat.net/covid-19/news-569080>

- Pratruangkrai, P. (2012). *'Investors confident' on flood prevention [online]*. Retrieved March 15, 2020, from <https://www.nationthailand.com/Economy/30190961>
- Punch, K.F. (2009). *Introduction to research methods in education*. 1st edn. London: SAGE Publications Ltd.
- Quintão, C., Andrade, P. & Almeida, F. (2020). How to improve the validity and reliability of a case study approach? *Journal of Interdisciplinary Studies in Education*, 9 (2), pp. 273–284.
- Raaijmakers, R., Krywkow, J. & van der Veen, A. (2008). Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Natural Hazards*, 46 (3), pp. 307–322.
- Raks Thai Foundation (2014). *Voices of the children: Attitudes and opinions of children regarding disaster response and preparedness, research study on the 2011 floods in Thailand*. Bangkok: Raks Thai Foundation.
- Ramey-Gassert, L., Waberg III, H.J. & Walberg, H.J. (1994). Reexamining connections: Museums as science learning environments. *Science Education*, 78 (4), pp. 345–363.
- Ravetz, J. (2005). *The no-nonsense guide to science*. Oxford: New Internationalist/Verso.
- Rees, J.H., Klug, S. & Bamberg, S. (2015). Guilty conscience: Motivating pro-environmental behavior by inducing negative moral emotions. *Climatic Change*, 130 (3), pp. 439–452.
- Regmi, K., Naidoo, J. & Pilkington, P. (2010). Understanding the processes of translation and transliteration in qualitative research. *International Journal of Qualitative Methods*, 9 (1), pp. 16–26.
- Rennie, L.J. (2007). Learning science outside of school. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education*. Mahwah: Lawrence Erlbaum Associates.
- Rennie, L.J. & Williams, G.F. (2006). Communication about science in a traditional museum: Visitors' and staff's perceptions. *Cultural Studies of Science Education*, 1 (4), pp. 791–820.
- Riedinger, K. (2012). Family connections: family conversations in informal learning environments. *Childhood Education*, 88 (2), pp. 125–127.

- Robert Isaksen, K. (2016). Reclaiming rational theory choice as central: A critique of methodological applications of Critical Realism. *Journal of Critical Realism*, 15 (3), pp. 245–262.
- Saito, N. (2014). Challenges for adapting Bangkok's flood management systems to climate change. *Urban Climate*, 9, pp. 89–100.
- Samaranayake, M. (1996). Significance of participatory approaches in empowering people for sustainable development. In S. Bastian & N. Bastian (Eds.), *Assessing participation: A debate from South Asia*. Delhi: Konark Publishers, pp. 46–66.
- Sasipornkarn, E. (2020). *Thailand protests reveal growing generational gap on political issues*. Made for Minds [online]. Retrieved May 05, 2021, from <https://www.dw.com/en/thailand-protests-reveal-growing-generational-gap-on-political-issues/a-55410906>
- Schild, R. (2016). Environmental citizenship: What can political theory contribute to environmental education practice? *The Journal of Environmental Education*, 47 (1), pp. 19–34.
- Schusler, T.M., Krasny, M.E., Peters, S.J. & Decker, D.J. (2009). Developing citizens and communities through youth environmental action. *Environmental Education Research*, 15 (1), pp. 111–127.
- Science Museum Group (2020). *Inspiring futures: Strategic priorities 2017–2030: REISSUED 2020 (Plan)*. London: Science Museum Group, Retrieved April 18, 2021, from <https://www.sciencemuseumgroup.org.uk/wp-content/uploads/2020/05/SMG-Inspiring-Futures-May-2020.pdf>
- Science Museum Group (Great Britain), Archer, M. & Blatchford, I. (2017). *Science Museum Group annual report and accounts 2016-2017*. London: HM Government. Retrieved November 16, 2018, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/630058/SMG_RA_2016-17_INSIDE.PDF
- Scott, D. (2010). *Education, epistemology and critical realism*. New studies in critical realism and education. London; New York: Routledge.
- Scott, D. (1996). Methods and data in educational research. In *Understanding educational research*. London: Routledge, pp. 52–73.

- Seah, S., Martinus, M., Qian, A.S. & Jiahui, Q. (2020). *The Southeast Asia climate outlook: 2020 survey report*. Singapore: ISEAS-Yusof Ishak Institute.
- Seijger, C., Otter, H. S., van Tatenhove, J. & Dewulf, G. (2016). Socially robust knowledge in coastal projects. *Environmental Science & Policy*, 55, pp. 393-407.
- Shamsuddoha, Md. & Chowdhury, R.K. (2007). *Climate change impact and disaster vulnerabilities in the coastal areas of Bangladesh*. Dhaka: COAST Trust.
- Shaw, R. (2014). Overview of concepts: Education for Sustainable Development and Disaster Risk Reduction. In R. Shaw (ed.), *Education for Sustainable Development and Disaster Risk Reduction*. Tokyo: Springer.
- Shaw, R., Shiwaku Hirohide Kobayashi, K. & Kobayashi, M. (2004). Linking experience, education, perception and earthquake preparedness. *Disaster Prevention and Management: An International Journal*, 13 (1), pp. 39–49.
- Shettel, H.H. (1968). An evaluation of existing criteria for judging the quality of science exhibits. *Curator: The Museum Journal*, 11 (2), pp. 137–153.
- Shiwaku, K., Shaw, R., Chandra Kandel, R., Narayan Shrestha, S. & Mani Dixit, A. (2007). Future perspective of school disaster education in Nepal. *Disaster Prevention and Management: An International Journal*, 16 (4), pp. 576–587.
- Shrestha, A., Babel, M.S. & Weesakul, S. (2015). Integrated modelling of climate change and urban drainage. In A.K. Anal, P.A. Salam, S. Shrestha & M. van der Valk (Eds.), *Managing water resources under climate uncertainty: Examples from Asia, Europe, Latin America, and Australia*. Springer Water. Cham: Springer International Publishing, Imprint, Springer, pp. 89–103.
- Siddiqi, A. (2014). Climatic disasters and radical politics in Southern Pakistan: The non-linear connection. *Geopolitics*, 19 (4), pp. 885–910.
- Siegrist, M. & Gutscher, H. (2008). Natural hazards and motivation for mitigation behavior: People cannot predict the affect evoked by a severe flood. *Risk Analysis*, 28 (3), pp. 771–778.

- Singkran, N. (2017). Flood risk management in Thailand: Shifting from a passive to a progressive paradigm. *International Journal of Disaster Risk Reduction*, 25, pp. 92–100.
- Slovic, P. (1987). Perception of risk. *Science*, 236 (4799), pp. 280–285.
- Slovic, P. (2000). *The perception of risk, risk, society, and policy series*. London; Sterling: Earthscan Publications.
- Slovic, P., Fischhoff, B. & Lichtenstein, S. (1980). Facts and fears: Understanding perceived risk. In R.C. Schwing & W. A. Albers (Eds.), *Societal risk assessment: How safe is safe enough*. New York: Plenum Press.
- Slovic, P., Flynn, J.H. & Layman, M. (1991). Perceived risk, trust, and the politics of nuclear waste. *Science*, 254 (5038), pp. 1603–1607.
- Smederevac-Lalic, M., Finger, D., Kováč, I., Lenhardt, M., Petrovic, J., Djikanovic, V., Conti, D. & Boeve-de Pauw, J. (2020). Knowledge and environmental citizenship. In A.Ch. Hadjichambis, P. Reis, P., D. Paraskeva-Hadjichambi, J. Činčera, J. Boeve-de Pauw, N. Gericke & M.-C. Knippels (Eds.), *Conceptualizing Environmental Citizenship for 21st century education, environmental discourses in Science Education*. Cham: Springer International Publishing, pp. 69–82.
- Solomon, J. (2013). *Science of the people: Understanding and using science in everyday contexts*. London: Routledge/Taylor & Francis Group.
- Soren, B. & Armstrong, J. (2014). Qualitative and quantitative audience measures. In B. Lord & M. Piacente (Eds.), *Manual of museum exhibitions*. Lanham, Maryland: Rowman & Littlefield, pp. 40–53.
- Sörqvist, P., Langeborg, L., 2019. Why people harm the environment although they try to treat it well: An evolutionary-cognitive perspective on climate compensation. *Frontiers in Psychology*, 10, pp. 1-5.
- Speller, G. (2015). *Improving community and citizen engagement in flood risk management decision making, delivery and flood response* (R&D technical report). Bristol: Environmental Agency.
- Speller, G. & Ravenscroft, N. (2005). Facilitating and evaluating public participation in urban parks management. *Local Environment*, 10 (1), pp. 41–56.

- SPRING, 2022. *Traffy Fondue, report Bangkok issues: 29 days 50 thousand issues, 20 thousand has been solved [translated from Thai, online]*. Retrieved July 05, 2022, from <https://www.springnews.co.th/news/826483>
- Stake, R.E. (1995). *The art of case study research*. Thousand Oaks: SAGE Publications.
- Stake, R.E. (2005). Qualitative case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *The SAGE handbook of qualitative research*. Thousand Oaks: SAGE Publications, pp. 443–466.
- Stake, R.E. (2006). *Multiple case study analysis*. New York: The Guilford Press.
- Stapleton, S.R. (2015). Environmental identity development through social interactions, action, and recognition. *The Journal of Environmental Education*, 46 (2), pp. 94–113.
- Stern, P.C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56 (3), pp. 407–424.
- Stern, P.C. (2011). Contributions of psychology to limiting climate change. *American Psychologist*, 66 (4), pp. 303–314.
- Stocklmayer, S.M., Rennie, L.J. & Gilbert, J.K. (2010). The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education*, 46 (1), pp. 1–44.
- Stueber, K. (2019). *Measuring empathy*. Stanford encyclopedia of philosophy [online]. Retrieved July 05, 2022, from <https://plato.stanford.edu/entries/empathy/measuring.html>
- Sturgis, P. & Allum, N. (2004). Science in society: Re-evaluating the deficit model of public attitudes. *Public Understanding of Science*, 13 (1), pp. 55–74.
- Subhamitr, J.C. & Chen, K.T.N. (2013). On-site digital interpretations, a comparison of 3 museums in Bangkok, Thailand. *Interdisciplinary Studies Journal*, 5 (13), pp. 7–27.
- Sutoris, P. (2022). *Our environmental crisis requires political fixes, not technological ones*. Scientific America [online]. Retrieved March 29, 2022, from <https://www.scientificamerican.com/article/our-environmental-crisis-requires-political-fixes-not-technological-ones/>

- Takahashi, B., Tandoc, E.C., Duan, R. & Van Witsen, A. (2017). Revisiting environmental citizenship: The role of information capital and media use. *Environment and Behavior*, 49 (2), pp. 111–135.
- Takeuchi, Y. & Shaw, R. (2008). Traditional flood disaster reduction measures in Japan. In R. Shaw, N. Uy & Baumwoll, J. (Eds.), *Indigenous knowledge for disaster risk reduction: Good practices and lessons learned from experiences in the Asia-Pacific Region*. Bangkok: UNISDR Asia Pacific, pp. 23–26.
- Tanprasertkun, S. (2013). *Greenhouse gas mitigation potential of biogas generation from municipal solid waste and domestic wastewater in Thailand*. MSc Dissertation. Pathum Thani: Asian Institute of Technology.
- Tanwattana, P. & Murayama, H. (2014). Community planning and policy process for regional vitalization against a disaster: Thailand's readiness and experiences from Japan. *政策科学*, 21 (1), pp. 27–42.
- Tanwattana, P. & Toyoda, Y., (2018). Contributions of gaming simulation in building community-based disaster risk management applying Japanese case to flood prone communities in Thailand upstream area. *International Journal of Disaster Risk Reduction*, 27 (1), pp. 199–213.
- Texier, P. (2008). Floods in Jakarta: When the extreme reveals daily structural constraints and mismanagement. *Disaster Prevention and Management: An International Journal*, 17(3), pp. 8–372.
- Thai Safe Schools (2018). *Thai safe schools: Disaster risk reduction and climate change adaptation curriculum [translated from Thai, online]*. Retrieved May 05, 2021, form <https://thaisafeschools.com/>
- Thanvisitthpon, N., Shrestha, S. & Pal, I. (2018). Urban flooding and climate change: A case study of Bangkok, Thailand. *Environment and Urbanization ASIA*, 9 (1), pp. 86–100.
- Thapatiwong, A. (2011). *An empirical analysis of national culture and performance-related pay in multinational and local companies in Thailand*. PhD Thesis. Cardiff: Cardiff University.
- The Economist Intelligence Unit (2016). *Democracy Index 2015: Democracy in an age of anxiety [online]*. Retrieved July 01, 2021, form <https://www.yabiladi.com/img/content/EIU-Democracy-Index-2015.pdf>

- The Netherlands Embassy (2020). *Living with water [online]*. Retrieved January 3, 2021, from <https://nl.intheusa.com/living-with-water/>
- Tingsanchali, T. (2012). Urban flood disaster management. *Procedia Engineering*, 32, pp. 25–37.
- Tobin, G.A. & Montz, B.E. (1997). *Natural hazards: Explanation and integration*. New York: Guilford Press.
- Torry, W.I. (1979). Hazards, hazes and holes: A critique of the environment as hazard and general reflections on disaster research. *Canadian Geographer*, 23 (4), pp. 368–383.
- Trenberth, K.E., Fasullo, J.T. & Shepherd, T.G. (2015). Attribution of climate extreme events. *Nature Climate Change*, 5 (8), pp. 725–730.
- Trench, B. & Bucchi, M. (2010). Science communication, an emerging discipline. *Journal of Science Communication*, 9 (3), pp. 1-5.
- Trench, B. & Bucchi, M. (2015). Science communication research over 50 years: Patterns and trends. In B. Schiele, J. Le Marec & P. Baranger (Eds.), *Science communication today-2015: Current strategies and means of action*. Nancy: PUN-Éditions universitaires de Lorraine, pp. 15–27.
- Tressel, G.W. (1980). The role of museums in science education. *Science Education*, 64 (2), pp. 257–260.
- Tucker, C.M., Eakin, H. & Castellanos, E.J. (2010). Perceptions of risk and adaptation: Coffee producers, market shocks, and extreme weather in central America and Mexico. *Global Environmental Change*, 20 (1), pp. 23–32.
- UCL Data Protection Office (2018). *Research with children: Guidance on data protection issues*. Retrieved May 15, 2018, from https://www.ucl.ac.uk/data-protection/sites/data-protection/files/research_with_children_guidance.pdf
- Ullah, R., Suleman Rana, M., Qadir, M., Usman, M. & Ahmed, N. (2021). Coronavirus Pandemic: A major public health crisis for the developed and developing world. *The Journal of Infection in Developing Countries*, 15 (3), pp. 366–369.
- United Nations (2015). *Sendai framework for disaster risk reduction 2015 - 2030*. Geneva: United Nations Office for Disaster Risk Reduction.

- Retrieved September 15, 2019, from
https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf
- United Nations (2016). *Transforming our world: The 2030 agenda for sustainable development*. Retrieved June 14, 2022, from
<https://sustainabledevelopment.un.org/topics/disasterriskreduction>
- UNISDR (2004). *Living with risk - A global review of disaster reduction initiatives*. New York: United Nations.
- Usher, R. (1996). A critique of the neglected epistemological assumptions of education research. In D. Scott & R. Usher (Eds.), *Understanding Educational Research*. London: Routledge, pp. 9–32.
- van Oenen, G. (2002). Turning on the citizen: Modern citizenship and its cultural hazards. *Citizenship Studies*, 6 (2), pp. 109–125.
- Wachinger, G., Renn, O., Begg, C. & Kuhlicke, C. (2013). The risk perception paradox-implications for governance and communication of natural hazards: The risk perception paradox. *Risk Analysis* 33 (6), pp. 1049–1065.
- Waddell, E. (1977). The hazards of scientism: A review article. *Human Ecology*, 5 (1), pp. 69–76.
- Wade, R. (2008). Education for sustainability: Challenges and opportunities. *Policy and Practice: A Development Education Review*, 6 (Spring), pp. 30–48.
- Walsh, F. (2007). Traumatic loss and major disasters: Strengthening family and community resilience. *Family Process*, 46 (2), pp. 207–227.
- Watersnoodmuseum (2020). *The youth flood museum - Visiting the museum with your kids*. Watersnoodmuseum [online]. Retrieved July 14, 2020, from
<https://watersnoodmuseum.nl/en/the-youth-flood-museum/>
- Wehn, U., Rusca, M., Evers, J. & Lanfranchi, V. (2015). Participation in flood risk management and the potential of citizen observatories: A governance analysis. *Environmental Science & Policy*, 48, pp. 225–236.
- Weinstein, N.D. (1989). Effects of personal experience on self-protective behavior. *Psychological Bulletin*, 105 (1), pp. 31–50.
- Wellington, J. (1991). Newspaper science, school science: Friends or enemies? *International Journal of Science Education*, 13 (4), pp. 363–372.

- Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research*, 11 (3), pp. 351–374.
- Wilde, D., Hupe, A.L., Trahan, S., Abel, C.G., Longueval, S.K. & McLaughlin, C. (2021). *Rethinking food: Co-creating citizen science for sustainability transitions*. NORDES 2021: MATTERS OF SCALE. NORDES.
- Wisner, B., Blaikie, P., Cannon, T. & Davis, I. (1994). *At risk: Natural hazards, people's vulnerability, and disasters*. London; New York: Routledge.
- Wisner, B., Blaikie, P., Cannon, T. & Davis, I. (2004). *At risk: Natural hazards, people's vulnerability, and disasters*. 2nd edn. London; New York: Routledge.
- Wormald, D. (2018). *The impact of meeting scientists: A public engagement literature review*. London: National History Museum.
- Wynne, B. (1992). Public understanding of science research: New horizons or hall of mirrors? *Public Understanding of Science*, 1 (1), pp. 37–43.
- Yaneva, A., Rabesandratana, T.M. & Greiner, B. (2009). Staging scientific controversies: A gallery test on science museums' interactivity. *Public Understanding of Science*, 18 (1), pp. 79–90.
- Yin, R.K. (1984). *Case study research: Design and methods, applied social research methods series*. Beverly Hills: SAGE Publications.
- Yin, R. K. (2003). *Case study research: Design and methods*. 3rd edn. Thousand Oaks: SAGE Publications.
- Yin, R. K. (2013). *Case study research: Design and methods*. 5th edn. New York: SAGE Publications.
- Yin, R.K. (2017). *Case study research and applications: Design and methods*. 6th edn. Los Angeles: SAGE.
- Young, I.M. (2000). *Inclusion and democracy*. Reprint edn. Oxford political theory. Oxford: Oxford University Press.
- Young, J.C., Carsten Conner, L.D. & Pettit, E. (2020). 'You really see it': Environmental identity shifts through interacting with a climate change-impacted glacier landscape. *International Journal of Science Education*, 42 (18), pp. 3049–3070.

- Yucel, R. (2018). Scientists' ontological and epistemological views about science from the perspective of critical realism. *Science & Education*, 27 (5-6), pp. 407–433.
- Yuen, E., Jovicich, S.S. & Preston, B.L., (2013). Climate change vulnerability assessments as catalysts for social learning: Four case studies in south-eastern Australia. *Mitigation and Adaptation Strategies for Global Change*, 18 (5), pp. 567–590.
- Zaleskiewicz, T., Piskorz, Z. & Borkowska, A. (2002). Fear or money? Decisions on insuring oneself against flood. *Risk Decision and Policy*, 7 (3), pp. 221–233.
- Zhou, Q., Valiente, C. & Eisenberg, N. (2003). Empathy and its measurement. In S. J. Lopez & C. R. Snyder (Eds.), *Positive psychological assessment: A handbook of models and measures*. Washington: American Psychological Association, pp. 269–284.
- Ziman, J. (1991). Public understanding of science. *Science, Technology, & Human Values*, 16 (1), pp. 99–105.

Appendices

Appendix 1: Pressure and Release (PAR) model

The Pressure and Release (PAR) model proposed by Wisner et al. (1994) is one of the more influential models for assessing vulnerability in hazard research. As shown in Figure 1, the model aims to illustrate the succession of vulnerability from its 'root causes' to the 'unsafe conditions' (Wisner et al., 1994).

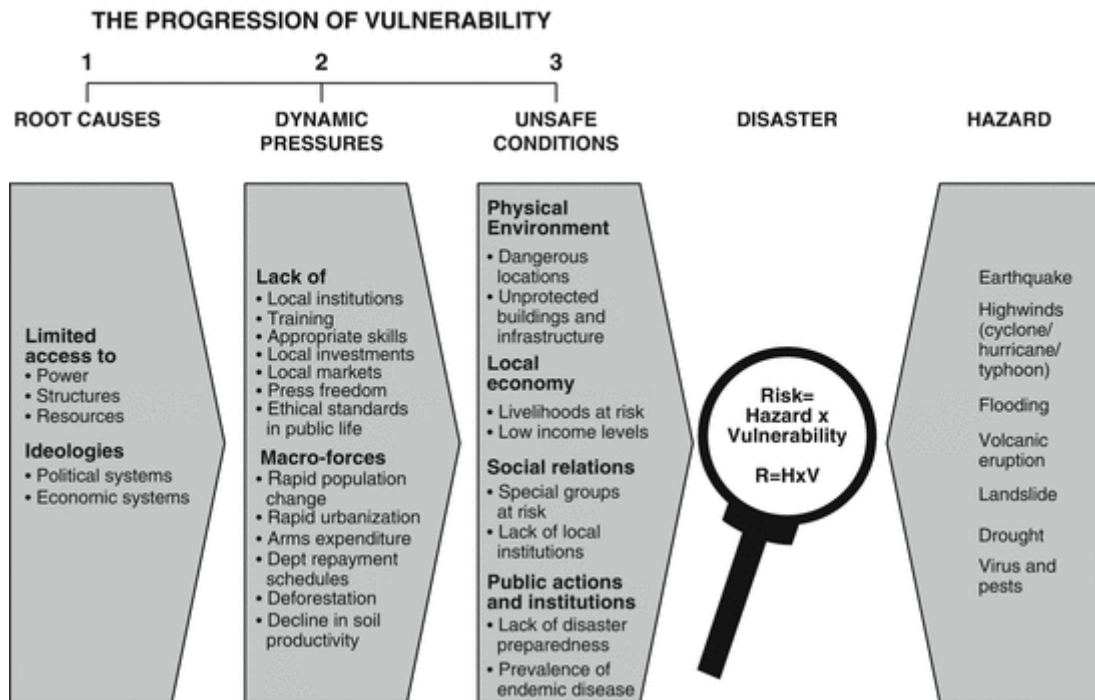


Figure 1. PAR model (Wisner et al., 1994, p.51)

Root Causes

The root causes create inequality in access to resources regarding economic and political processes that influence the distribution of resources for mitigating disaster risks. People who have limited access to such resources tend to be more vulnerable (Wisner et al., 1994). Marginalised people tend to be neglected by their government in order to deal with hazards. According to Wisner et al. (2004), because of limited power, marginal people are more likely to stop trusting their culture of safety and lose confidence in their abilities to deal with hazards. Thus, the root causes do not only disempower people materially but psychologically.

Dynamic Pressure

Dynamic pressures refer to processes and activities that are the effects of root causes leading to unsafe conditions (Wisner et al., 2004).

Unsafe conditions

Unsafe conditions are the explicit forms of vulnerability in terms of time and space in relation to hazards (Wisner et al., 2004).

Appendix 2: Research Ethics Application Form

Doctoral Student Ethics Application Form

Anyone conducting research under the auspices of the Institute of Education (staff, students or visitors) where the research involves human participants or the use of data collected from human participants, is required to gain ethical approval before starting. This includes preliminary and pilot studies. Please answer all relevant questions in simple terms that can be understood by a lay person and note that your form may be returned if incomplete.

Registering your study with the UCL Data Protection Officer as part of the UCL Research Ethics Review Process

If you are proposing to collect personal data i.e. data from which a living individual can be identified **you must be registered with the UCL Data Protection Office before you submit your ethics application for review**. To do this, email the complete ethics form to data-protection@ucl.ac.uk. Once your registration number is received, add it to the form* and submit it to your supervisor for approval.

If the Data Protection Office advises you to make changes to the way in which you propose to collect and store the data this should be reflected in your ethics application form.

Section 1 Project details			
a.	Project title	Environmental capital accumulation of Thai people toward flooding through a collaborative game in a science museum, Thailand	
b.	Student name and ID number (e.g. ABC12345678)	Supa Tanprasertkun (TAN15135421)	
c.	UCL Data Protection Registration Number	Z6364106/2018/07/92	
c.	Supervisor/Personal Tutor	Principal supervisor: Ralph Levinson Subsidiary Supervisor: Ruth Amos	
d.	Department	Curriculum Pedagogy and Assessment	
e.	Course category (Tick one)	PhD <input checked="" type="checkbox"/>	EdD <input type="checkbox"/>
		DEdPsy <input type="checkbox"/>	
f.	If applicable , state who the funder is and if funding has been confirmed.		
g.	Intended research start date	15 August 2018	
h.	Intended research end date	31 December 2019	
i.	Country fieldwork will be conducted in <i>If research to be conducted abroad please check www.fco.gov.uk and submit a completed travel risk assessment form (see guidelines). If the FCO advice is against travel this will be required before ethical approval can be granted: http://ioe-net.inst.ioe.ac.uk/about/profservices/international/Pages/default.aspx</i>	Thailand	

May 2018

j.	Has this project been considered by another (external) Research Ethics Committee?	
	Yes <input type="checkbox"/>	External Committee Name:
	No <input checked="" type="checkbox"/> ⇒ go to Section 2	Date of Approval:

If yes:

- Submit a copy of the approval letter with this application.
- Proceed to Section 10 Attachments.

Note: Ensure that you check the guidelines carefully as research with some participants will require ethical approval from a different ethics committee such as the [National Research Ethics Service \(NRES\)](#) or [Social Care Research Ethics Committee \(SCREC\)](#). In addition, if your research is based in another institution then you may be required to apply to their research ethics committee.

Section 2 Research methods summary (tick all that apply)

- | | |
|---|---|
| <input checked="" type="checkbox"/> Interviews | <input type="checkbox"/> Controlled trial/other intervention study |
| <input checked="" type="checkbox"/> Focus groups | <input type="checkbox"/> Use of personal records |
| <input checked="" type="checkbox"/> Questionnaires | <input type="checkbox"/> Systematic review ⇒ <i>if only method used go to Section 5.</i> |
| <input type="checkbox"/> Action research | <input type="checkbox"/> Secondary data analysis ⇒ <i>if secondary analysis used go to Section 6.</i> |
| <input checked="" type="checkbox"/> Observation | <input type="checkbox"/> Advisory/consultation/collaborative groups |
| <input checked="" type="checkbox"/> Literature review | <input type="checkbox"/> Other, give details: |

Please provide an overview of the project, focusing on your methodology. This should include some or all of the following: purpose of the research, aims, main research questions, research design, participants, sampling, data collection (including justifications for methods chosen and description of topics/questions to be asked), reporting and dissemination. Please focus on your methodology; the theory, policy, or literary background of your work can be provided in an attached document (i.e. a full research proposal or case for support document). *Minimum 150 words required.*

Research aim and questions

The research aim is to explore and investigate how environmental capital features regarding flood issues in Thailand might be shared and built amongst Thai visitors by using a flood-related collaborative game as a discussion platform in science museum contexts.

The research questions are:

- 1) How can environmental capital, in the context of a flood plain, be built through a collaborative game in a museum setting in Thailand?
- 2) What features of environmental capital are shared and expanded during and as a result of the game?
- 3) What aspects of environmental action are reflected on after the game?

Research Design

This research is a qualitative study. Qualitative based approaches will be used to investigate environmental capital accumulation amongst Thai visitors while they are participating in a flood-related collaborative game in a science museum in Thailand. To gain an in-depth understanding of how the visitors participate in the game activity, methodological approaches based on interpretative approaches which involve gathering data from video-based observations, conversation audio-records, observations, and interviews

will be employed.

The research consists of two phases: the preliminary study and the main study. The preliminary study aims to identify and select a suitable game which will be used as a discussion platform in the main study and get to know how museum visitors typically behave before implementing the activity. The summary of data collection methods involved participants and purposes of each method are presented in Table 1.

Summary of data collection methods

Table 1 Research data collection methods, involved participants and purposes of each method

Methods and tools	Involved participants	Purposes
1. The preliminary study phase (see the research instruments for the preliminary study in Appendix 1)		
1.1 Non-participant observation (field note taking)	Thai visitors to a science museum (could include families, adults, school students)	To understand learning processes, visitors' behaviours and visitor-visitor and visitor-staff interactions during their visits
1.2 Semi-structured interviews (audio-recording)	Thai visitors to a science museum (could include families, adults, school students)	To explore the visitors': - agenda and expectation of their visits - demographic information - perceptions and experiences related to flood issues and flood education in Thailand - expectations and interests in flood education programmes in a science museum setting
	Stakeholders in flood risk mitigation, flood education, and museum education	To gain a better understanding of the field of flood risk mitigation, flood education, and museum education in Thailand from the experts' perspective (the term 'experts' include local people who experienced flood situations, curriculum developers and local authorities who are responsible for flood mitigation etc.
2. The main study phase (see the research instruments for the main study in Appendix 2)		
2.1 Participant observation and focus group interview (audio- and video-recording, photographing and field note taking)	20 groups of Thai visitors who participate in the flood-related collaborative game activities	To explore: - what environmental capital features regarding flood issues are shared and built during the activity (if there are any) - how can these features be shared and built through social interactions during the activity

Methods and tools	Involved participants	Purposes
2. Main research data collection phase (Con.)		
2.2 Short questionnaire survey	Thai visitors who participate in the flood collaborative game activities	<ul style="list-style-type: none"> - To gather demographic information for the participants - To obtain activity feedback from the participants' perspective. - To obtain contact information of the participants for future purposes such as sending thanks and research findings, and follow-up interviews
2.4 Follow-up interview: semi-structured interview (if necessary and possible, audio recording)		To clarify and confirm points that may emerge during the activity and questionnaire surveys

Data analysis

The raw data will be managed. The field notes will be rewritten as soon as I can, and audio records will be transcribed. The managed data and video records will be analysed using thematic analysis that will consist on finding common themes and looking for absences regarding the research questions, theoretical framework and the data themselves.

Section 3 Research Participants (tick all that apply)

- | | |
|---|--|
| <input type="checkbox"/> Early years/pre-school | <input checked="" type="checkbox"/> Adults <i>please specify below</i> |
| <input checked="" type="checkbox"/> Ages 5-11 | <input type="checkbox"/> Unknown – specify below |
| <input checked="" type="checkbox"/> Ages 12-16 | <input type="checkbox"/> No participants |
| <input checked="" type="checkbox"/> Young people aged 17-18 | |

NB: Ensure that you check the guidelines carefully as research with some participants will require ethical approval from a different ethics committee such as the [National Research Ethics Service](#) (NRES) or [Social Care Research Ethics Committee](#) (SCREC).

Section 4 Security-sensitive material (only complete if applicable)

Security sensitive research includes: commissioned by the military; commissioned under an EU security call; involves the acquisition of security clearances; concerns terrorist or extreme groups.

a.	Will your project consider or encounter security-sensitive material?	Yes <input type="checkbox"/> *	No <input type="checkbox"/>
b.	Will you be visiting websites associated with extreme or terrorist organisations?	Yes <input type="checkbox"/> *	No <input type="checkbox"/>
c.	Will you be storing or transmitting any materials that could be interpreted as promoting or endorsing terrorist acts?	Yes <input type="checkbox"/> *	No <input type="checkbox"/>

* Give further details in **Section 8 Ethical Issues**

Section 5 Systematic reviews of research (only complete if applicable)

a.	Will you be collecting any new data from participants?	Yes <input type="checkbox"/> *	No <input type="checkbox"/>
b.	Will you be analysing any secondary data?	Yes <input type="checkbox"/> *	No <input type="checkbox"/>

* Give further details in **Section 8 Ethical Issues**

If your methods do not involve engagement with participants (e.g. systematic review, literature review) **and** if you have answered **No** to both questions, please go to **Section 8 Attachments**.

Section 6 Secondary data analysis (only complete if applicable)

a.	Name of dataset/s		
b.	Owner of dataset/s		
c.	Are the data in the public domain?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
		If no, do you have the owner's permission/license?	
		Yes <input type="checkbox"/>	No* <input type="checkbox"/>
d.	Are the data anonymised?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
		Do you plan to anonymise the data?	Yes <input type="checkbox"/> No* <input type="checkbox"/>
		Do you plan to use individual level data?	Yes* <input type="checkbox"/> No <input type="checkbox"/>
		Will you be linking data to individuals?	Yes* <input type="checkbox"/> No <input type="checkbox"/>
e.	Are the data sensitive (DPA 1998 definition)?	Yes* <input type="checkbox"/>	No <input type="checkbox"/>
f.	Will you be conducting analysis within the remit it was originally collected for?	Yes <input type="checkbox"/>	No* <input type="checkbox"/>
g.	If no , was consent gained from participants for subsequent/future analysis?	Yes <input type="checkbox"/>	No* <input type="checkbox"/>
h.	If no , was data collected prior to ethics approval process?	Yes <input type="checkbox"/>	No* <input type="checkbox"/>

* Give further details in **Section 8 Ethical Issues**

If secondary analysis is only method used **and** no answers with asterisks are ticked, go to **Section 9 Attachments**.

Section 7 Data Storage and Security

Please ensure that you include all hard and electronic data when completing this section.

a.	Data subjects - Who will the data be collected from? Thai visitors to a science museum (families, adults, adolescents, children) and key persons from flood risk mitigation/flood education/science museum education fields
----	---

b. **What data will be collected?** Please provide details of the type of personal data to be collected

Participants	Personal data to be collected
Thai visitors	Their want-to-be-called name*, contact information (if they are willing to offer) and demographic data (e.g. living area, career, education, and age)
Museum staff	Their want-to-be-called name* and contact information
Key persons in flood risk mitigation/flood education/science museum education fields	Their want-to-be-called name* and contact information (obtain from researching and snowball shambling technique)

Remark: *The participants' want-to-be-called names will be used only during the data collection process to create a friendly and relaxed environment. Then, a pseudonym will be assigned to each participant immediately after the data collection is finished. This is to reduce the chances of them being identified.

Disclosure – Who will the results of your project be disclosed to?

I will be the only person with access to the original data collected. The anonymised data will be shared with my supervisors who are necessarily involved with the research data analysis. In the case that I need to mention specific participants to report the research findings, pseudonyms will be used.

The final findings of my research will be disclosed in my thesis, academic publications and presentations at academic events. In addition, I will give the final report of the findings to the participants and the museum at the end of the project.

Data storage – Please provide details on how and where the data will be stored i.e. UCL network, encrypted USB stick*, encrypted laptop* etc.

The digital data will be encrypted and kept on password-protected devices: encrypted laptop, USB stick and UCL network. Printed paperwork, including field notes and consent letters, will be kept in lockable drawers. All records will be anonymised, and the lists of original names and pseudonyms will be kept in separate secure storages.

*Advanced Encryption Standard 256 bit encryption which has been made a security standard within the NHS

e. **Data Safe Haven (Identifiable Data Handling Solution) – Will the personal identifiable data collected and processed as part of this research be stored in the UCL Data Safe Haven (mainly used by SLMS divisions, institutes and departments)?** Yes No

How long will the data and records be kept for and in what format?

The personal data, e.g. contact information, will be destroyed immediately after successfully completing my PhD.

The rest of the original data and prepared data, e.g. interview transcripts, will be kept for 10 years after successfully completing my PhD. All the digital data will be stored in password-protected devices and printed materials will be kept in lockable drawers. Then, all the data will be destroyed.

Will personal data be processed or be sent outside the European Economic Area? (If yes, please confirm that there are adequate levels of protections in compliance with the DPA 1998 and state what these arrangements are:

No. It will not be.

Will data be archived for use by other researchers? (If yes, please provide details.)

No, the data will not be used by other researchers.

Section 8 Ethical issues

Please state clearly the ethical issues which may arise in the course of this research and how will they be addressed.

All issues that may apply should be addressed. Some examples are given below, further information can be found in the guidelines. *Minimum 150 words required.*

- | | |
|--|--|
| <ul style="list-style-type: none">- Methods- Sampling- Recruitment- Gatekeepers- Informed consent- Potentially vulnerable participants- Safeguarding/child protection- Sensitive topics | <ul style="list-style-type: none">- International research- Risks to participants and/or researchers- Confidentiality/Anonymity- Disclosures/limits to confidentiality- Data storage and security both during and after the research (including transfer, sharing, encryption, protection)- Reporting- Dissemination and use of findings |
|--|--|

I consider that there may be ethical issues that might arise from conducting the study. The data collection methods: observing, audio- and video-recording and asking for the research participants' personal data etc., data storage and usage may cause discomfort to the participants. The research participants might feel insecure, especially the Thai visitors who are under 18 years old. To mitigate the issues that might arise, the procedure presented below will be used.

Recruitment and gatekeepers

- Recruiting Thai visitors and science museum staff

As the main participants are Thai visitors in a science museum and science museum staff, it is important to get permission from the museum director to approach their visitors and staff. In order to get the permission, I will conduct my research in one science museum in Thailand where I already have a connection with the museum director. I informally contacted her and talked about my research with her a few times. She has shown interest in supporting my research. A month before going to collect the data, I will email her to inform her about my data collection plan in brief and arrange a personal meeting with her when I arrive in Thailand to talk about my research plan in detail and obtain consent for conducting my research in the setting. (See Appendix 1 for the letter and consent form for the science museum director)

Once the permission is obtained, I will use an opt-in approach to recruit Thai visitors and museum staff. For Thai visitors, I will approach them (walk-in visitors) at the museum entrance and invite them to participate in my research. I will inform them about my research (See Appendix 4.1, 4.2, 5.1 and 5.2 for the information sheet for museum visitors) and ask their consent (See Appendix 4.4 and 5.4 for the participant consent forms). Parental consent will be asked for the participants who are under 18 years old (See Appendix 4.5 and 5.5 for the parental consent forms). For the young participants, I will inform them about my research by using the research information sheet for children (Appendix 4.2 and 5.2). In the case that I have to invite the museum visitors in advance, the research information sheets will be sent through email with an invitation letter.

Similar to recruiting the visitors, an opt-in approach will be used to recruit the museum staff. When I get the museum staff contacts from the museum director, I will arrange a personal meeting with them to explain my research and their role in my research (See Appendix 5.3 for information sheet for museum staff). If they are willing to participate, I will ask for their consent by using the participant consent form (Appendix 5.4).

- recruiting key persons in flood risk mitigation, flood education and science museum education fields

For key persons in flood risk mitigation, flood education and science museum education fields, I will contact and inform them about my research (see *Appendix 4.3 for the information sheet for flood stakeholders and museum educators*). This can be done through emails, telephone calls, or in meetings, depending on the contact information I get. Then, I will invite them to participate in my research. If they agree to participate, I will arrange an interview meeting and ask for their consent (*Appendix 4.4*) at the beginning of the interview. In case that the interviews will be conducted through a telephone calls or Skype calls (determined by interviewees' preferences, possibility of arranging a personal meeting and my safety), I will send and ask them to return the consent forms through emails.

I will make sure that I inform all target participants that their participation is voluntary: they do not have to take part in my research if they do not want to. They also can withdraw themselves from my research at any time. Selecting not to participate or withdrawing from my research will not affect them at all, especially their career path in the case of the museum staff.

Data collection methods

During the data collection process, the participants may feel uncomfortable as they are being observed, interviewed, and audio- and video-recorded. Therefore, apart from informing and obtaining the participants' consent as described above, it is crucial to establish a good rapport and a friendly, respectful, relaxed and safe environment to encourage open communication. The following measures will be taken:

- offer the participants a brief introduction about myself.
- remind the participants that they can decide to stop recording, being observed or interviewed at any time, and skip questions that they do not want to answer. Also, they are able to withdraw their participation up until December 2019. Their data will not be used in my research. Their decision will be respected and remain confidential. There will be no negative repercussions resulting from their decision.
- use language that is appropriate and not patronising.
- reassure the participants that I am a researcher who is genuinely interested in knowing and learning from them not an expert who will evaluate their answers.
- make sure the participants know how to contact me and my supervisors.

Disclosure and limits to confidentiality

To safeguard confidentiality and anonymity of the participants, I will be the only person with access to the original data. Video and audio records, and the audio transcripts will be strictly confidential. They will be encrypted and stored in my personal storages (password-protected devices, the UCL server and lockable drawers). During the course of the research, the anonymised data will not be available to any person beyond me and my supervisors. During analysing and presenting the research findings, if it is necessary to mention information from specific participants, pseudonyms will be used to protect the participants' confidentiality.

Data storage and security both during and after the research

The digital data will be encrypted and kept on password-protected devices: encrypted laptops, USB sticks and the UCL network. Printed materials: field notes, copies of the transcripts and consent letters, will be kept in lockable drawers. All records will be anonymised, and the lists of original names and pseudonyms will be kept in separate secure storages.

The personal data (e.g. contact information) will be destroyed immediately after successfully completing my PhD. The rest of the original data and prepared data (e.g. interview transcripts) will be kept for 10 years after successfully completing my PhD. After this period, all the data will be destroyed.

International research

Currently, there is no formal national regulation for conducting educational or social research in Thailand. The common practice is to obtain permission and consent from gatekeepers of the research settings and the research participants. This

is regularly done by providing clear information about the research and obtaining written informed consent. This means that I do not need further approval from a Thai committee or institution.

Risks to participants and/or researchers

The participants and I will not be exposed to any risky situations. During my fieldwork, I will ensure I take the proper safety measures. For myself as a researcher, being Thai in this case is an advantage as I already know the language and the culture.

The majority of the research fieldwork will be conducted in the museum setting and their office during open hours. The museum visitors will always be in the museum setting where the visitors’ safety is their priority throughout the process of the data collection. Also, children will be interviewed with their parent(s) present at all time. Therefore, there is very low risk for the participants and me during the data collection process in the setting.

Nevertheless, I consider that interviewing the stakeholders outside the museum setting may raise some risks to the interviewees and me. Hence, to mitigate this risk, I will arrange interview meetings in a safe environment: public and open spaces, where the interviewees and I feel safe and comfortable. If such places cannot be arranged, other interview methods such as a telephone interview or a Skype interview will be used instead. The telephone or Skype interviews will be recorded.

Section 9 Attachments Please attach the following items to this form, or explain if not attached

a.	Information sheets, consent forms and other materials to be used to inform potential participants about the research (<i>List attachments below</i>)	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
Attachments:			
Appendix 1: Research instruments for the preliminary study			
Appendix 2: Research instruments for the main study			
Appendix 3: Letter and consent form for the science museum director			
Appendix 4: Research information sheets and participant consent forms for the preliminary study			
Appendix 5: Research information sheets and participant consent forms for the main study			
If applicable/appropriate:			
b.	Approval letter from external Research Ethics Committee		Yes <input type="checkbox"/>
c.	The proposal ('case for support') for the project		Yes <input checked="" type="checkbox"/>
d.	Full risk assessment		Yes <input type="checkbox"/>

Section 10 Declaration

I confirm that to the best of my knowledge the information in this form is correct and that this is a full description of the ethical issues that may arise in the course of this project.

I have discussed the ethical issues relating to my research with my supervisor. Yes No
 I have attended the appropriate ethics training provided by my course. Yes No

I confirm that to the best of my knowledge:
 The above information is correct and that this is a full description of the ethics issues that may arise in the

course of this project.

Name	Supa Tanprasertkun
Date	28 th August 2018

Please submit your completed ethics forms to your supervisor for review.

Notes and references

Professional code of ethics

You should read and understand relevant ethics guidelines, for example:

[British Psychological Society](#) (2009) *Code of Ethics and Conduct*, and (2014) *Code of Human Research Ethics*

or

[British Educational Research Association](#) (2011) *Ethical Guidelines*

or

[British Sociological Association](#) (2002) *Statement of Ethical Practice*

Please see the respective websites for these or later versions; direct links to the latest versions are available on the Institute of Education <http://www.ucl.ac.uk/ioe/research/research-ethics>

Disclosure and Barring Service checks

If you are planning to carry out research in regulated Education environments such as Schools, or if your research will bring you into contact with children and young people (under the age of 18), you will need to have a Disclosure and Barring Service (DBS) CHECK, before you start. The DBS was previously known as the Criminal Records Bureau (CRB) . If you do not already hold a current DBS check, and have not registered with the DBS update service, you will need to obtain one through at IOE.

Ensure that you apply for the DBS check in plenty of time as will take around 4 weeks, though can take longer depending on the circumstances.

Further references

The www.ethicsguidebook.ac.uk website is very useful for assisting you to think through the ethical issues arising from your project.

Robson, Colin (2011). *Real world research: a resource for social scientists and practitioner researchers* (3rd edition). Oxford: Blackwell.

This text has a helpful section on ethical considerations.

Alderson, P. and Morrow, V. (2011) *The Ethics of Research with Children and Young People: A Practical Handbook*. London: Sage.

This text has useful suggestions if you are conducting research with children and young people.




Wiles, R. (2013) *What are Qualitative Research Ethics?* Bloomsbury.

A useful and short text covering areas including informed consent, approaches to research ethics including examples of ethical dilemmas.

Departmental use

If a project raises particularly challenging ethics issues, or a more detailed review would be appropriate, the supervisor **must** refer the application to the Department Research Ethics Coordinator (via ioe.researchethics@ucl.ac.uk so that it can be

submitted to the Research Ethics Committee for consideration. A departmental research ethics coordinator or representative can advise you, either to support your review process, or help decide whether an application should be referred to the REC. If unsure please refer to the guidelines explaining when to refer the ethics application to the IOE Research Ethics Committee, posted on the committee's website.

Student name	Supa Tanprasertkun	
Student department	Curriculum, Pedagogy and Assessment	
Course	RRDEDUSCUR01 - Research Degree: Curriculum, Pedagogy & Assessment	
Project title	Environmental capital accumulation of Thai people toward flooding through a collaborative game in a science museum, Thailand	
Reviewer 1		
Supervisor/first reviewer name	Dr. Ralph Levinson	
Do you foresee any ethical difficulties with this research?	No	
Supervisor/first reviewer signature		
Date	27.07.2018	
Reviewer 2		
Second reviewer name	Ms Ruth Amos,	Dr. Mark Hardman
Do you foresee any ethical difficulties with this research?	No	No, through discussion it is evident that ethics has been carefully considered.
Supervisor/second reviewer signature		
Date	30.07.18	
Decision on behalf of reviews		
Decision	Approved	<input checked="" type="checkbox"/>
	Approved subject to the following additional measures	<input type="checkbox"/>
	Not approved for the reasons given below	<input type="checkbox"/>
	Referred to REC for review	<input type="checkbox"/>
Points to be noted by other reviewers and in report to REC		
Comments from reviewers for the applicant		
<i>Once it is approved by both reviewers, students should submit their ethics application form to the Centre for Doctoral Education team: IOE.CDE@ucl.ac.uk.</i>		

Appendix 3: Climate Change Exhibition at the Science Museum

Data from my museum observation fieldnotes (September 10, 2018)

During the research data collection period, the Climate Change Exhibition was the only exhibition in the Science Museum that promoted environmental awareness and pro-environmental actions among their audience. The exhibition was set up in an open area together with the other three exhibitions (i.e. Thailand's geographical information, organic agriculture, and structures and buildings in Thailand).

The Climate Change Exhibition displayed three main themes of content: (1) the causes and impacts of climate change; (2) the scientific explanation of global warming; and (3) personal approaches to mitigate climate change issues (e.g. recycling and saving electricity). The content was presented (in Thai and English) to their audience using a one-way communication approach through the display of pictures, texts, and short video clips. Figure 2 shows a part of the exhibition that displayed the impacts of climate change.



Figure 2. Part of the Climate Change Exhibition that demonstrates the impacts of climate change.

In terms of the impacts, the exhibition focused mostly on the impacts of climate change around the world, such as coastal erosion (ice-covered coasts) in Siberia and Alaska and natural disasters (Hurricane Katrina) in the USA. There was only one display that stated the impact that is most pertinent to Thailand: the damage to archaeological sites due to sea-level rise.

'Archaeological Site Threatened

The ordination hall of Khun Samut Thara was a Temple in Samut Prakan, which used to sit about one km. from the shoreline, but not anymore. Today, seawater is clearly threatening to submerge the hall after coastal erosion has already submerged most parts of the temple's compound. The temple once spanned over more than 70 rai [~27.68 Acres] of land. But now, its area has covered just five to six rai [~2 Acres]. The temple has also lost its walk ways and access as a result of the invading seawater.'

*(Excerpts from the text panel of the exhibition,
Fieldnotes, September 10, 2018)*

Although the display highlighted sea-level rise issues, the link between climate change and flood risks in Bangkok Metropolitan Region, the location of the Science Museum, was not made explicit.

Appendix 4: Thai Public visitor's demographic questionnaire

General Information of museum visitors

[This information is collected for supporting the data analysis of academic and museum development only. The research participant could not be identified by the research findings]

1. Age Range (Years old)

- Less than 13 13 – 18 19 – 25 26 – 30
 31 – 40 41 – 50 51 – 60 More than 60

2. Gender

- Female Other
- Male Prefer not to answer

3. Level of Education

- Primary school Bachelor's degree in
- High school Master's degree in
- Vocational education PhD in.....
- Other (Please specify)

4. Occupation *(Please specify: e.g. teacher, farmer, student, house wife and retired)*

.....

5. When was your last visit to the museum?

- Never, this is my first time
- Within the past 6 months
- Within the past year
- More than 1 year

6. Your contact information *(not compulsory)*

*(The information in this section will be used to contact you just in the case that the researcher want to ask you to clarify your interview information or sending you the research findings (if you are interested) is **not compulsory** to answer.)*

Name

Tel. No.

E-mail.....

Appendix 5: Data collection instruments - participant child visitors

5.1 Drawing-and-explain task guideline

Themes	Topic/Questions
Introduction	<ul style="list-style-type: none"> - Introduce the interviewer's name and role as a PhD student - Ask if the child visitor(s) would like to participate in the drawing task to help improve the museum's practice - Ask the child visitor(s)'s guardians for permission to collect data from their child(ren) - Inform the child visitor(s) and their guardians that the conversation will be audio-recorded while data collection is taking place. - For those who agreed to participate, inform them of the research details, how their data will be used and stored, their rights to withdraw from the research (anytime until December 2019), and provide my contact card. - Make sure a consent form and a Thai public visitor's demographic questionnaire for each participant are filled out and signed by one of their guardians - Turn on my audio-recorder
<p style="text-align: center;">(I)</p> <p>Drawing</p> <p>[Using flood drawing sheet]</p>	<ul style="list-style-type: none"> - Provide each participant child visitor with a box of 24-colour crayons and a flood drawing sheet and ask them to draw about non-flooding and flooding. <p><u>Guiding question:</u></p> <p>(1) Based on your understanding, could you draw me what you think about non-flooding and flooding?</p> <ul style="list-style-type: none"> - Inform the participants that there is no right or wrong way to draw and they can spend as much time as they need - Take notes of parents' or guardians' influences
<p style="text-align: center;">(II)</p> <p>Drawing explanation</p>	<ul style="list-style-type: none"> - Ask the participants to explain their drawings <p><u>Guiding questions:</u></p> <p>(2) Could you explain what you have drawn here [in the flood sheet]?</p> <p>(3) What are the similarities and differences between non-flooding and flooding circumstances?</p> <p>Prompts [based on what they drew on the sheet]:</p> <p>Tell me more about...? What do you mean by...?</p> <p>Can you explain...? Why did... come to your mind?</p> <p>Can you tell me why you drew...?</p>

Themes	Topic/Questions
(III) Flood experiences	(4) Have you ever experienced flooding? If yes: - Could you tell me more about your flood experience? - Where did you encounter flooding? - How did flooding positively affect you? - How did flooding negatively affect you?
(IV) Museum visiting agenda and experience	(5) Why are you visiting the museum today? (6) Are there any exhibitions or activities you plan to visit? (7) Who are you here with? (8) When did you last visit this science museum?
Ending the data collection	- Inform the participants and their guardians that the data collection is finished - Thank them for their time and contributions - Ask if there is anything the participants would like to ask, comment on, or inform me

5.2 Blank flood drawing sheet (A4 size)

(non-flooding)		(flooding)	
Date	Code	Age	Gender

Appendix 6: Data collection instruments - participant adult visitors

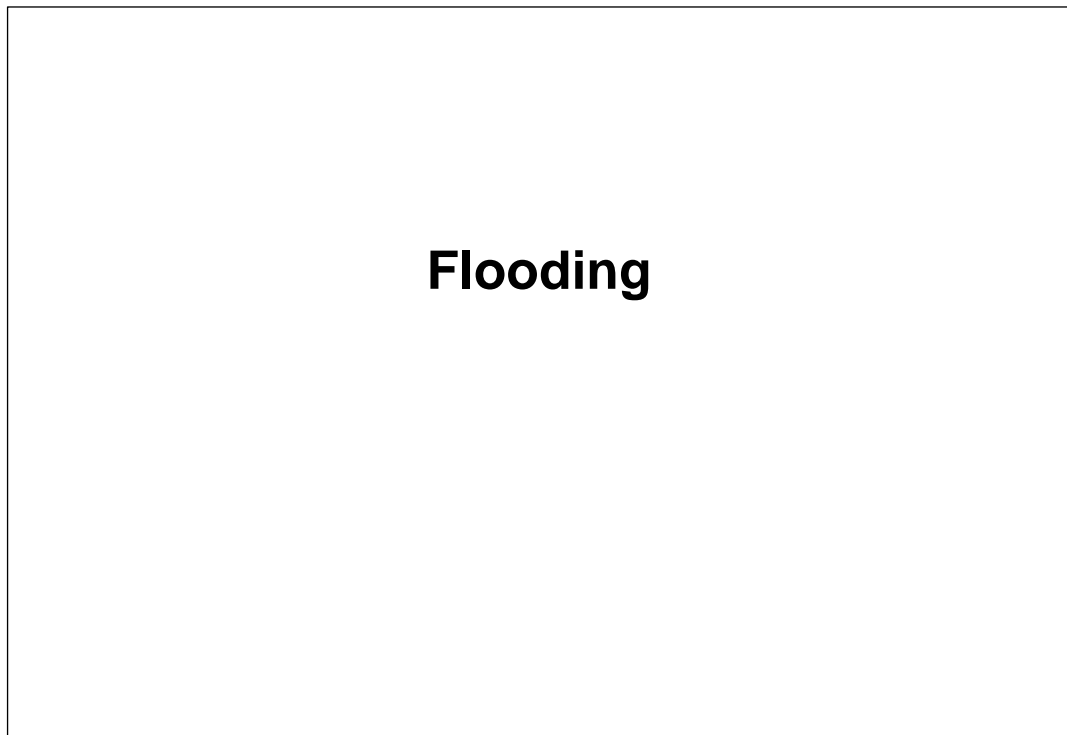
6.1 Data collection guidelines

Themes	Topic/Questions
Introduction	<ul style="list-style-type: none"> - Introduce the interviewer's name and role as a PhD student - Ask if they could be interviewed for about 30 minutes to help improve the museum practice - Inform the adult visitors that the conversation during data collection will be audio-recorded - For those who agreed to participate, inform them of the research details, how their data will be used and stored, their rights to withdraw from the research (anytime until December 2019), and provide my contact card - Make sure a consent form and a Thai public visitor's demographic questionnaire are filled out and signed by each participant - Turn on my audio-recorder
<p>(I)</p> <p>Museum visiting agenda and experiences</p> <p>[Ice-breaking]</p>	<p>(1) Why are you visiting the museum today?</p> <p>(2) Are there any exhibitions or activities you plan to visit?</p> <p>(3) Who are you here with?</p> <p>(4) When did you last visit this science museum?</p>
<p>(II)</p> <p>Flood experiences, perceptions of flooding issues, and engagement with FRM</p> <p>[Assist with flood PMM sheet]</p>	<p>(5) I would like to talk to you about flooding. What comes to your mind when you hear the word 'flood'?</p> <p>Using this sheet, I would like you to write words or phrases that you associate with flooding (blue pen).</p> <p>Prompts [based on what they write on the sheet]:</p> <p>Tell me more about...? What do you mean by...?</p> <p>Can you explain...? Why did... come to your mind?</p> <p>Can you tell me why you wrote...?</p> <p>(6) How do you relate to flooding?</p> <p>(7) Have you ever experienced flooding?</p> <p>If not, go to question (8)/ If yes:</p> <ul style="list-style-type: none"> - Could you tell me more about your flood experience? - Where did you encounter flooding? - How did flooding positively affect you?

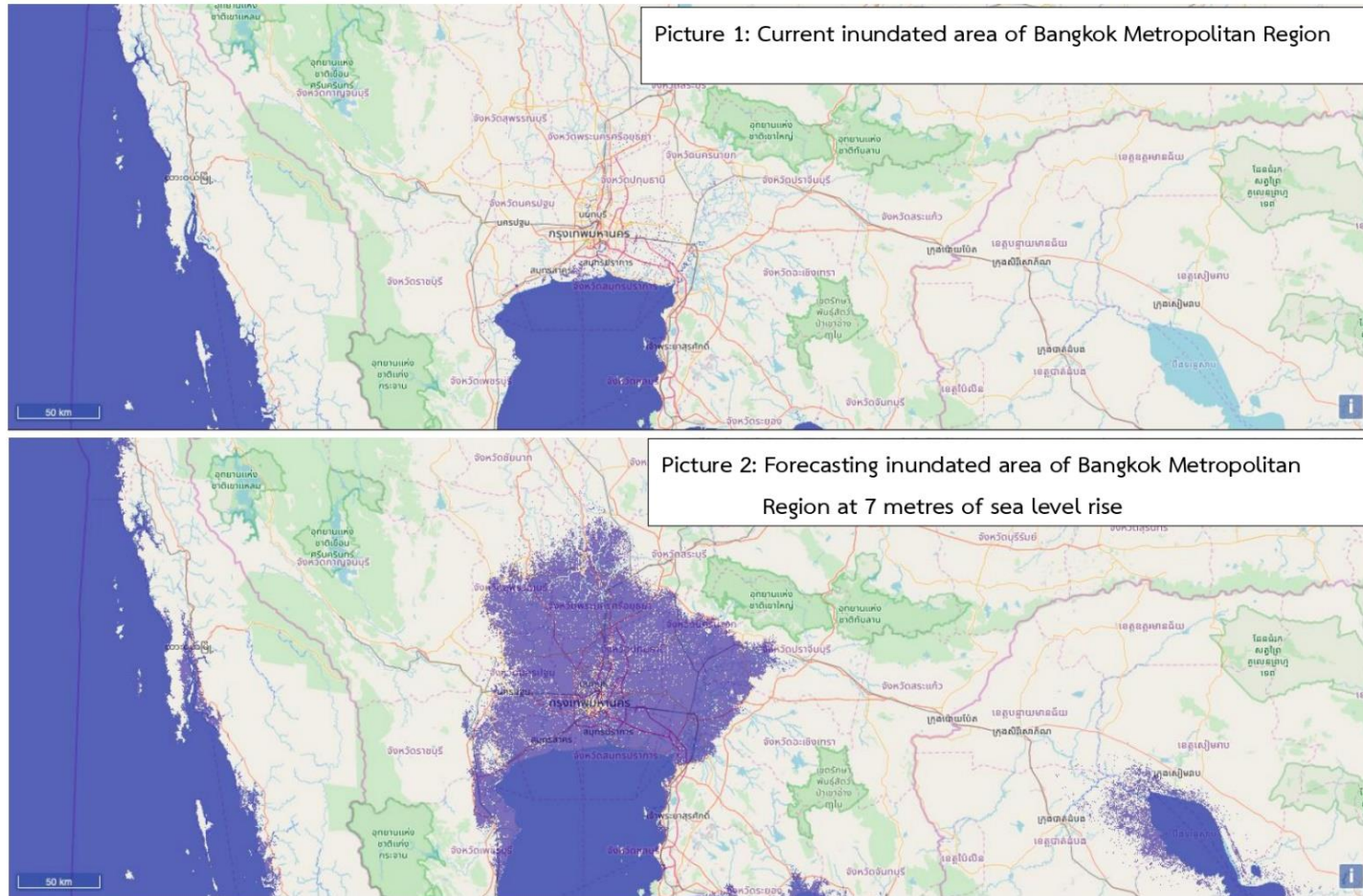
Themes	Topics/Questions
	<ul style="list-style-type: none"> - How did flooding negatively affect you? - How did you cope with the floods? - After the floods had gone, how did you recover to live normally? - In the past 10 years, how many times have floods happened in the area where you live? - In your opinion, what causes flooding issues? <p>(8) In your opinion, will a great flood like in 2011 happen again? Why? / Why not?</p> <p>(9) If it does happen, what would you like to do to mitigate flooding issues?</p> <p>(10) How do you relate to flooding issues?</p>
<p>(III)</p> <p>Desire to know/tell others about flooding issues</p>	<p>(11) If you could ask anyone three questions about flooding issues, what would they be?</p> <p>(12) Is there anything you want to tell other people about flooding issues?</p>
<p>(IV)</p> <p>Climate change perceptions</p>	<p>(13) Now, I would like to talk to you about 'climate change.' What comes to your mind when you hear the phrase 'climate change'?</p> <p>(14) How do you relate to climate change?</p> <p>(15) Have you ever been affected by climate change?</p>
<p>(V)</p> <p>Climate Change Exhibition visiting experience</p>	<p>(17) Have you visited the climate change exhibition today?</p> <p>Prompt [based on their answers]:</p> <p>If not, why not?</p> <p>If yes, - Which exhibits did you visit?</p> <p>- What do you think the exhibits are about?</p>
<p>(VI)</p> <p>Perceptions of the relationship between flooding and climate change issues</p>	<p>(18) What do you think when many researchers say that climate change will increase the frequency of severe flood events in Thailand?</p> <p>Introduce the participants with the map of the inundation prediction area in Bangkok at 7 metres of sea level rise, forecasted by NASA.</p>
<p>(VII)</p> <p>Desire to know/tell others about climate change</p>	<p>(19) If you could ask anyone three questions about climate change, what would they be?</p> <p>(20) Is there anything you want to tell other people about climate change?</p>

Themes	Topics/Questions
Post-interview reflection [Assist with flood PMM sheet]	(21) After our chat, is there anything you would like to add or amend on the flood sheet I gave you at the beginning of the interview? (red pen)
Ending the interview	<ul style="list-style-type: none">- Inform the participants that the interview is finished- Thank the participants for their time and contributions- Ask if there is anything the participants would like to ask, comment on, or inform me

6.2 Blank flood personal meaning map (PMM) (half A4 size)



6.3 Map of the inundation prediction area in Bangkok at 7 metres of sea level rise, forecasted by NASA



Appendix 4: Inundated area of Bangkok Metropolitan Region due to sea level rises

Data source : NASA, 2561 (<http://flood.firetree.net/?l=16.3412,97.3388&zoom=5>), accessed by 10 November 2018

According to World Bank's forecasting, 40 % of Bangkok Metropolitan Region area will be flooded in 2030 due to climate change impacts (Universe Current Affairs, 2018).

Appendix 7: An example of the participant child visitors' data set

Participant code: C.12

Gender: Male

Age (years old): 11 years old

non-flooding

flooding



Drawing explanation: (I = the interviewer)

I: Wow, look great. Can you tell me what you have drawn here?

C12: Flooding. When there is no flood, everything is plenteous. Water. If we do not damage forests, there will be no flood; trees will absorb water. If we cut trees, there will be no trees to prevent floods. Flood water will decrease slowly and cause property damage.

I: Is there any benefit from flooding?

C12: No, it damages property and causes loss of property.

I: Have you ever experienced flooding before?

C12: Hmm...yes.

I: How did that flooding last?

C12: About a month.

I: Is there anything else that causes floods, except deforestation?

C12: Climate change

I: How?

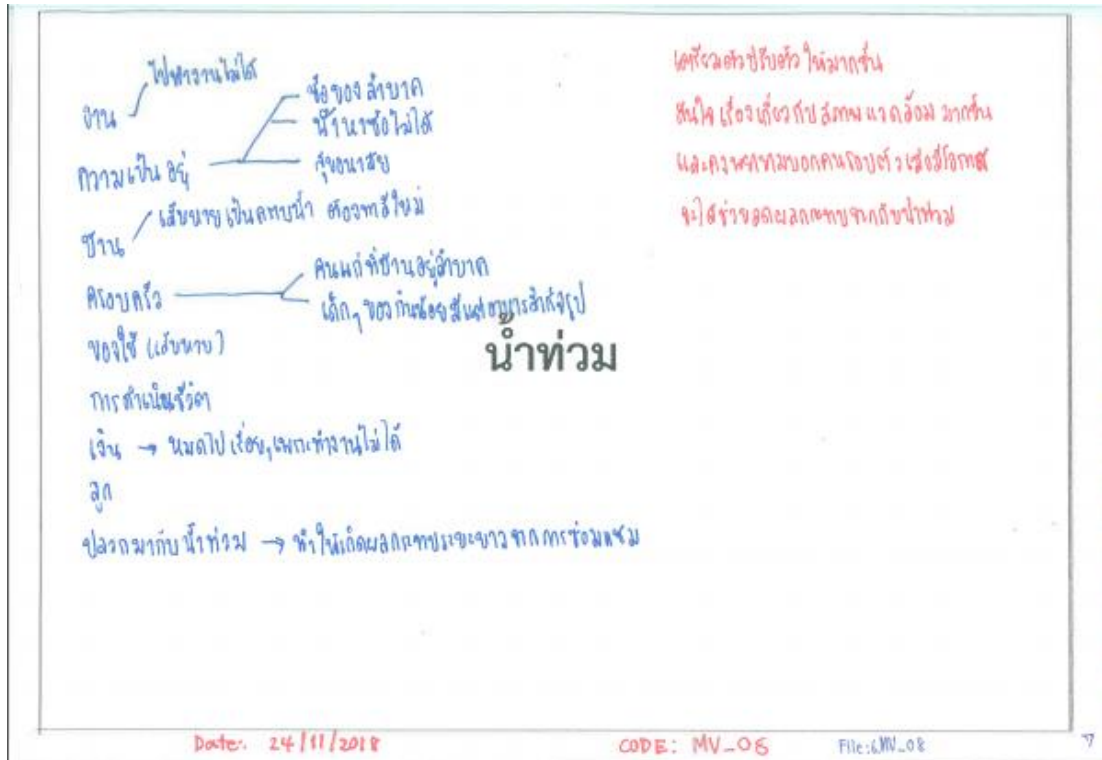
C12: [smile]....

I: It's okay. Is there anything you would like to tell me more about flooding?

C12: No. [smile].

Appendix 8: An example of the participant adult visitors' data set

8.1 MV.08's flood PMM (original)



8.2 MV.08's processed data

Note: The data below were just a part of MV.08's interview transcript.

Participant code: MV.08

General information

Age (Years old): 31-40

Gender: Female

Visiting Agenda: Take my son to visit, so he could stay away from his PC

Target activities: No

Visiting companion: My son

Living location: Pathum Thani

Interview themes and questions	Participant responses	Notes
2. Flood perception and experience		
2.1 Phrases/words on pre-interview flood PMM	Job/couldn't go to work Dwelling/difficulty in finding food and water/hygiene House dilapidation/flood marks/repainting Family/difficulty for the elderly and children to live/low food supplies/only instant food Utensils (damaged) Lifestyle Money/had to spend my savings because I lost my job	

	Children Termite issues/long-term house maintenance	
2.2 Clarifying words/phrases they had written	<p>MV.08: I was so upset about it [termite issues]; I took a chemical procedure to prevent termites when I built my house. They [termites] came with the flood. So, I had to rebuild my whole house. So, pissed off.</p> <p>MV.08: They [the government] dammed up floodwater to stay in my living area. In other areas, it flooded for a short time, no longer than a month. But in some areas, like Saimai, it flooded for a long time, more than a month or two. So, we could do nothing.</p> <p>[So how did you cope with the flood? Did you stay in the house the whole time?] MV.08: I travelled to other places, like Phuket and Nakorn Sawan. But I also went back home [in the flood-affected area] ...like back and forth. Because I had to work at Future Park (a shopping mall in the flood-affected area). They pumped out floodwater and opened as normal, so I had to go to work [even though her house and the surrounding area were still flooded]. So, I had to come to stay at my home [for work].</p> <p>[Why did you write the word "<i>Family</i>"?] MV.08: Family — the elderly and children. It was difficult for them to live during the flooding.</p> <p>[Water?] MV.08: Yes, I walked from Klong 2 to Klong 4 (more than 3.5 miles) to find drinking water. No shops or superstores were left open. So, I took empty bottles to get water from the water machines. It was so difficult. But my son didn't stay with me at that time. I sent him to stay with his grandfather at Klong 7. So, I didn't need to worry about him. I walked with my friends through the floodwaters to find food and water</p>	[] = interviewer's speeches

	supplies. There was no car. There were some military trucks or volunteers. If it passed us and still had some space available, we could get on. But normally we walked because we tried to save spaces [on the trucks] for the elderly and children.	
2.3 How do you relate to flooding issues?	MV.08: I might contribute to the causes of flooding, like littering, which may block the draining system. I'm trying to dispose of the trash in its place. But only me trying, it's not gonna work. Although I dispose of the trash correctly, other people, like garbage men, could unconsciously drop the trash when they are collecting the trash. The trash could be dropped into the drain system. It might be because we didn't pack our trash properly enough. So, the drains may be blocked, and the water may not drain. This [the littering issue] is a cause of flooding. Also, about taking care of the environment, because I am not strict about that so much.	Perceived herself as a cause of flooding issues by littering and not taking care of the environment seriously
2.4 Have you ever experienced flooding?	<p>MV.08: Yes, in 2011. There were so many problems at that time, such as cash machines didn't work. I've got money in my account but no cash. I couldn't take out my money because the machines were flooded. I got only a few 100-baths. Goods were so expensive; people took advantage.</p> <p>[Did many people stay at home at that time?]</p> <p>MV.08: A lot because people were worried about their houses; there were thieves. If houses had more than one floor, we could still cut the electricity on the first floor [which was flooded] and live on the other floors. But the first floor smelled dirty.</p> <p>MV.08: Floodwater came in so fast, like within 4-6 hours. At the beginning of the flood event, I went out to help people in other areas make sandbags because I thought that my house would not be flooded. So, I went out to help others. When I came back to my house, floodwater broke out into my house through the house drains. We could not even move out because it was dark already, about 7.00 pm.</p>	She did mention a lot as well in 2.2 above

	Floodwater broke out from our toilets and drains. My grandmother could not be evacuated because we had no working car. Our car was damaged because of the floods. I was so upset. It was like I had to start my life from the beginning again. But I comforted myself that being flooded was better than being on fire in which I might lose everything.	
9. Phrases/words on the post-interview flood PMM	Be more prepared for and adaptable to [floods] Pay more attention to the environment and will try to tell others when I have a chance to reduce the future flood impacts.	Intention to mitigate flooding issues: - to pay more attention to taking care of the environment - to tell others to mitigate flood risks when she has chances

Appendix 9: Drawing and drawing explanation analysis

Notice that drawing explanation data were used to triangulate the findings from the drawing item analysis.

Drawing item analysis				Number of the participant child visitors (n=18)	Identified perception of flooding (finding theme)
Drawing indication	Examples of Drawing (Attached at the end of this table)	Examples of drawing explanation	Code		
The drawing indicates water symbols cover all over human habitat in the flooding site.	C.08, C.10, C.11, C.15, C.19	<i>"Flooding...the city sink." (C17)</i>	Flooding covers most dwellings	13	Flood impacts
The damaged trees were drawn in the flooding site to replace the healthy trees in the non-flooding sites.	C.8, C.15, C.19	<i>"If there is no flooding, living things will be plenteous. and forest." (C12)</i>	Trees/nature were damaged when it floods	10	
The damaged things such as buildings, cars, and houses were depicted in the flooding site.	C.08	<i>"...[Flood] damages our things and properties." (C.08)</i> <i>"[In flooding circumstance,] things sank into the water and were damaged!" (C7)</i>	Properties/belongings were damaged when it floods	10	
The damaged vehicles (e.g., upside-down cars) were drawn in the flooding site.	C.08	<i>"[in flooding circumstance,] using cars is forbidden." (C.08)</i>	Flooding affects transport by vehicles	4	

Drawing item analysis					
Drawing indication	Examples of Drawing (Attached at the end of this table)	Examples of drawing explanation	Code	Number of the participant child visitors (n=18)	Identified perception of flooding (finding theme)
When compared to the non-flooding site, there are no agricultural products such as fruits and rice on its trees/fields in the flooding site.	C.19	<i>“When there is no flood, rice farmers won’t lose rice. If flood water comes, rice farmers won’t be able to plant rice. It will damage their product which results in losing their profit.” (C.19)</i>	Flooding affects agriculture	2	
The drawing indicates a larger volume of water symbols in the flooding site.	C.05, C.08, C.10, C.11, C.15, C.19	<i>“It [the two situations] differs because this one [non-flooding site] has less water than this one [flooding site].” (C.05)</i>	Flooding is having a higher amount of water on the earth’s surface	18	Describing what flooding is
The drawing indicates water symbols covers natural and man-made environment symbols (e.g., trees, buildings and cars) in the flooding site.	C.08, C.10, C.11, C.15, C.19	-	Flooding covers both natural and man-made environment	12	
Meanwhile, natural areas were selected to present the non-flooding site, urban or human habitats were depicted in the flooding site.	C.10, C.11	<i>“No flooding when the forest is plenteous.” (C.10)</i>	Flooding does not happen in natural areas	4	

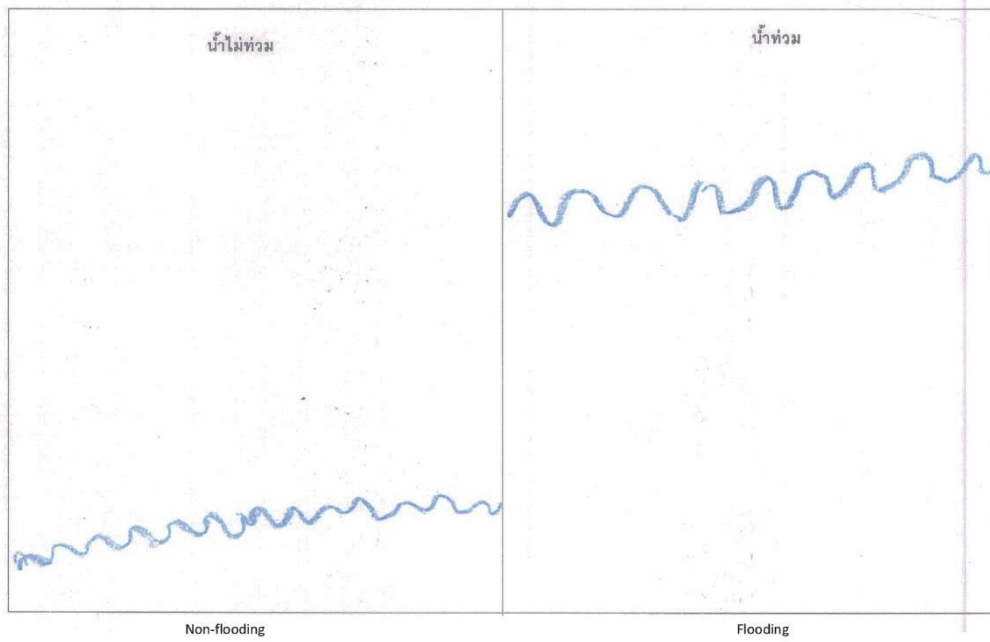
Drawing item analysis					
Drawing indication	Examples of Drawing (Attached at the end of this table)	Examples of drawing explanation	Code	Number of the participant child visitors (n=18)	Identified perception of flooding (finding theme)
The rural environment (e.g., rural houses and rice fields) was depicted to represent the flooding site.	C.11, C.19	<i>"I drew rice field here. It is usually flooded." (C18).</i>	Flooding happens in rural areas	4	Causes of flooding: Unsafe condition
The urban environment (e.g., high buildings) was depicted to represent the flooding site.	C.08, C.10	-	Flooding happens in urban areas	3	
When compared to the non-flooding site, there is no rain in the flooding site.	C.11, C.15	<i>"Because rain causes flooding." (C1)</i>	Flooding happens when it rains	10	
When compared to the non-flooding site, there is no sun or a smaller sun in the flooding site.	C.08, C.10, C.15	-	There is less sun during flooding	9	
When compared to the non-flooding site, there are more clouds or darker sky colour in the flooding site.	C.10	-	Flooding happens when clouds/sky are/is dark	8	

Drawing item analysis					
Drawing indication	Examples of Drawing (Attached at the end of this table)	Examples of drawing explanation	Code	Number of the participant child visitors (n=18)	Identified perception of flooding (finding theme)
Meanwhile, forest areas were depicted in the non-flooding site, urban areas were depicted in the flooding site. ^a	C.10	<i>“When you damage trees. It won’t grow up, and when water comes, the trees [that were damaged] won’t absorb the water.” (C2)</i>	Destroying trees/forests causes flooding	5	Causes of flooding: dynamic pressure
Meanwhile, forest areas were depicted in the non-flooding site, urban areas were depicted in the flooding site.	C.10	<i>“When it is flooding... because of constructing of buildings and damaging and cutting forests.” (C.10)</i>	Urban development associated with flooding	4	
-	-	<i>“Also, it’s about the heat of the Earth. It makes the ice at the north pole melt.” (C.10)</i> <i>“Climate change.” (C12)</i>	Global warming/climate change causes flooding	2	
-	-	<i>“It happens because [people]... threw garbage in [flood] drainages.” (C14)</i> <i>“[Flood happens] because there are careless people.” (C.14)</i> <i>“Floods happen when people damaged forests.” (C.11)</i>	People cause flooding	4	Role of people towards flooding

Drawing item analysis					
Drawing indication	Example of Drawing (Attached at the end of this table)	Example Drawing explanation	Code	Number of the participant child visitors (n=18)	Identified perception of flooding (finding theme)
The human symbols with words like 'help' and 'SOS' were depicted in the flooding site, but the non-flooding site	C.11	-	People need to be rescued during flooding	2	
Meanwhile, forest areas were depicted in the non-flooding site, urban areas were depicted in the flooding site.	C.10, C.11	<i>"Trees help to slow down floodwater." (C.09)</i> <i>"If we cut trees, there will be no trees to prevent floods." (C.12)</i>	Nature/trees prevent flooding	4	Role of nature towards flooding
The symbols that expressed the negative feeling were depicted in the flooding site such as a sad-face sun.	C.11	<i>"I don't think that it [flooding] is good for our real-life...because it damages our things and properties. We will be inconvenient because we can go nowhere." (C.08)</i>	Flooding is negative*	4	Attitude towards flooding
-	-	<i>"There are some advantages and disadvantages... An advantage is...there is water to use. A disadvantage is it might cause difficulty in travelling." (C.18)</i>	Flooding has both advantages and disadvantages*	2	
-	-	<i>"It's all good. Nothing [about flooding] is bad because I like playing with water." (C.01)</i>	Flooding is positive*	1	

Remark: * Attitude toward flooding was interpreted as negative, both positive and negative, and positive when, respectively, only disadvantages, both advantages and disadvantages, and only advantages of flooding were mentioned.

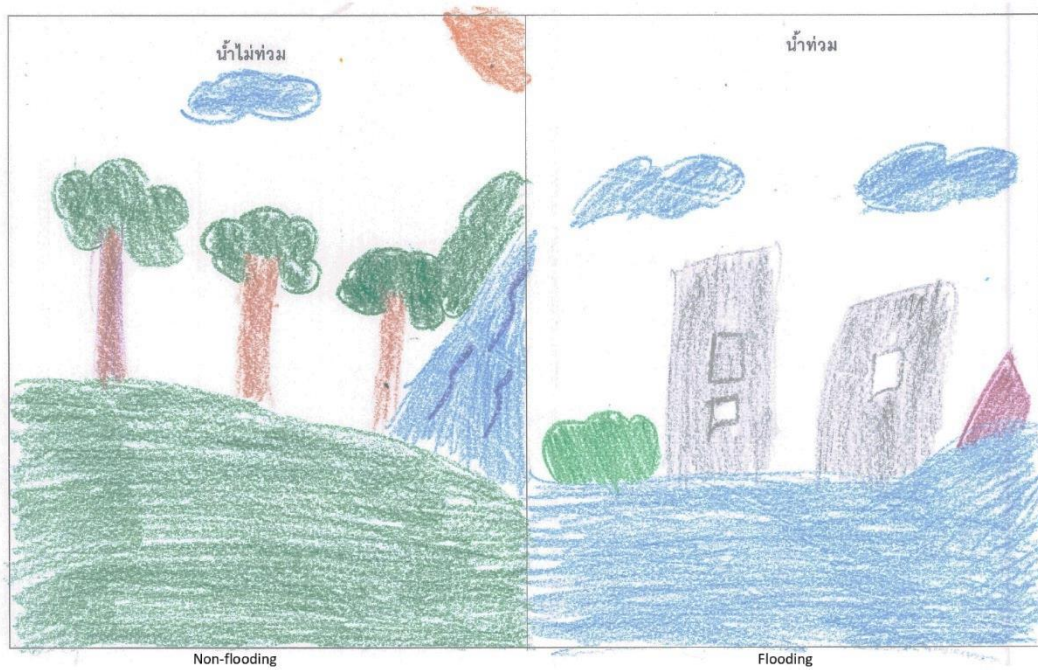
Examples of participant child visitor's drawings



C.05's drawing



C.08's drawing



10

C.10's drawing



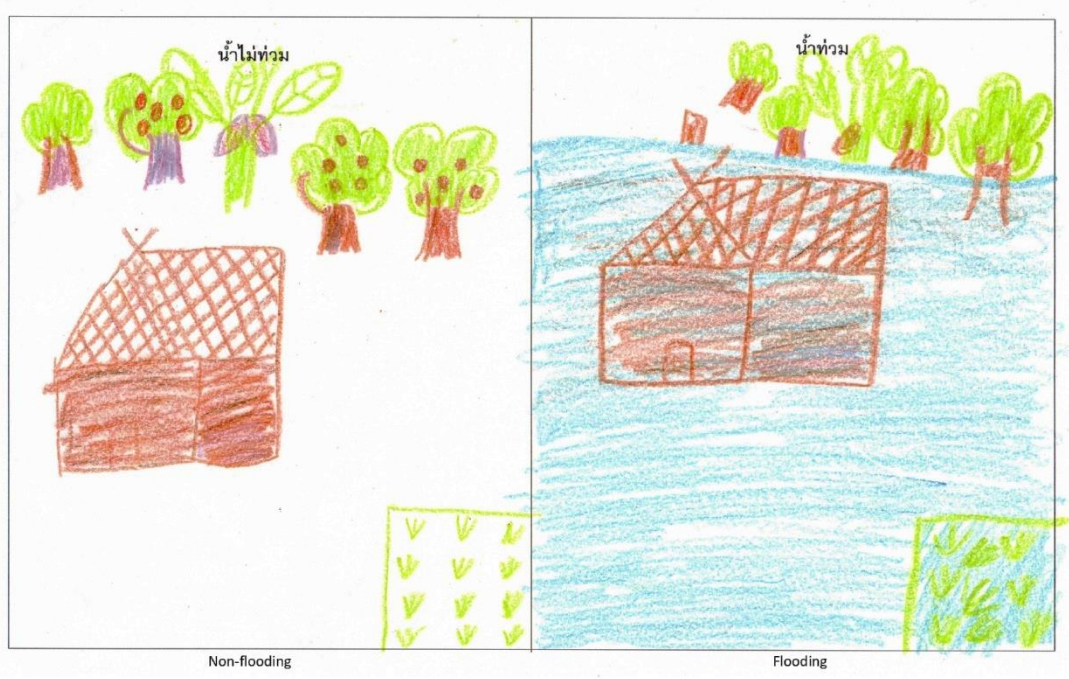
11

C.11's drawing



15

C.15's drawing



19

C.19's drawing

Appendix 10: Pre-interview flood PMM response analysis

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>House dilapidation: flood marks, repainting, Maintenance Utensils (damaged), Termite issues: long-term house maintenance, House problems, House dilapidation/furniture/collections/cars, Damages from floods, Damages, Causing damage, Damaged belongings: car, furniture, electrical equipment, Utensils (damaged), Property damages</i>	Damaged properties/loss of belongings	16	Flood impacts: at the personal level
<i>Dwelling: difficult to find food and drinking water, Family: difficult for the elderly and children to live, Low food supplies (only instant food), Dwelling: difficult to find shelters, food, transportation, Difficult transportation: no car, must instead rely on boats, Moving belongings, Infrastructure and services are unavailable, Lack of shelters, Harder to communicate, Lack of food, Faced difficulties, Starving, Living issues, Difficult to live, Caused suffering, Dwelling: difficult to find food and water, Changed lifestyle, Exposed to harms</i>	Living difficulties	13	
<i>Hygiene, Health, Illness, Athlete's Foot disease No clean water system, Nutriment: difficult to find healthy food, had the same food (e.g. instant noodles)</i>	Personal and family members' health impacts	11	
<i>Job: couldn't go to work, Money: had to spend my savings, unable to work, A lack of income, higher living costs</i>	Household economic impacts	6	

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>Feeling: difficult, Sadness of losing belongings, Sadness, Cry</i>	Emotional impacts	5	
<i>Rubbish, Wastewater, Rubbish that came with floods, Environment: wastewater, dangerous animals, Pollution, Leeches, Harm from poisonous animals, Harm from animals, Dirtiness</i>	Unpleasant environmental condition	3	
<i>Couldn't go to school</i>	Disturbing educational process	1	
<i>Loss [her grandfather], Loss of family members</i>	Loss of family members	1	
<i>The economic downturn, Economy loss, Impacts on economic</i>	National economic downturn	4	Flood impacts: at the public level
<i>Victims' troubles, Flood victims, Loss of lives and belongings of those who encountered floods</i>	Suffered flood victims	2	
<i>Trees died, Environmental loss</i>	Impacts on nature and the environment	1	
<i>Pestilence</i>	Health issues	1	
<i>Robbers</i>	Crimes	1	
<i>Impacts on agriculture</i>	Impacts on the agricultural sectors	1	
<i>Moved to evacuation centres, Moved belongings to high places, Hurry to pack things, Moved out, Planning how to live, food, Following weather forecast, Stockpiled rice and dry food, Finding ways to prevent Leptospirosis</i>	Preparing for floods	5	Flood experiences
<i>Need helps</i>	Need helps	3	

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>Had no time to move things upstairs</i>	Have no time to prepare	2	
<i>Waiting for water to reduce, Cleaning</i>	Recovery after flooding	1	
[The drawing of a Thai traditional (stilt) house]	Traditional way of living with flood	1	
<i>Amount of water each year, Raining, Storms</i>	Annual rainfall/storm	4	Flood causes
<i>People's constructions obstruct water flow in the area. Humans are a cause: blocking floodways, carelessness in living, rubbish, deforestation</i>	Human	3	
<i>Blocked drain system: unable to drain water in urban areas, Water system management, City planning, Size of drainpipes, Community/state water draining systems are not effective and neglected</i>	Flood draining insufficiency	2	
<i>Dumping rubbish into rivers</i>	Littering issue	2	
<i>Corruption</i>	Political issue	2	
<i>Natural disasters</i>	Flooding is a natural phenomenon	4	Flood phenomenon descriptions
<i>The unusual amount of water [on land]</i>	Flooding is having an unusual amount of water on land surfaces	1	
<i>Hard to predict</i>	Flooding is unpredictable	1	

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>Can happen in almost every country</i>	Flooding happens globally	1	
<i>Flooding in Thailand is flash floods</i>	Flooding in Thailand is flash floods	1	
<i>Issue solution: building dams and weirs, Build dams</i>	Build dams/weirs	2	Solutions for flooding issues: Government actions/responsibilities
<i>Taking care of the environment, Not destroying forests</i>	Pay more attention and collaboratively take care of the environment	3	Solutions for flooding issues: General people
<i>Sharing, Helping, Received relief packages [from other people], Offering helps, Being generous</i>	Helping and having empathy	1	
<i>Humans could help, but awareness about the issues [flooding] has been fading from societies, A lack of awareness, Personal profits</i>	Showing rapport/help during flood events	2	Roles of people: Positive roles
<i>Humans are a cause: blocking floodways, carelessness in living, rubbish, deforestation</i>	causing flooding issues	3	Roles of people: Negative roles
<i>Don't like [flooding]</i>	Sad/do not like	3	Negative feelings towards flooding
<i>Building harmoniousness</i>	Building harmoniousness among people	1	Flood advantages
<i>Trees, forests, the balance of nature, prevent flash floods</i>	Trees help to slow down run-off water	1	Role of nature towards flood risk

Appendix 11: Post-interview flood PMM response analysis

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>Improve water drainage systems, Water draining management, Manage water resources systematically, Water management, People who are responsible for water management in Thailand should take care of the water management system to be more efficient, The government must act on time</i>	Improve water management systems	6	Solutions for flooding issues: Government actions/responsibilities
<i>Solve [flood] problems by addressing their root causes, Should study the root causes of the problems and prepare solutions in advance, Find [flood] problem solutions and flood prevention strategies</i>	Find flood solutions from their root causes	4	
<i>“Communication: communication is not enough, especially in the news. They said only that it would flood and how to prepare just a short time before the flood arrived. They told us just a little about how they [the state] would solve it. Sometimes, not at all. When the floods had gone, there was no more communication about floods. It’s not continuous.” Solutions: should warn or inform people to prepare ahead of time. Long term solutions for potential impacts, The government must tell the truth</i>	Improve public communication about flood risk	3	
<i>Awareness of new generations, Social values: need to make people see that preparing to cope with floods is essential, Promote public awareness, Raise public awareness about pollution</i>	Promote social values and awareness of flood risk reduction	2	

Responses	Code	Number of the participant adult visitors (n=38)	Identified perception of flooding (Finding theme)
<i>Pay attention to taking care of our earth/ the environment, Take care of our earth, Love nature more, Make our world a better place to live, Conserve nature collaboratively, Want people to take care of the environment, Collaborate to take care of nature, Take care of the environment for the next generations, Live sustainably, Conserve natural resources</i>	Pay more attention and collaboratively take care of the environment	7	Solutions for flooding issues: General people
<i>Taking care of oneself, Preparing, Be prepared for the [flooding] phenomenon, Be more adaptive [to living with floods]</i>	Should be prepared for floods	4	
<i>Climate change, Global warming, Climate change causes various problems, Seawater, Caused by climate change, Uncertain climate: the weather is hotter</i>	Climate change issues	5	Flooding causes
<i>Caused by deforestation: no tree roots to hold the soil surface, Deforestation</i>	Deforestation	2	
<i>Caused by terrain change</i>	Terrain change issue	1	
<i>Littering</i>	Littering issue	1	
<i>Humans have been destroying nature by not taking care of the environment</i>	Human	1	
<i>Will try to tell people around me to mitigate flooding issues if I have the chance.</i>	To tell other people to contribute to flood risk reduction if there is a chance	1	Intention to reduce flood risk
<i>Teach my children to prepare</i>	Teach their children to prepare for their future	1	
<i>Illness</i>	Health impacts	1	Flood impacts

Appendix 12: Interview guideline - participant FRM key actors

Themes	Questions
(I) Relationship with flooding issues	(1) How do you relate to the flooding issues in Thailand?
(II) Opinions about challenges in improving FRM in Thailand	(2) From your experiences, what are the challenges in improving FRM in the context of Thailand?
(III) Expected engagement from the public	(3) In your opinion, should the public engage with FRM? If yes, how?
(IV) Opinions about challenges and how to promote public engagement in FRM	(4) Have you had any experience in developing, running or attending any educational activity related to the promotion of public engagement in FRM? If no, skip to (6) If yes: - could you please tell me more about it? - what are/were those activities? - what are/were the activities' objectives? (5) Based on your experience or opinion, what are the challenges in promoting public engagement in FRM? (6) In your opinion, how should we promote public engagement in FRM in Thailand?
(V) Expected support from science museums to help improve FRM	(7) In your opinion, how can science museums help support FRM in Thailand? (8) If science museums establish public flood education programmes, what do you expect to see from the programmes?
(VI) Suggestions for other key actors	(9) Could you suggest other people who could give more opinions on this topic?