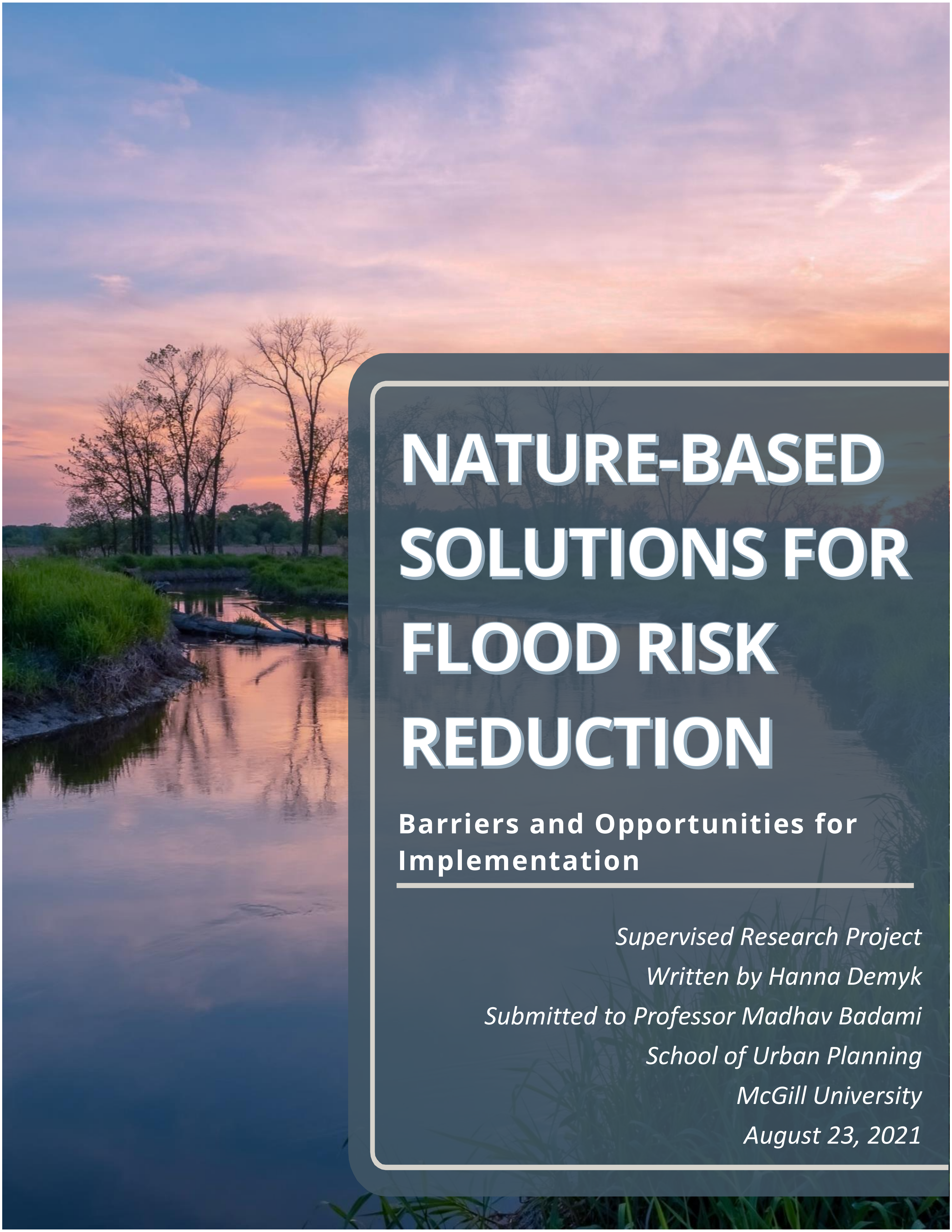

# NATURE-BASED SOLUTIONS FOR FLOOD RISK REDUCTION

**Barriers and Opportunities for Implementation**

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# Executive Summary

The impacts of climate change are increasingly being felt around the world and drawing attention to the critical need for climate mitigation and adaptation efforts from our governments. Reducing flood risk is particularly important because populations are increasingly moving into flood-prone areas. Asia is one of the most vulnerable regions to climate-related disasters and many communities lack human and financial capacity to cope with the impacts of climate change. While different types of climate adaptation options exist, **nature-based solutions (NBS)** have the potential to provide both socioeconomic and ecological benefits and are increasingly seen as valuable interventions.

This report seeks to identify barriers, opportunities, and guiding principles for successful implementation of NBS to reduce flood risk and improve the lives of local communities. Barriers to implementation have been identified based on a literature review and include path dependency towards hard engineered solutions, the focus on one-size-fits-all solutions, a lack of knowledge and awareness of NBS, a lack of collaborative decision-making, a lack of interest and prioritization of NBS, inappropriate spatial planning, a lack local adaptive capacity, and social equity concerns related to NBS. Various opportunities for implementation have also been highlighted, such as improving policies to better integrate climate change adaptation (CCA) into development plans, integrating CCA and NBS into spatial planning, improving local access to technical and financial support to increase uptake of NBS, prioritizing inclusive decision-making, and promoting context-specific design.

Two case studies are presented, including **Building with Nature (BwN) in Indonesia** and **Enhancing Climate Change Resilience of Rural Communities living in Protected Areas (AFCPA) in Cambodia**. The case studies are evaluated using guiding principles for successful implementation of NBS, including (1) context relevance, (2) evidence base, (3) integration into wider context, (4) social equity, and (5) collaborative decision-making. It is found that the case studies have been successful at implementing NBS projects and incorporating these guiding principles to varying degrees. The report highlights the importance of these guiding principles in NBS projects and draws lessons learned from the case studies and literature review. Although the presented case studies focus on Southeast Asian countries, **findings in this report are relevant to all cities seeking to reduce flood risk through nature-based interventions**.

# Résumé

Les impacts des changements climatiques se font de plus en plus sentir dans le monde et commence à souligner le besoin critique pour nos gouvernements d'adopter des mesures d'atténuation et d'adaptation face à ces changements. La réduction des risques d'inondation est particulièrement importante car les populations se déplacent de plus en plus vers les zones susceptibles aux inondations. L'Asie est l'une des régions les plus vulnérables aux catastrophes liées au climat et de nombreuses communautés manquent les ressources humaines et financières requises pour faire face aux impacts des changements climatiques. Bien qu'il existe différents types de mesures d'adaptation climatique, les solutions fondées sur la nature (SFN) ont le potentiel d'apporter des avantages socio-économiques et écologiques et sont de plus en plus considérées comme des interventions à prioriser par nos gouvernements.

Ce rapport cherche à identifier les obstacles, les opportunités et les principes directeurs pour une mise en œuvre réussie des SFN afin de réduire les risques d'inondation et d'améliorer la vie des communautés locales. Les barrières à l'implantation ont été identifiés sur la base d'une revue de la littérature et incluent les obstacles suivants: la dépendance des gouvernements sur l'infrastructure grise, l'accent mis sur des solutions universelles, un manque de connaissances des SFN, un manque de prise de décision collaborative, un manque d'intérêt et de priorisation des SFN, un aménagement du territoire inappropriée, un manque de ressources et de capacité d'adaptation locale, et des problèmes d'équité sociale liés aux SFN. Des opportunités de mise en œuvre ont également été soulignées, y compris mais sans s'y limiter la nécessité d'une réforme des politiques afin de : intégrer l'adaptation au changement climatique (ACC) dans les plans de développement, promouvoir les SFN et améliorer l'aménagement du territoire, améliorer l'accès au soutien technique et financier pour les habitants, promouvoir une prise de décision collaborative et assurer une conception spécifique au contexte.

Deux études de cas sont présentées, notamment « **Building with Nature (BwN) in Indonesia** » et « **Enhancing Climate Change Resilience of Rural Communities living in Protected Areas (AFCPA) in Cambodia** ». Les études de cas sont évaluées à l'aide de principes directeurs pour une mise en œuvre réussie des SFN, notamment (1) la pertinence du contexte, (2) la mise en valeur des faits importants, (3) l'intégration dans un contexte plus large, (4) l'équité sociale et (5) la prise de décision collaborative. On constate que les études de cas ont réussi à mettre en œuvre des projets de SFN et à intégrer, à des degrés divers, ces principes directeurs. Le rapport souligne l'importance de ces principes directeurs dans les projets de SFN et tire les enseignements des études de cas et de la revue de la littérature. Bien que les études de cas présentées se concentrent sur les pays d'Asie du Sud-Est, **les conclusions de ce rapport sont pertinentes pour toutes les villes qui cherchent à réduire les risques d'inondation grâce à des interventions basées sur la nature**.

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# Abbreviations and Acronyms

| | |
|---|---|
| **BGI** | Blue-green infrastructure |
| **BwN** | Building with Nature |
| **CCA** | Climate change adaptation |
| **PA** | Protected areas |
| **CPA** | Community protected areas |
| **DRM / DRR** | Disaster risk management / Disaster risk reduction |
| **EA / EBA** | Ecosystem approaches / Ecosystem-based adaptation |
| **EE** | Ecological engineering |
| **ES** | Ecosystem services approach |
| **FRM / FRR** | Flood risk management / flood risk reduction |
| **HFA** | Hyogo Framework for Action |
| **IPCC** | Intergovernmental Panel for Climate Change |
| **IUCN** | International Union for Conservation of Nature |
| **IUWM** | Integrated urban water management |
| **LID** | Low impact development |
| **NBS / NBI** | Nature-based solutions / nature-based infrastructure |
| **SUDS** | Sustainable urban drainage systems |
| **UNDRR** | United Nations Office for Disaster Risk Reduction |
| **WSUD** | Water-sensitive urban design |

# Chapter 1: Introduction

The impacts of climate change are being felt across the world and are only expected to increase in frequency and severity in the years ahead (IPCC, 2014). Extreme weather events as a result of a changing climate, including sea-level rise, droughts, extreme rainfall, floods, wildfires, and heat waves, have the potential to devastate ecosystems, human settlements, infrastructure, livelihoods, and pose a major threat to human health and well-being (IPCC, 2014). Reducing flood risk is particularly important because populations around the world are increasingly moving into flood-prone areas, which means a greater proportion of people, assets, infrastructure, and economies are under threat (Jongman, 2018). To reduce and manage the impacts of flooding, governments must prioritize climate change adaptation (CCA); however, while adaptation is increasingly becoming an important component of planning and policymaking, a significant amount of work remains (Dulal, 2019; IPCC, 2014; Seddon et al., 2020).

Flood risk can be viewed as the potential for flooding to occur compounded by the potential social, economic, or environmental consequences of flooding (Aerts, 2018). Flood risk depends on the context, including physical characteristics of the landscape, level of exposure (e.g. amount of people living in flood-prone areas), and the level of vulnerability of the population, infrastructure and essential services to potential hazards (Aerts, 2018). CCA focuses on adapting human and natural systems to reduce harm as a result of climatic changes (IPCC, 2014, p. 118; UN Office for Disaster Risk Reduction, 2009). CCA seeks to address a wide variety of issues, including long term impacts of sea-level rise, agricultural productivity and loss of livelihoods, biodiversity and habitat loss, as well as the detrimental impacts of extreme climate-related disasters such as hurricanes, wildfires, and floods (Shaw et al., 2010). While the idea of adaptation has long been discussed in literature, strategic planning to adapt human and natural systems to a changing climate is a more recent phenomenon (Shaw et al., 2010).

A variety of CCA strategies have been implemented to enhance resilience against flooding, and in many cases a combination of interventions can be useful for effective mitigation (Jongman, 2018). Examples of interventions include engineered gray infrastructure, nature-based solutions (NBS), early warning systems, land use planning strategies, community behavioural or managerial changes, and financial instruments related to risk (Francisco, 2008; Jongman, 2018). Gray infrastructure, such as seawalls and dikes, are conventionally seen as cost-effective, however these interventions require significant capital investments and potential failures of these solutions in the long term could be disastrous (Jongman, 2018). Alternatively, NBS, which focus on restoring and working with natural systems to reduce climate-related risk, have become increasingly recognized as low cost and effective solutions to enhance community resilience (Bush & Doyon, 2019; IPCC, 2014; Jongman, 2018; Seddon et al., 2020). Examples of NBS include protecting and restoring wetlands, forests, and other ecosystems, as well as the integration of blue-green infrastructure (BGI)[1] to reduce flood risk (Jongman, 2018; Seddon et al., 2020). If strategically implemented, NBS have the potential to promote climate mitigation (i.e. by increasing vegetation that sequesters carbon) and adaptation (i.e. by directly reducing the impacts of climate change) while simultaneously protecting and enhancing biodiversity (i.e. by integrating a diverse range of native vegetation into an ecosystem) (Seddon et al., 2020).

[1] Blue-green infrastructure (BGI) is a term emphasizing the use of water and land-based natural features to enhance urban flood resilience (Liao et al., 2017). Examples of BGI include rain gardens, bioswales, green roofs, and the creation of wetlands for stormwater management (Liao et al., 2017).

Although climate change is an international issue, cities across Asia are extremely vulnerable to major flood events and related hazards, with potential economic costs estimated at US$13 billion (Dulal, 2019). In fact, Asian cities have been impacted the most by climate-related disasters, particularly in coastal regions (Chan et al., 2018; Francisco, 2008). A 2014 Intergovernmental Panel for Climate Change (IPCC) report states that half of Asia's urban population lives within at-risk coastal zones and floodplains (Hijoka et al., 2014; IPCC, 2014). Moreover, recent headlines estimate that monsoon floods have impacted nearly 17 million people and killed 700 in Southeast Asia this year alone (Alam et al., 2020), and the risk will only increase as populations increase, economies grow, and urban development continues in flood-prone areas (Chan et al., 2018; Francisco, 2008). Vulnerability to extreme weather events, combined with other issues such as water resource scarcity and unsustainable farming practices, present the urgency to prioritize CCA across Asia in the years ahead (Hijoka et al., 2014). Unfortunately, despite being at high risk, many regions in Asia are only at the beginning stages of CCA planning (Dulal, 2019). Notably, even countries that have the capacity to integrate costly flood risk management (FRM) strategies remain at high risk to sea-level rise, intensive rain storms, and flash floods (Chan et al., 2018; Chow et al., 2016; IPCC, 2014).

While wealthy cities across Asia, such as Hong Kong and Singapore, have the capacity to integrate FRM strategies through a variety of approaches including more costly solutions (Chan et al., 2018; Chow et al., 2016), cities and communities in less developed countries typically have lower adaptive capacities and often require outside support to be able to increase their resilience to climate change (Francisco, 2008). Many of the world's vulnerable populations, including the urban poor, are forced to settle in areas where they are more vulnerable to climate hazards, leading to vulnerable and marginalized populations being at high risk to the impacts of climate change, including flooding (Dodman & Satterthwaite, 2009; IPCC, 2014; Uitto & Shaw, 2016). Dodman and Satterthwaite (2009) highlight limited institutional capacity and "*...the failure of urban management...*" to reduce risk for vulnerable populations as key issues to address (Dodman & Satterthwaite, 2009, p. 67). Notably, social equity must be recognized and considered in resilience and adaptation planning, yet it has often been neglected in discourse and in practice (Anguelovski et al., 2016; Francisco, 2008; Frantzeskaki, 2019; Kabisch et al., 2016; Meerow et al., 2019). If social equity is not considered during the implementation process, solutions can have social equity trade-offs, for instance when interventions prioritize the rich over the poor or cause displacement of poor communities (Anguelovski et al., 2016; Frantzeskaki, 2019; Kabisch et al., 2016). This must be a key consideration in CCA projects to ensure resilience across communities and reduced vulnerability over the long term.

## Scope and purpose of report

The purpose of the following report is to provide planners, policymakers, and key decision-makers with guiding principles on the implementation of NBS for flood risk reduction (FRR). Specifically, the objectives are to (1) investigate the barriers and opportunities in implementing NBS, (2) identify guiding principles for nature-based adaptation, and (3) recommend pathways for successful implementation. Case studies of wetland and forest restoration projects in Southeast Asia are evaluated. These projects aim to protect and enhance the livelihoods of vulnerable populations and reduce the flood risk in these regions. The case studies are presented as evidence of changes necessary for successful implementation of NBS over the long term.

Explicitly, the central research question guiding the report is the following:

**What are the barriers, opportunities, and guiding principles for successful implementation of nature-based solutions to reduce flood risk and improve the lives of local communities?**

To date, most research related to NBS has focused on providing broad evidence of the co-benefits provided by NBS interventions, which means there is a need for more research focused on lessons learned and how to operationalize these lessons in practice (Frantzeskaki, 2019). Most existing research also focuses on the Global North despite the fact that the populations most vulnerable to climate change are located in the Global South, including Southeast Asia (Chausson et al., 2020). Small and medium-sized cities in Southeast Asia have also been neglected in CCA research despite having different social, economic, and political conditions compared to larger Asian cities (Daniere et al., 2019). Moreover, practice-based and site-specific evidence of successful NBS projects is essential to highlight the benefits of these strategies and promote widespread use (Bush & Doyon, 2019; Chausson et al., 2020). For these reasons, this report aims to synthesize existing research while also providing an analysis of two recent NBS projects in the Southeast Asian context. **Although case studies presented focus on Southeast Asian countries, findings in this report are relevant to all cities seeking to reduce flood risk through nature-based interventions.**

The report is divided into seven chapters which guide the reader through a presentation of methods used (ch.2), a literature review on disaster risk reduction, climate adaptation, nature-based solutions, and barriers and opportunities for implementation (ch.3), an introduction to climate adaptation and disaster risk reduction in the Southeast Asian context (ch.4), a presentation and evaluation of case studies, (ch.5-6), and a discussion and conclusion summarizing barriers and opportunities, and recommending pathways for successful implementation of NBS (ch.7).

# Chapter 2: Methodology

## Literature review

A survey of academic and non-academic literature is used to provide a foundation for key concepts discussed throughout the report. Concepts are defined using scholarly research articles, as well as non-academic works by the UN Office of Disaster Risk Reduction (UNDRR) and International Panel on Climate Change (IPCC), as these agencies seek to provide a common understanding of concepts relating to climate change and DRR. A literature review summarizing current discourse surrounding CCA and NBS is also presented, including barriers and opportunities to implementing NBS for FRR. The literature review informs the evaluation framework used to analyse and compare case studies presented in the report.

## Case study research

A case study consists of a single example of a particular context, program, organization, institution or event, including the reasons why or how decisions were made, as well as the outcomes of these decisions (Flyvbjerg, 2006; Yin, 2018). When looking at NBS interventions, case study research is particularly important because practice-based evidence is crucial for long term success (Bush & Doyon, 2019; Chausson et al., 2020; Seddon et al., 2020). The report draws on both academic and non-academic literature to explore case studies of NBS projects for FRR in Southeast Asia. Case studies used in this report have been selected based on the amount of information readily available online for recent NBS interventions in Southeast Asia. For each case study, gray literature was collected from online platforms, including government agencies and international organizations, as well as academic articles focused on the given context.

# Chapter 3: Literature Review

The following section provides definitions of key concepts relevant to CCA and FRM, discusses CCA more broadly in discourse and in practice, provides details on the emergence of and preoccupations relating to NBS, and highlights barriers and opportunities for building urban resilience in the Asian context and beyond. Key terms related to CCA have been conceptualized to provide readers with a common understanding.

## Disaster risk reduction, vulnerability, and climate resilience

Many coastal cities are at increased risk of disastrous flooding events due to rapid urban and socioeconomic development (Chan et al., 2018; Hanson et al., 2011). Disaster risk can be defined as "…the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period" (UN Office for Disaster Risk Reduction, 2009, pp. 9–10). Similarly, Shaw et al. (2010) define risk as "…a function of exposure to the hazard, the vulnerability of people, and the degree to which society has been engaged in disaster mitigation activities" (Shaw et al., 2010, p. 5). Risk encompasses vulnerability, exposure, and capacity to cope with and bounce back from disastrous events that occur in a community (Shaw et al., 2010).

The terms vulnerability and adaptive capacity are interrelated. The vulnerability of populations at different scales is often a central focus of research surrounding CCA (Daniere & Garschagen, 2019). Vulnerability can be viewed as the amount of exposure a community or ecosystem has to the impacts of climate change, the sensitivity of a community or ecosystem to climate change impacts, and the adaptive capacity of the community or ecosystem to adjust to the impacts of climate change (Seddon et al., 2020; UN Office for Disaster Risk Reduction, 2009). Similarly, adaptive capacity is discussed in adaptation literature as “the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” of climate change (IPCC, 2014, p. 118). Capacity development, on the other hand, is “the process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions” (UN Office for Disaster Risk Reduction, 2009, p. 6). While adaptive capacity implies that communities have a limit in their ability to respond to climatic hazards, capacity development emphasizes that the adaptative capacity of a community can be improved through specific interventions that enhance resilience to climatic events.

Climate resilience is a term that has increased in popularity in recent years, in some instances being highlighted as the ‘new sustainability’ (Kirchain & Ulm, 2021). Broadly, climate resilience encompasses the ability of social, economic, and environmental systems to deal with climatic hazards in such a way that essential elements of a community can bounce back and even improve over time despite disturbances (Bush & Doyon, 2019; IPCC, 2014, p. 127). A literature review by Meerow et al. (2016) argues that definitions of urban resilience in scholarly research tend to be inconsistent and proposes the concept be defined more inclusively as “…the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity” (Meerow et al., 2016, p. 45). This definition points to the need to protect and enhance the adaptative capacity of a community to reduce vulnerability to hazards over the long term, linking these key concepts together.

In order to reduce risk, governments tend to focus on disaster risk reduction (DRR), which is the idea of reducing risks related to disasters by directly addressing underlying causes of climatic hazards (UN Office for Disaster Risk Reduction, 2009). Interventions include reducing vulnerability and exposure of people and property to potential hazards, managing land use and natural systems, and improving emergency preparedness for potentially disastrous events (UN Office for Disaster Risk Reduction, 2009). The *Sendai Framework for Disaster Risk Reduction 2015-2030*, previously known as the Hyogo Framework for Action (HFA), was adopted at the UN World Conference on Disaster Risk Reduction in 2015 and acts as a global framework created to help monitor international progress in reducing disaster risk (UN Office for Disaster Risk Reduction, 2015). The document outlines targets, priorities for action, and guiding principles of DRR (**Figure 1**; UN Office for Disaster Risk Reduction, 2015). Priorities include (1) improving knowledge of DRR strategies, (2) strengthening disaster risk governance, (3) investing in DRR, and (4) enhancing disaster preparedness for response, recovery, rehabilitation and reconstruction efforts (UN Office for Disaster Risk Reduction, 2015).

**Priorities for Action**

There is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas.

| **Priority 1**<br>Understanding disaster risk | **Priority 2**<br>Strengthening disaster risk governance to manage disaster risk | **Priority 3**<br>Investing in disaster risk reduction for resilience | **Priority 4**<br>Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction |
| --- | --- | --- | --- |
| Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment | Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk | Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation | Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases |

***Figure 1.*** *Sendai Framework priorities for global DRR. Source: UN Office for Disaster Risk Reduction (UNDRR), 2015, p. 36.*

Notably, under the third priority action, *investing in disaster risk reduction for resilience*, the framework highlights that at the local and national level, it is necessary "…to strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction" (UN Office for Disaster Risk Reduction, 2015, p. 20). Furthermore, under the second priority action, *strengthening disaster risk governance to manage disaster risk*, the document highlights the prioritization of "…transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources, such as within river basins and along coastlines, to build resilience and reduce disaster risk, including epidemic and displacement risk" (UN Office for Disaster Risk Reduction, 2015, p. 18). These action items express the growing recognition of NBS as an essential component of DRR, as well as the need to strengthen regulatory and institutional systems related to DRR.

## Nature-based solutions: Definition, related concepts, and co-benefits

*"If we take care of nature, nature will take care of us." - David Attenborough*

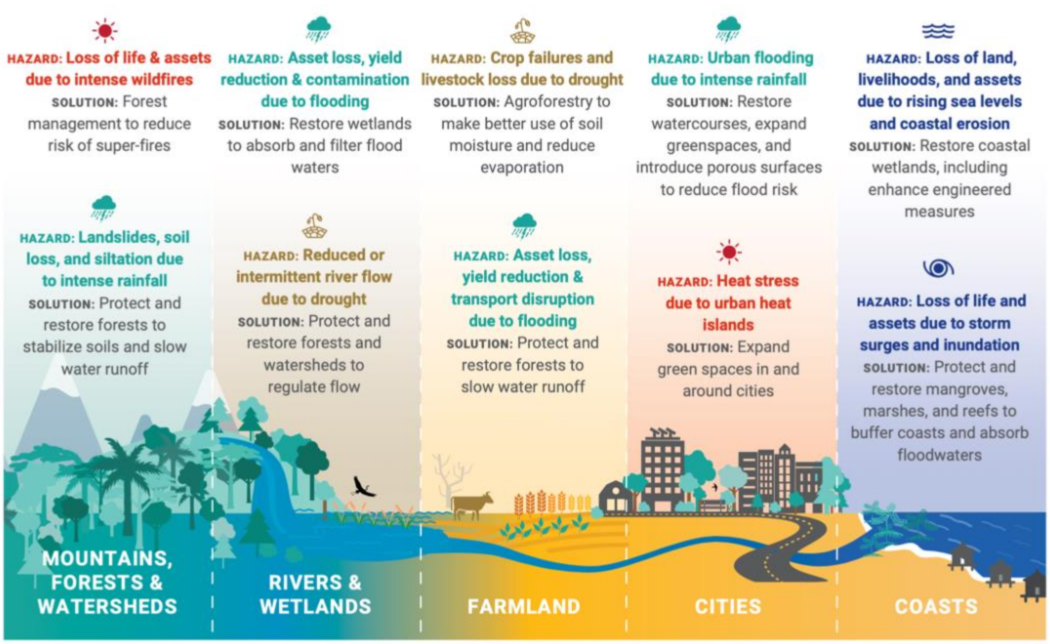


***Figure 2**. Nature-based solutions in different landscapes to address climatic hazards. Source: Global Commission on Adaptation, 2019, p. 32.*

There are different types of CCA infrastructure, including gray 'hard' engineered solutions (e.g., seawalls and dikes), 'soft' nature-based solutions (e.g., wetland and mangrove restoration), and hybrid solutions combining these strategies (Schoonees et al., 2019, p. 1710). NBS are defined by the IUCN as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (*Nature-Based Solutions to Address Global Societal Challenges*, 2016, p. 2). More simply, the European Commission defines NBS as "…actions which are inspired by, supported by or copied by nature" (European Commission, 2015, p. 4). NBS also take on a variety of forms depending on the context and hazards facing a region, including forest protection and enhancement, agroforestry, wetland and mangrove restoration, and the expansion of urban green spaces (Bush & Doyon, 2019; Global Commission on Adaptation, 2019; Jongman, 2018; Seddon et al., 2020). **Figure 2** highlights the variety of NBS strategies available and the hazards that NBS can help mitigate (Global Commission on Adaptation, 2019, p. 32).

Although gray infrastructure has been the main focus of CCA projects globally, NBS have grown in popularity and numerous benefits of NBS for both communities and ecosystems have been identified by researchers (Seddon et al., 2020). If successfully implemented, co-benefits to humans, wildlife, and nature provided by NBS can include biodiversity conservation, climate mitigation through increased carbon storage, as well as recreation, tourism, and other economic opportunities (Jongman, 2018). Research also indicates that NBS have the potential to provide positive physical and mental health impacts to communities due to proximity to natural environments (Kolokotsa et al., 2020). Furthermore, these solutions have been shown to reduce socioeconomic vulnerability of communities and enhance resilience of natural systems to the impacts of climate change (Seddon et al., 2020). Despite the growing popularity and research on NBS internationally, adoption of these strategies is slow and gray infrastructure continues to be the dominant choice for CCA investments due to uncertainty in design, planning, maintenance, and financing of NBS (Chan et al., 2018; Davies & Lafortezza, 2019; Drosou et al., 2019; Jongman, 2018). This is a concern because research highlights existing hard engineered solutions as increasingly problematic due to unprecedented extreme weather events being experienced globally (Duy et al., 2018).

There are a number of concepts closely related to NBS regularly used by researchers and practitioners, including blue-green infrastructure (BGI), green infrastructure (GI), ecological engineering (EE), ecosystem-based adaptation (EBA), and ecosystem services approach (ES) (Drosou et al., 2019; Nesshöver et al., 2017). These terms share similar qualities and subtle differences. BGI is an approach to FRM combining water management techniques and green infrastructure to reduce flood risk and promote environmental, economic, and social benefits to society (Drosou et al., 2019; Ghofrani et al., 2017). Alternatively, NBS can be viewed as an umbrella term incorporating different concepts into a broad adaptation framework based on nature-based interventions (Nesshöver et al., 2017). Other terms focus specifically on stormwater management and drainage system design, including integrated urban water management (IUWM), sustainable urban drainage systems (SUDS), water sensitive urban design (WSUD), and low impact development (LID) (Drosou et al., 2019; Fletcher et al., 2015). While these terms share similar qualities to NBS, they are mainly focused on stormwater management through the improvement of drainage systems (Drosou et al., 2019; Fletcher et al., 2015). As an emerging concept, NBS offers opportunities for collaboration between scientists, government and various stakeholders for designing, monitoring, and knowledge-building based on practice-based evidence (Nesshöver et al., 2017; Schanze, 2017).

Numerous articles compare the use of hard engineered solutions (i.e. gray infrastructure) and NBS. Alves et al. (2019) quantify the co-benefits of gray, green, and blue infrastructure options for FRR and find that the benefits of green infrastructure tend to outweigh the costs when co-benefits are considered, however the authors note that a combination of green, gray, and blue infrastructure can yield the best results. Similarly, Ourloglou et al. (2020) compare conventional engineered infrastructure and NBS for flood risk reduction along urban streams and find that NBS are more cost-effective and efficient than conventional interventions because they simultaneously provide ecosystem service benefits to society. An analysis by Reguero et al. (2018) on the costs and benefits of implementing NBS, grey infrastructure, and policy measures for coastal protection highlights a combination of these strategies as the most cost-effective way to meet multiple objectives at once. Overall, NBS are increasingly recognized as cost-effective with benefits often tremendously outweighing the costs (Global Commission on Adaptation, 2019; Seddon et al., 2020). Notably, scholarly research shows that it is not a matter of 'either-or' when it comes to gray infrastructure and NBS, since in many cases hybrid solutions integrating both green and gray infrastructure have been most successful at enhancing resilience (Alves et al., 2019; Jongman, 2018; Ourloglou et al., 2020; Reguero et al., 2018).

## Barriers and opportunities for building urban resilience through NBS

### Barriers

- Path dependency
- One-size-fits-all solutions
- Lack of knowledge and awareness
- Silo thinking and lack of collaborative decision-making
- Lack of interest and prioritization of climate adaptation
- Inappropriate spatial planning
- Lack of resources and local capacity
- Potential social equity trade-offs

### Opportunities

- Policy reform to break path dependency
- Policy reform to improve spatial planning processes
- Explicit government roles
- Proactive and long term governance
- Improved funding mechanisms and support
- Inclusive and collaborative decision-making
- Context-appropriate design
- Pilot projects for innovative solutions

***Figure 3.*** *Barriers and opportunities for the implementation of NBS. Created by author based on literature review.*

## Barriers to reducing flood risk through NBS

### *Path dependency towards hard engineered solutions*

Numerous regulatory, institutional, and financial barriers exist that inhibit the implementation of NBS internationally. First, path dependency towards hard engineered solutions is frequently cited as a major barrier to the implementation of NBS (Chan et al., 2018; Davies & Lafortezza, 2019; Drosou et al., 2019; Jongman, 2018; Matthews et al., 2015, p. 201; Zuniga-Teran et al., 2020). Gray infrastructure is costly and does not address underlying issues related to flooding, yet governments continue to prioritize hard engineered solutions to address flood risk rather than focusing on the most optimal solutions for the local context, whether that be NBS or a combination of blue, green, and gray infrastructure (Chan et al., 2018; Davies & Lafortezza, 2019; Drosou et al., 2019). In many cases, NBS have been found to be more affordable than traditional gray infrastructure, however economic benefits tend to be reduced due to frustrating regulatory frameworks focused on traditional interventions, making it difficult to implement emerging solutions (Zuniga-Teran et al., 2020).

### *A focus on one-size-fits-all solutions*

Researchers also find that implemented solutions are ineffective when the local context is not considered in decision-making. For instance, Drosou et al. (2019) conduct interviews in Semarang, Indonesia, and highlight numerous issues related to implemented BGI projects, including green roofs attracting mosquitos and safety issues related to constructed retention ponds. Community members argued that both economic and environmental benefits need to be balanced in order to improve the lives of locals, which the government failed to achieve (Drosou et al., 2019). Governments need to consider alternative and innovative solutions to address flood risk while also ensuring that solutions are relevant to the social, economic, political, and environmental context in which CCA projects are implemented (Drosou et al., 2019; Zuniga-Teran et al., 2020).

### *Lack of climate change knowledge and awareness*

Both policymakers and the public tend to lack general awareness climate change impacts and benefits of CCA (Drosou et al., 2019; IIED, 2014). Academics identify gaps in understanding on the part of local governments and decision-makers, including how to plan for, design, implement, operate, maintain, measure, and evaluate NBS and the ecosystem service benefits provided by these solutions (Drosou et al., 2019; Wihlborg et al., 2019; Zuniga-Teran et al., 2020). For example, Wihlborg et al. (2019) note that governments lack the ability to make specific demands to developers related to NBS because they lack technical expertise and regulatory frameworks, leading to inefficient planning approaches related to NBS. Governments need to work towards enhancing their technical knowledge while also raising public awareness of flood risk and the potential benefits of NBS.

***Lack of prioritization of climate adaptation and inappropriate spatial planning***

Municipal governments have the responsibility to provide essential infrastructure and services to the public, such as water, sanitation, drainage, as well as public health and emergency services (Dodman & Satterthwaite, 2009). Despite this responsibility, local governments often fail to meet these objectives, particularly for the most vulnerable populations such as the urban poor (Dodman & Satterthwaite, 2009). This is partially due to a lack of authority across government departments to address key issues related to flood risk, but also due to conflicting interests. The example of Hong Kong governance is presented by Chan et al. (2018), who find that local planners are able to reduce flood risk through management of drainage systems, however urban development in high flood risk areas continues due to a lack of authority to restrict urban development in these regions.

The author also highlights that official community plans actually promote urban densification in flood-prone regions, which will only exacerbate flood risk (Chan et al., 2018). When cities decide to build infrastructure in vulnerable locations, such as flood-prone areas, they are choosing to promote unsustainable development practices and consequently increasing disaster risk in the area (Duy et al., 2018; Uitto & Shaw, 2016). Duy et al. (2018) argue that "…inappropriate spatial planning for urban development can be a primary cause of the increased vulnerability because of the results of the rapid growth of new residences in flood prone areas while decreasing urban resilience to extreme weather" (Duy et al., 2018, p. 8). Numerous authors highlight a lack of interest and prioritization of CCA, as the political agenda continues to promote rapid urban development, densification, and economic growth above environmental and social concerns (Chan et al., 2018; Daniere & Garschagen, 2019; Drosou et al., 2019; Wihlborg et al., 2019).

### *Silo thinking and a lack of collaborative decision-making*

Another challenge in the implementation of NBS is understanding who is responsible for implementation, maintenance, and financing of CCA in local government (Zuniga-Teran et al., 2020). The responsibilities of each department tend to be unclear and every department has a set budget and specific interest related to urban development, which often leads to a lack of action as departments are unwilling to take on further responsibility (Drosou et al., 2019; Wihlborg et al., 2019). This also presents challenges in figuring out who finances the implementation and maintenance of these solutions (Drosou et al., 2019; Wihlborg et al., 2019). Numerous articles discuss this key challenge as 'silo thinking', meaning departments work separately rather than taking a holistic approach to solving community issues (Chan et al., 2018; Francesch-Huidobro et al., 2017; Wihlborg et al., 2019). The separation of tasks, lack of inter- and intra-governmental collaboration, and lack of regulatory frameworks to promote collaborative work between stakeholders leads to inefficient processes that do not address key issues, makes it difficult to implement CCA projects, and inhibits government's ability to gather and share evidence on the benefits of NBS (Chan et al., 2018; Francesch-Huidobro et al., 2017; Wihlborg et al., 2019). In Semarang, Indonesia, Drosou et al. (2019) find that community members view the lack of collaboration between governments, researchers, and the public as major barriers to the successful implementation of BGI in their communities. This example highlights the critical need for policy reform and institutional changes to encourage collaboration across governments and between stakeholders throughout CCA projects.

### *Potential social equity trade-offs of climate adaptation projects*

Vulnerable populations, such as the urban poor, often live in highly flood-prone areas that lack resilient infrastructure such as proper drainage systems, have less adaptative capacity to deal with flood-related risk, are less of a priority to local governments in the provision of essential infrastructure and services, and consequently have less legal and financial protection from the impacts of climate change (Dodman & Satterthwaite, 2009, p. 69; Uitto & Shaw, 2016). There is a need to address social equity concerns in CCA initiatives in order to promote flood resilience across entire communities (Zuniga-Teran et al., 2020).

Definitions for social equity vary depending on the context (Meerow et al., 2016, 2016; Schlosberg, 2004). Meerow et al. (2019) discuss social equity in the context of urban resilience planning and state that recognitional, distributional, and procedural equity can shape the resilience of communities (Meerow et al., 2019). The authors define recognitional equity as the "acknowledgement and respect of different groups", distributional equity as the "equitable distribution of goods, services, and opportunities", and procedural equity as the "equitable participation in decision-making processes" (Meerow et al., 2019, p. 796). While the exact definition of social equity depends on the context in which the term is being discussed, the definition provided by Meerow et al. (2019) directly relates to CCA planning.

Numerous academic articles examine the relationship between climate adaptation and equity. Anguelovski et al. (2016) analyze CCA initiatives in different cities and find two distinct social equity issues, including "acts of commission" that lead to displacement of socioeconomically vulnerable communities, and "acts of omission" that prioritize elite groups (p. 333). There has also been growing recognition that community-based adaptation (CBA) is necessary to reduce disaster risk (Shaw et al., 2010). Top-down approaches to CCA are often not designed with the specific context in mind and researchers often point out that the needs and priorities of a community are better anticipated through inclusive decision-making processes that integrate community members into adaptation planning (Shaw et al., 2010).

## Opportunities to enhance resilience through NBS

Scholarly research highlights several opportunities to enhance flood resilience through NBS focused on regulatory, institutional, and social improvements across communities. A combination of structural and non-structural solutions is increasingly seen as valuable, including policy reform, governance shifts towards inclusive decision-making processes, promoting alternative and innovative solutions, and prioritizing proactive and long term thinking over short-term thinking and reactive approaches (Chan et al., 2018; Drosou et al., 2019; Zuniga-Teran et al., 2020). Above all, we need to move beyond silo thinking and solely focusing on hard engineered solutions towards the integration of green, sustainable, and equitable practices (Chan et al., 2018). Opportunities to integrate NBS into adaptation and spatial planning are summarized below.

### *Policy reform to integrate NBS into decision-making*

Opportunities exist for policy reform to better integrate NBS into decision-making. One example is highlighted by Chan et al. (2018), who analyze the *Active, Beautiful, Clean (ABC) Waters programme* in Singapore that uses a variety of water management approaches to reduce flood risk across the region. Through the programme, NBS, including bioretention systems and constructed wetlands, have been implemented to replace or enhance hard engineered drainage systems (Chan et al., 2018). Similar to the integration of water sensitive drainage systems in Hong Kong, Singapore seeks to look at drainage systems more holistically, including the "…flood source (e.g. rainfall, wind, waves and tidal changes), pathways (e.g. overtopping, overflow, breaching, over-washing) and receptor (e.g. people and properties)" (Chan et al., 2018, p. 583).

Zwierzchowska et al. (2019) also highlight numerous ways in which NBS can be integrated into urban policy for successful and widespread implementation, including embedding NBS into building and urban drainage system guidelines, promoting green community-based projects at the local scale, prioritizing awareness and education of NBS, and promoting economic opportunities related to NBS. Urban planning policies should prioritize the conservation of open green space as much as possible, particularly during present times of rapid urban expansion (Daniere & Garschagen, 2019; Zuniga-Teran et al., 2020). Other scholars emphasize the need for flexible policies and decision-making processes that can easily adapt to changing social, political, economic, and environmental circumstances over the long term (Chan et al., 2018; Buurman and Babovic, 2016). Moreover, authors point out that policy reform is required to promote collaboration and knowledge sharing between disciplines, enhance technical knowledge of NBS within government, and break path dependency towards gray infrastructure (Davies & Lafortezza, 2019). Rather than viewing urban development and CCA as separate competing forces, adaptation must be built into urban development policies (Dodman & Satterthwaite, 2009).

### *Policy reform to improve spatial planning and delegate responsibilities*

Given the high vulnerability of coastal areas, it is unreasonable for governments to continue permitting densification in flood-prone areas (Chan et al., 2018; Duy et al., 2018; Uitto & Shaw, 2016). Physical features, including land elevation, proximity to waterbodies and floodplains, building coverage, and green space coverage, can tremendously impact community resilience to flooding (Chen et al., 2020). Duy et al. (2018) argue that policy reform is necessary to shift spatial planning in a direction that reduces flood risk and community vulnerability. The authors highlight the critical need for alternative approaches to CCA in the Southeast Asian context, arguing that engineered flood defenses are “unsustainable solutions to increasingly volatile climate in recent years” (Duy et al., 2018, p. 8). Moreover, transparency and clear communication of climate-related information to the public, implementation of resilient infrastructure, and densification outside of flood-prone areas need to be prioritized (Duy et al., 2018). Finally, numerous authors point out that local governments need to have more clearly defined roles and responsibilities surrounding CCA and FRM (Anguelovski et al., 2014; Chan et al., 2018; Dodman & Satterthwaite, 2009; Drosou et al., 2019; Wihlborg et al., 2019).

### *Improved funding mechanisms and support*

Considering the high vulnerability in flood-prone areas and difficulties in identifying funding sources for NBS, researchers point to the need for governments to improve access to housing finance and insurance for lower income households, ensure wider flood insurance coverage to reduce economic risk and enhance resilience, and seek funding from higher levels of government and international organizations to work on CCA projects (Chan et al., 2018; Dodman & Satterthwaite, 2009; Zuniga-Teran et al., 2020). Notably, in areas with limited adaptative capacities, building relationships between different levels of government, civil society, and international organizations can help in the funding and implementation of CCA projects (Dodman & Satterthwaite, 2009). Higher levels of government should provide financial, regulatory, and institutional support to local governments while also working on large-scale risk management strategies to enhance resilience over the long term (Anguelovski et al., 2014; Dodman & Satterthwaite, 2009).

### *Inclusive and collaborative decision-making*

A highly discussed opportunity to enhance resilience across communities is the prioritization of inclusive and collaborative approaches to CCA and DRR. Municipal governments play a key role in CCA due to their close connection to citizens and direct role in maintaining essential infrastructure and services (Anguelovski et al., 2014). At the same time, despite DRR and sustainable development being interconnected concepts, work in these areas tends to be conducted separately by different government sectors (Uitto & Shaw, 2016). For successful implementation, CCA requires collaboration across all levels of government, with national governments focusing on general guidance and frameworks, municipalities focusing on planning and implementation of interventions, and regional governments establishing links between these different levels (Bauer & Steurer, 2014). Policy reform should enable inter- and intra-governmental cooperation and collaboration between stakeholders while encouraging the use of alternative FRM strategies such as NBS (Archer et al., 2014; Frantzeskaki et al., 2020).

Vulnerable populations such as the urban poor must also be prioritized in CCA policies and urban planning processes to ensure equitable adaptation outcomes (Chu et al., 2016; Dodman & Satterthwaite, 2009). Researchers focusing on case studies in the Global South and abroad have found that inclusive and collaborative governance, where relationships are developed between government and community actors through permanent regulatory and institutional changes, can promote long term climate equity and justice (Anguelovski et al., 2014; Chu et al., 2016; Dodman & Satterthwaite, 2009; Mason et al., 2019; Meerow et al., 2016). Meerow et al. (2019) assess social equity in urban resilience plans and argue that recognitional and procedural equity should be prioritized in resilience plans to ensure that social, cultural, and political differences are recognized and the needs of vulnerable populations are included in decision-making processes (Meerow et al., 2019). An inclusive and collaborative approach to adaptation integrates vulnerable populations into decision-making processes and encourages collaboration between planners, developers, policymakers, scientists, as well as different levels and sectors of government (Chan et al., 2018; Frantzeskaki et al., 2020; Mason et al., 2019; Shmueli et al., 2020; Zuniga-Teran et al., 2020).

Inclusive governance has the potential to enhance social capital within a community and build trust between the community and local government (Lo et al., 2015). CBA and participatory decision-making are seen as critical tools in CCA to ensure that the needs and concerns of vulnerable populations are fully understood while also raising awareness of flood risk and the benefits of NBS across communities (Archer et al., 2014, p. 201; Dodman & Satterthwaite, 2009; Drosou et al., 2019;

Nesshöver et al., 2017). Overall, this is a proactive and inclusive way for government to implement solutions best suited to the local context based on local needs, concerns, and conditions (Chu et al., 2016; Drosou et al., 2019).

### *Context-appropriate design and innovative solutions*

It is critical that local governments prioritize the implementation of contextually relevant CCA solutions to ensure long term success (Albert et al., 2020). The best CCA solutions are those that take into account local socioeconomic and ecological conditions (Schoonees et al., 2019). As previously stated, inclusive governance practices ensure that local preferences, needs, and priorities are taken into account (Chu et al., 2016; Drosou et al., 2019).

Pilot projects are also valuable for the implementation of innovative solutions in order to gather valuable practice-based insight into the benefits of NBS (Kabisch et al., 2016; Zuniga-Teran et al., 2020). For instance, thirty 'pilot cities' have been selected in China as testing beds for the Sponge City concept, which seeks to promote flood-resilient infrastructure for urban stormwater management and water conservation through the use of natural systems, such as wetlands (Chan, 2018). If combined with participatory approaches, local government can continuously learn from practice-based evidence and local knowledge while gaining public support for NBS projects over the long term (Albert et al., 2020; Bush & Doyon, 2019; Zuniga-Teran et al., 2020).

### *Summary*

Local governments, including urban planners, have the potential to contribute to the successful implementation of NBS as they are poised to address social equity trade-offs and prioritize inclusionary and participatory decision-making practices (Bush & Doyon, 2019). Research reveals the need for transdisciplinary, intra- and inter-governmental partnerships to promote knowledge-sharing, and collaborative decision-making (Chan et al., 2018; Frantzeskaki, 2019). Moreover, many adaptation projects are reactive in nature (i.e. implemented post-disaster), however successful adaptation will require long term, proactive, and context-sensitive planning approaches, which are currently lacking in practice (Bush & Doyon, 2019; Chan et al., 2018; IPCC, 2014; Seddon et al., 2020). Overall, there are critical issues surrounding the implementation of NBS that remain unaddressed in the context of Southeast Asia and internationally, therefore decision-makers need to carefully consider these barriers and opportunities for effective, long term, and equitable CCA in the years ahead.

## Evaluating NBS projects

In recent years, numerous articles have been published proposing evaluation frameworks and guiding principles for successful implementation of NBS (Albert et al., 2020; Cohen-Shacham et al., 2019; Raymond et al., 2017). Of particular interest is a comprehensive evaluation framework presented by Albert et al. (2020), which highlights characteristics, planning principles, and steps governments and project organizers should take to successfully implement NBS (Albert et al., 2020, p. 3). The framework acknowledges the barriers and opportunities highlighted in the literature review as well as the institutional and regulatory changes necessary to successfully implement NBS projects and integrate these solutions into local adaptation planning and governance.

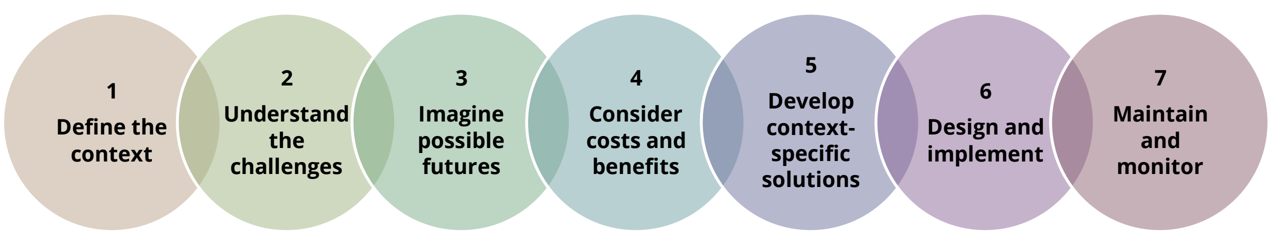


***Figure 4.*** *Ideal project phases for planning NBS projects. Adapted from: Albert et al., 2020.*

According to Albert et al. (2020), in an ideal scenario the planning process would include specific project phases, beginning with context definition and ending with design and implementation, however I argue that monitoring and maintenance should be an additional and separate final step in the process (**Figure 4**; Albert et al., 2020). The authors state that the planning process should begin by (1) defining the social, political, economic, and ecological context in collaboration with decision-makers and affected stakeholders (Albert et al., 2020). Next, (2) the project should be framed based on identified challenges, stakeholders' individual preferences and priorities, as well as target ecosystem services (Albert et al., 2020). Third, (3) planners should consider alternative solutions to NBS in collaboration with local stakeholders. Next, (4) costs and benefits of NBS using both quantitative and qualitive values should be explored, including socioeconomic and ecological aspects (Albert et al., 2020). (5) Context-specific solutions should then be developed that consider government resources and capacity for long term maintenance and monitoring. Next, (6) the design and implementation phase should involve transdisciplinary collaboration and knowledge-sharing (Albert et al., 2020). Lastly, (7) NBS projects should plan for long term maintenance and monitoring to ensure long term viability of the solution, increase the evidence base for NBS, and gain community support for similar solutions over the long term (Albert et al., 2020).

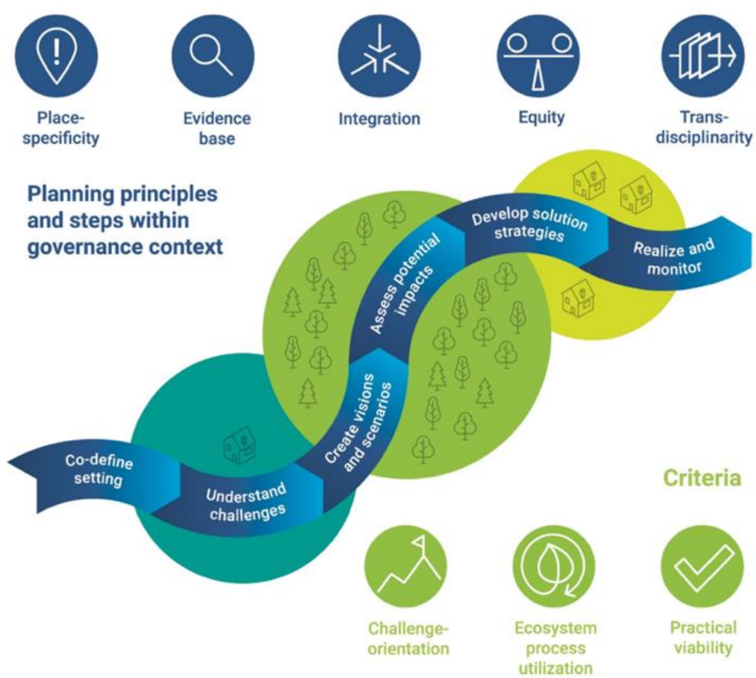


*__Figure 5.__ Guiding principles, steps, and criteria for implementation of NBS. Source: Albert et al., 2020, p. 3.*

Finally, Albert et al. (2020) highlight five guiding principles related to the implementation of NBS that recognize the barriers and opportunities frequently noted by researchers (**Figure 5**). The first principle, **place-specificity**, presents the critical need to ensure that implemented solutions are contextually relevant (i.e., socially, politically, economically, ecologically) (Albert et al., 2020). The second principle is **evidence base**, which emphasizes the need for evidence-based practice when choosing, designing, and implementing NBS (Albert et al., 2020). Third, **integration** focuses on holistic thinking that seeks to integrate solutions across different spatial and temporal scales and within wider regulatory and institutional frameworks (Albert et al., 2020). Fourth, **equity** reflects the need to prioritize social equity in all its forms and environmental justice in participatory planning approaches and outcomes (Albert et al., 2020). Finally, **transdisciplinarity** presents the need for collaborative decision-making by promoting cooperation across sectors and disciplines at different stages of the planning process (Albert et al., 2020). These guiding principles are used to evaluate case studies presented in the remaining chapters.

# Chapter 4: Climate adaptation in Southeast Asia

Southeast Asia is one of the most flood-prone and vulnerable areas in the world (Daniere et al., 2019; Dulal, 2019). Between 2012 and 2020, flooding was the most frequently reported type of disaster amongst ASEAN member countries, including but not limited to Indonesia, Cambodia, Malaysia, Vietnam, and the Philippines (The ASEAN Secretariat, 2020, p. 9). A recently published article assessing global sea-level rise vulnerability found that low-elevation coastal zones in the tropics, particularly in Southeast Asia, have the highest burden of coastal flood risk due to rapid population growth in these regions and limited capacity to deal with the impacts of climate change (Hooijer & Vernimmen, 2021). Even one metre of sea-level rise has the potential to be devastating for these coastal regions, not accounting for increasingly intense and frequent pluvial-related flooding expected from climate change (**Figure 6**; Hooijer & Vernimmen, 2021, p. 5).

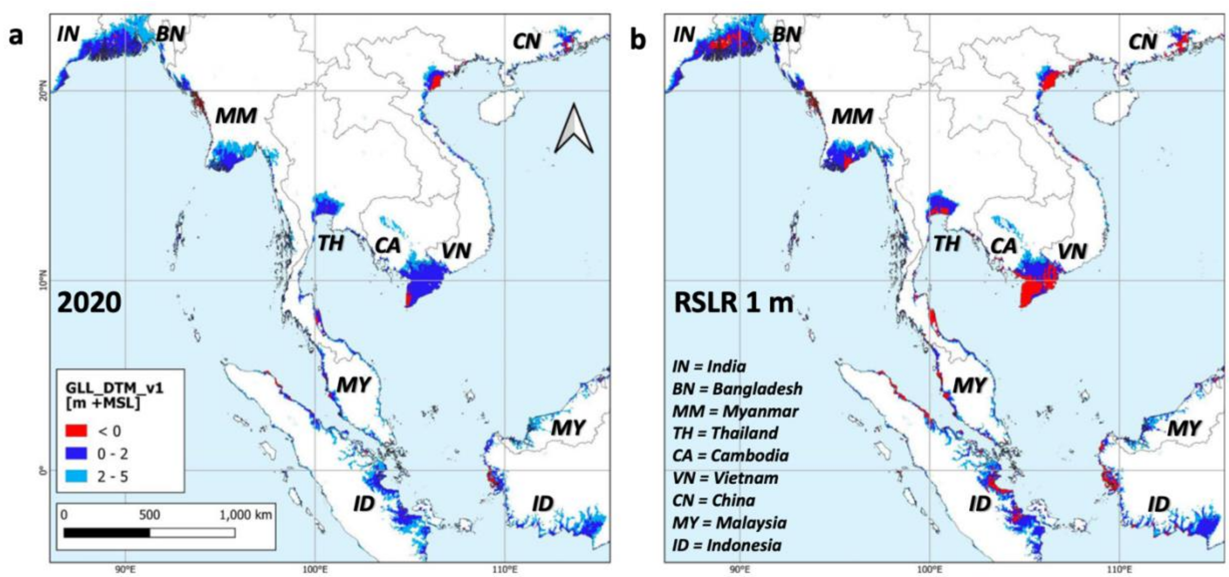


***Figure 6.*** *Elevation above sea-level in (a) 2020 (to the left) and (b) after one metre relative sea-level rise (to the right). Source: Hooijer and Vernimmen, 2021, p. 5.*

Southeast Asian countries are aware of the devastating economic consequences of inaction due to the billions of dollars' worth of damage that has occurred as a result of major floods, typhoons, and related disasters in the last decade (The ASEAN Secretariat, 2020). At the same time, despite a new global treaty aimed at protecting 30% of the world's plants, animals, and ecosystems by 2030, there has been a lack of commitment on the part of Southeast Asian governments to protect the natural environment (Taylor, 2021). One example of this is reflected in a recent news article highlighting unprecedented deforestation in Southeast Asia (Cowan, 2021). Consequences of deforestation in the region include mass carbon storage loss, landslides, soil erosion, biodiversity loss, local warming, water quality reduction, flooding, and displacement (Cowan, 2021). Southeast Asian countries are facing several immediate and interconnected issues, including climate change, biodiversity loss, deforestation, and air pollution (Daniere & Garschagen, 2019). For this reason, it is critical for local governments to shift their priorities away from solely economic growth and rapid urbanisation towards social and ecological improvements (Daniere & Garschagen, 2019; Taylor, 2021; The ASEAN Secretariat, 2020). Overall, more needs to be done to mitigate social, economic, and ecological impacts of climate change over the long term.

The following case studies take place within this context of limited local government resources and capacity, competing interests and priorities, and increasing vulnerability of lowland coastal regions across Southeast Asia as rapid urbanisation and densification continues in flood-prone areas across Asia. Amidst these challenges limiting the implementation of climate adaptation strategies, NBS projects are being implemented to mitigate the impacts of climate change in urban and non-urban regions of Southeast Asia. The following case studies highlight two recent nature-based interventions focused on addressing socioeconomic and ecological issues in Indonesia and Cambodia.

# Chapter 5: Ecosystem-based adaptation in Cambodia

## Overview

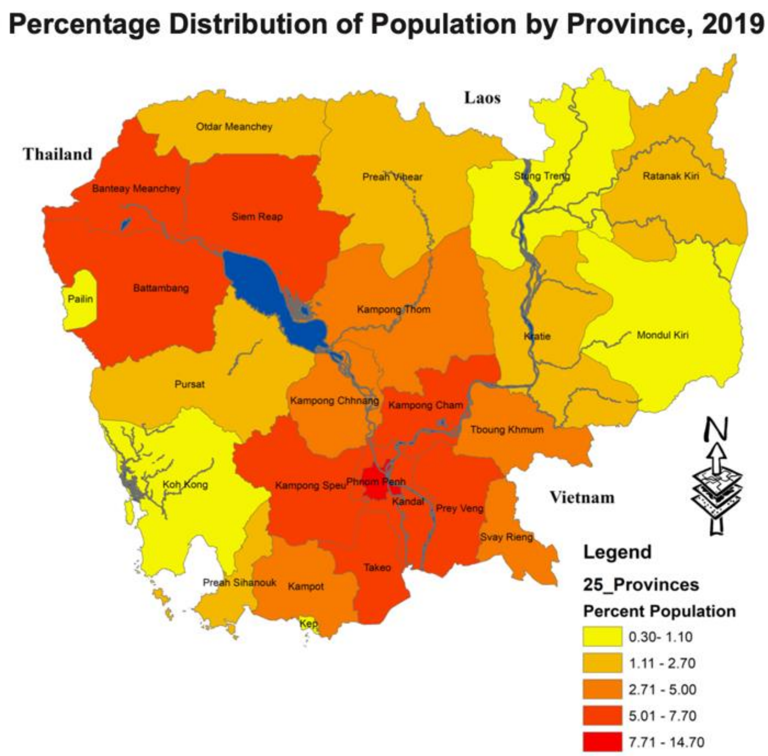


***Figure 7.*** *Map of Cambodia showing population by province. Source: National Institute of Statistics (NIS) & Ministry of Planning, 2020.*

Cambodia is located between Thailand (to the north), Laos (to the northeast), and Vietnam (to the south), and includes the capital city of Phnom Penh, 24 other provinces, and a total of 26 municipalities (**Figure 7**; Asian Disaster Preparedness Center & UNDRR, 2019; National Institute of Statistics & Ministry of Planning, 2020). The majority of Cambodia's territory is covered by the Mekong River and Tonlé Sap waterbodies, and as of 2019, the country had 15.5 million inhabitants, including nearly 2.3 million in the capital alone (Asian Disaster Preparedness Center & UNDRR, 2019; NIS & Ministry of Planning, 2020).

Since 1993, governance in the country has been led by a constitutional monarchy and separated by the Council of Ministers (executive branch), Parliament (legislative branch), and Supreme, Appeals, and municipal/provincial Courts (judiciary) (Open Development Cambodia (ODC), 2016). Administration is divided into the Capital and Provinces, with second-level administration separating the provinces into districts and municipalities, and third-level into communes and subdivisions (i.e., *Sangkat*) (*MLIT, 2016*; Open Development Cambodia (ODC), 2016). Decentralization has been a major focus of the Cambodian government since the establishment of the *National Program for Democratic Development at the Sub-national Level 2010-2019* in 2010, with large investments being put towards shifting resources, power, and responsibilities to local levels of government (Open Development Cambodia (ODC), 2016).

Cambodia has a tropical monsoonal climate with a heavy rain season and dry season, causing periods of droughts and floods (Adaptation Fund, 2012; Asian Disaster Preparedness Center & UNDRR, 2019). Settlement in flood-prone areas, agricultural dependence, a lack of proper drainage systems, as well as a lack of access to infrastructure and services are exacerbating flood and disaster risk in the country (Asian Disaster Preparedness Center & UNDRR, 2019). For instance, a large proportion of Cambodia's lands are at a low elevation with major population hubs near waterbodies, leading to Cambodians being highly vulnerable to flooding (Asian Disaster Preparedness Center & UNDRR, 2019). Flooding is the most critical issue in Cambodia and the majority of disasters between 1996 and 2013 were flood-related, with fire, drought, and storm-related disasters occurring at half the frequency but still negatively impacting the country (**Figure 8**; NCDM & UNDP, 2009). Beyond natural hazards, the country is facing numerous environmental issues, including biodiversity and ecosystem service loss, land degradation, and deforestation despite most forests being legally protected (Adaptation Fund, 2012).

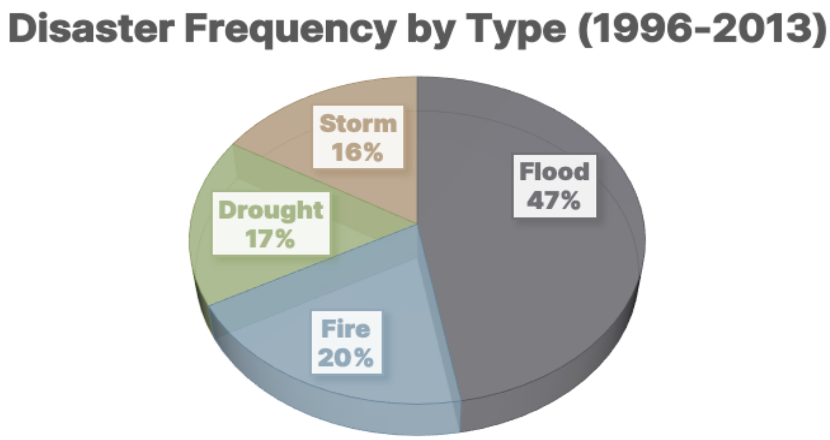


***Figure 8.*** *Disaster frequency by type between 1996 and 2013 in Cambodia. Data source: National Committee for Disaster Management (NCDM) & Ministry of Planning, 2008.*

A great deal of urbanization in Cambodia has also been unplanned, with at least 250,000 people moving to informal settlements in Phnom Penh alone who lack housing security and proper access to infrastructure and services (Asian Disaster Preparedness Center & UNDRR, 2019). Rural communities are also highly reliant on agriculture and lack adaptive capacity (Asian Disaster Preparedness Center & UNDRR, 2019). When a disaster strikes rural communities, poverty, debt, and access to vital infrastructure and services worsens as a result of agricultural productivity loss (Asian Disaster Preparedness Center & UNDRR, 2019). Notably, rice production and fishing are major contributors to the national GDP, however these sources of income are extremely vulnerable to hazards, which means climate change impacts are a major threat to livelihoods and food security (Asian Disaster Preparedness Center & UNDRR, 2019). Although Cambodia's economy is rapidly developing and working on moving away from dependence on agriculture, 61% of Cambodia's population still resides in rural regions with many still depending on agriculture-based livelihoods (Asian Disaster Preparedness Center & UNDRR, 2019; NIS & Ministry of Planning, 2020).

## Climate governance and policies

In Cambodia, the National Committee for Disaster Management (NCDM) is the main organization responsible for disaster risk management (DRM), while socioeconomic development is led by the Ministry of Planning (MoP), and spatial planning is led by the Ministry of Land Management, Urban Planning and Construction (MLMUPC) (Asian Disaster Preparedness Center & UNDRR, 2019; MLIT, 2016). In regard to DRM, the Royal Government has been focused on (1) the implementation of disaster information systems and increasing knowledge of climate risks, (2) integrating DRM into development planning and legal frameworks, (3) budgeting for DRM projects, and (4) enhancing climate resilience to 'build back better' in the event of disasters (Asian Disaster Preparedness Center & UNDRR, 2019).

Numerous barriers to implementing DRM in Cambodia have been highlighted in reports, including the lack of human and financial capacity at local and national levels of government, the lack of sustainable resource management across the country including in protected areas, and risk financing and insurance gaps related to natural hazards (Asian Disaster Preparedness Center & UNDRR, 2019). There is also a lack of DRM and CCA integration into institutional frameworks at local levels of government:

**"While the government is striving to mainstream DRR and CCA into national development plans as part of its efforts to streamline approaches, the same process is yet to take place at the sub-national level. As the country's policy and strategic directions lay solid framework for coherence, efforts to operationalize these plans for tangible outcomes at the local government levels remains to be achieved" (Asian Disaster Preparedness Center & UNDRR, 2019, p. 26).**

Contrastingly, since 2008 numerous national-level policies and plans have been implemented focused on climate change, adaptation, and DRM (**Figure 9**; Asian Disaster Preparedness Center & UNDRR, 2019). For instance, the *Cambodia Climate Change Strategic Plan 2014-2023* is the most recent plan that highlights CCA and sets out eight key objectives to promote climate resilience, including:

(1) improving food, water, and energy security,
(2) reducing vulnerability and climate-related health risks,
(3) enhancing resilience of ecosystems, biodiversity, protected areas, and heritage sites,
(4) promoting low-carbon sustainable development,
(5) Developing local capacity, including knowledge and awareness-building,
(6) promoting participatory planning approaches,
(7) integrating CCA and mitigation efforts into institutional and regulatory frameworks, and
(8) emphasizing regional collaboration between governmental and non-governmental sectors *(National Climate Change Committee, 2013).*

Many of the above noted objectives can be achieved through NBS. Notably, the plan's guiding principles emphasize evidence-based, ecosystem-based, and community-based approaches, as well as equitable, transparent, and locally-appropriate solutions (National Climate Change Committee, 2013, p. 4). Despite climate change action plans established by the Royal Government, communities across Cambodia continue to be vulnerable to the impacts of climate change, as tropical storms, flash floods, and major landslides have caused mass evacuation, widespread rice crop loss, and numerous deaths in 2020 alone (Chhengpor, 2020; Khaliq, 2020; The Associated Press, 2020, p. 000).

| IMPLEMENTATION | POLICY/PLAN | SCOPE | PURPOSE |
|---|---|---|---|
| ROYAL GOVERNMENT OF CAMBODIA | Sub-decree No.54 ANKR-BK | National | Mandates the establishment of the National Committee for Disaster Management |
| NATIONAL COMMITTEE FOR DISASTER MANAGEMENT | Sub-decree No. 30 ANKR-BK | National, Provincial | Supports the decree No. 54 by requiring disaster management committees to be established below the national level |
| NATIONAL COMMITTEE FOR DISASTER MANAGEMENT, OTHER RELEVANT PARTIES | National Action Plan for Disaster Risk Reduction (2008-2013) | National, Provincial, Districts | Provides focus on vulnerability and poverty reduction, a road map for comprehensive DRR |
| NATIONAL COMMITTEE FOR DISASTER MANAGEMENT, OTHER RELEVANT PARTIES | National Action Plan for Disaster Risk Reduction (NAP-DRR) (2014-2018) | National, Provincial, Districts | Articulates country's DRR strategic focuses and desired outcomes towards resilience building |
| NATIONAL COMMITTEE FOR DISASTER MANAGEMENT | Law on Disaster Management (2015) | National | Formalizes the role of the NDMC as the lead administrative organ of disaster management activities. Identifies roles and responsibilities of other institutions as well. |
| ALL RELEVANT STAKEHOLDERS FROM THE GOVERNMENT TO PRIVATE SECTOR | Climate Change Action Plan (2016-2018) | National, Provincial | Identifies the scope and needs to sustainable growth and utilization of natural resources. |
| ALL RELEVANT STAKEHOLDERS FROM THE GOVERNMENT TO PRIVATE SECTOR | Cambodia Climate Change Strategic Plan (2014-2023) | National, Provincial, Sectoral, Districts | First comprehensive policy document to address climate change to guarantee low-carbon, resilient and equitable development of sectors and society. |

***Figure 9.*** *Regulatory framework for the integration of DRM in Cambodia. Source: Asian Disaster Preparedness Center & UN Office for Disaster Risk Reduction (UNDRR), 2019, p. 18.*

## AFCPA Project Cambodia

| Project title | Context |
|---|---|
| Enhancing Climate Change Resilience of Rural Communities living in Protected Areas (AFCPA) | • Beung Per Wildlife Sanctuary, Phnom Prech Wildlife Sanctuary, and Phnom Kulen National Park in Cambodia<br>• ~ 318 families per CPA<br>• Ranging from 78 to 9,862 hectares in area<br>• Rural communities dependent on the land |
| **Issues being addressed** | **Strategies used** |
| • Degraded forest ecosystems<br>• High vulnerability to floods, erratic rainfalls, droughts, and other climate-related hazards<br>• Livelihoods at risk due to agricultural productivity loss and crop damage<br>• Forest-based income loss due to degraded forests | • Ecoagriculture approach including<br>(1) restoration of degraded CPA forests<br>(2) intensification and diversification of agricultural production<br>• Enhancing and diversifying livelihoods<br>• Improving patrolling systems to protect forests<br>• Integration of ecoagriculture approach into institutional and regulatory framework<br>• Knowledge gathering<br>• Capacity and awareness building |
| **Key stakeholders** | **Project timeline** |
| • UN Environment Programme (UNEP)<br>• Ministry of Environment (MoE) Cambodia<br>• Local communities in Community Protection Areas (CPAs) | 2013 - 2019 |

***Figure 10.*** *Summary of AFCPA Project Cambodia. Data sources: Adaptation Fund, 2012; C4EcoSolutions, 2015; UN Environment Programme, 2018.*

Numerous CCA projects are taking place across Cambodia to enhance resilience of vulnerable communities and restore agricultural productivity. A recent article from the FAO announced over $46.6 million in investments into climate mitigation, adaptation, and environmental restoration projects across eight countries, including Cambodia (FAO, 2021). The *Enhancing Climate Change Resilience of Rural Communities living in Protected Areas* (AFCPA) project focuses on reducing vulnerability of rural communities in community protected areas (CPAs) through ecosystem-based adaptation. Five CPAs within three protected areas (PAs) are prioritized for the project, including **Chiork Beungprey CPA**, **Chom Thlork CPA**, and **Skor Mreach CPA** in Beung Per Wildlife Sanctuary,

**Ronouk Khgeng CPA** in Phnom Prech Wildlife Sanctuary, and **Chop Tasok CPA** in Phnom Kulen National Park (**Figure 11;** Adaptation Fund, 2012).

There are 26 PAs in Cambodia, including wildlife sanctuaries, national parks, and protected landscapes, and they hold some of the rarest and most important species and biodiversity in the world (Lacerda et al., 2004; *World's Rarest Species Confirmed in Cambodia - Khmer Times*, 2021). Despite being protected under the 2008 *Protected Areas Law*, illegal logging is threatening their viability over the long term (Adaptation Fund, 2012; Humphrey, 2019; Open Development Cambodia, 2016; Turton, 2021).

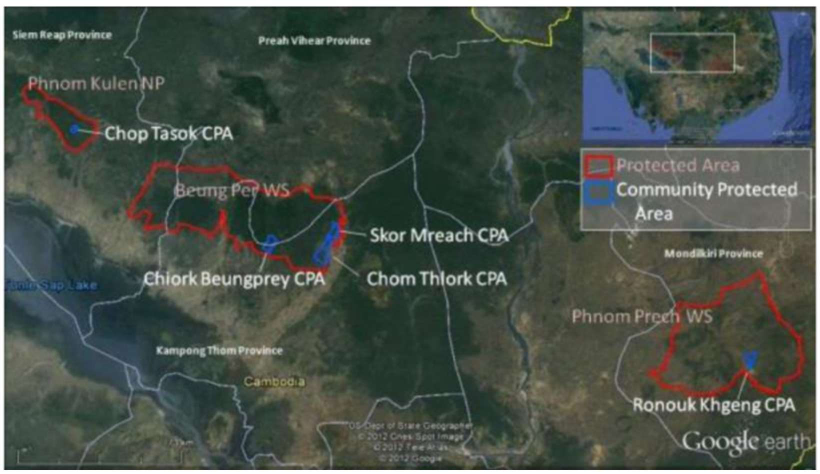


***Figure 11.*** *Project target locations in protected areas (PAs) of Cambodia. Source: Adaptation Fund, 2012, p. 27.*

The AFCPA project focuses on implementing the ecoagriculture approach [2] in selected communities with the aim of (1) restoring degraded forests for multi-use purposes by planting native species that provide ecosystem services including flood control, and (2) planting multi-use native tree species alongside rice and other crops to enhance agricultural productivity and diversify agricultural practices to be more sustainable and resilient (Adaptation Fund, 2012). Project organizers emphasize

[2] Ecoagriculture refers to "…integrated conservation–agriculture landscapes in which biodiversity conservation is an explicit objective of agriculture and rural development…" (Scherr & McNeely, 2008, p. 477). The aim of ecoagriculture is to balance ecological, social, and economic aspects of agricultural practices (Scherr & McNeely, 2008). Related concepts include agroforestry, which focuses on integrating trees and other woody perennials on farms for more sustainable agricultural production (FAO, 2015; Scherr & McNeely, 2008).

collaborating with local communities through participatory approaches, better integrating CPAs into policy and legislation, establishing multi-use forests, providing training on more sustainable agricultural practices, and ensuring long term management of restored forests (Adaptation Fund, 2012). Based on two stages of community surveys, target CPAs with high vulnerability were identified, as well as concerns and preferred solutions of locals (Adaptation Fund, 2012).

The project has faced a number of challenges, including organizing community members for tree planting and nursery management who have work and household commitments, understanding and integrating tree planting seasons into implementation plans, addressing illegal forest clearing, and issues surrounding travel restrictions imposed due to the COVID-19 pandemic which temporarily delayed final stages of the project (Adaptation Fund, 2017, 2020). Despite these challenges, project organizers state that climate change vulnerability has decreased in each CPA, although methods for computing this remain unclear (Adaptation Fund, 2020). According to project organizers, as of 2020 at least 947,690 native trees have been planted for forest restoration purposes, 518,542 fruit trees have been provided to community members, and numerous degraded forests have been restored (Adaptation Fund, 2020). Moreover, the majority of households have reported better water access, improved rice storage techniques, and new seed variety access due to interventions (Adaptation Fund, 2020). The project has also been successful at integrating CCA and ecoagriculture into national development policies and plans, and ecoagriculture interventions have been expanded beyond CPAs in Cambodia (Adaptation Fund, 2019, 2020).

## Evaluation of AFCPA Cambodia

### *Context relevance*

Ensuring that the project was contextually relevant was a high priority for the organizers. The local socioeconomic and ecological context was identified through climate forecasts, research groups, engineering studies, geographical and agricultural assessments, and participatory approaches (Adaptation Fund, 2012; UN Environment Programme, 2018). Moreover, native tree species were chosen for the project and organizers implemented experiments to identify drought-resistant rice crops that were successful in the local context (Adaptation Fund, 2012; UN Environment Programme, 2018). Alternative livelihoods (i.e., ecotourism, small-scale crafting) were also identified later in the project based on local conditions (Adaptation Fund, 2012; UN Environment Programme, 2018). Overall, the interventions chosen were designed to be contextually appropriate.

### *Evidence base*

As previously noted, the evidence base was also a high priority throughout the project. Data was collected on an ongoing basis through expert studies and assessments, local knowledge gathering, and long term monitoring techniques such as community-distributed surveys which directly involved local community members in ongoing efforts to learn from project outcomes (Adaptation Fund, 2012; UN Environment Programme, 2018).

### *Integration into wider context*

Integration of the interventions across spatial scales and into institutional and regulatory frameworks was prioritized at later stages of the project. Studies were conducted on surrounding CPAs to understand the impacts and benefits of the project at the landscape and regional scale (Adaptation Fund, 2012; UN Environment Programme, 2018). Work was also conducted to integrate farmers into domestic, regional, and global markets to improve their livelihoods (Adaptation Fund, 2012; UN Environment Programme, 2018). The organizers focused on integrating the ecoagriculture concept and CCA into national and provincial development plans during the final stages (Adaptation Fund, 2012; UN Environment Programme, 2018). Moreover, education and awareness-building efforts continue, including workshops, farm days, campaigns, and documentaries highlighting the project and benefits of ecoagriculture nationally and internationally (Adaptation Fund, 2012; UN Environment Programme, 2018). The project has also expanded to other CPAs in Cambodia and beyond (Adaptation Fund, 2012, 2020; UN Environment Programme, 2018). Although work on integrating the project into broader frameworks only began during final stages, the organizers have been successful at prioritizing integration as an important component of the project.

### *Social equity considerations*

Equitable decision-making was highly prioritized and considered one of the most valuable aspects of the project. Before the project began, community surveys were distributed to identify target CPAs based on their vulnerability to climate change, to understand major threats to their well-being, to identify intervention preferences of locals, and to understand the level of community support for the project as a whole (Adaptation Fund, 2012; UN Environment Programme, 2018). For instance, local community knowledge and preferences pertaining to native tree species directly influenced decision-making (Adaptation Fund, 2012; UN Environment Programme, 2018). Training and awareness-building for local community members, local authorities, and committee members was also a key component of the project (Adaptation Fund, 2012; UN Environment Programme, 2018). In particular, the organizers focused on local capacity development by training locals to plan, implement, and maintain ecoagriculture interventions (Adaptation Fund, 2012; UN Environment Programme, 2018). As the project reached its final stages, community members were provided increased access to technical and financial resources to enhance and diversify their livelihoods (Adaptation Fund, 2012; UN Environment Programme, 2018). Overall, equity was critically important throughout the AFCPA project.

### *Collaborative decision-making*

Collaborative decision-making was highly valued by AFCPA project organizers. For instance, during initial stages of the project numerous studies were conducted by different disciplines and sectors (Adaptation Fund, 2012; UN Environment Programme, 2018). Moreover, there have been ongoing efforts to encourage collaboration between different levels of government on future restoration projects and to promote capacity development amongst all stakeholders including local, provincial, and national levels of government (Adaptation Fund, 2012; UN Environment Programme, 2018). Transdisciplinarity has been promoted and highlighted as a valuable guiding principal.

### *Summary*

The AFCPA project benefited from developing a thorough understanding of the local context during early stages through a diverse evidence base. Integration of the project at the regional and national scale and into development plans was also seen as critically important at later stages of the project. Moreover, equity and transdisciplinarity were highly valued by project organizers as efforts were continuously made to promote participatory and collaborative decision-making, build local capacity, and gather data from local community members and across disciplines and government sectors. Overall, the guiding principles highlighted by Albert et al. (2020) have been successfully integrated into the AFCPA project in Cambodia.

# Chapter 6: Building with Nature in Indonesia

## Overview


***Figure 12.*** *Map of Indonesia. Source: Google Maps, 2021.*

Indonesia is home to over 271 million people, 36.5 million of whom are located in Central Java (**Figure 12**; Statistics Indonesia, 2021). With over 300 local languages, the country is extremely ethnically diverse with one of the largest Muslim populations on the planet (Dunne, 2019). Moreover, Indonesia is one of the most biodiverse countries in the world, containing 10% of the world's tropical rainforests, 36% of the world's tropical peatlands, and 23% of the world's mangroves (Barclay, 2019; Dunne, 2019; Taylor, 2021).

Until recently, Jakarta was the capital of Indonesia, however in 2019 the new capital city of Borneo, north of Java, was announced to shift development and investment away from the highly polluted and disaster-prone region of Java (Costa, 2019; Van de Vuurst & Escobar, 2020). Recent research and news articles point out unsustainable conditions on the island of Java and future threats to biodiversity due to the switch of Indonesia's capital to Borneo (Costa, 2019; Van de Vuurst & Escobar, 2020). Extreme deforestation, mass biodiversity loss, intense road traffic, and high pollution is occurring on the island of Java, and despite the fact that Borneo is currently considered a biodiversity hotspot with some of the largest remaining forests, the recognition of Borneo as the new capital sparks concern that unsustainable practices will lead to a “biodiversity catastrophe” (Van de Vuurst & Escobar, 2020, p. 4).

In Indonesia, 42 million people live in extremely flood-prone areas and the risk of low-lying coastal land disappearing as a result of sea-level rise is significant (Dunne, 2019; World Bank Group, 2011). Between 140 and 220 million people also live within 100 kilometres of the coast, the majority of whom depend on marine resources for their livelihoods (Dunne, 2019; World Bank Group, 2011). The loss of coastal natural resources has the potential to significantly threaten the country’s economy and livelihoods of locals:

**“Coastal and marine activities employ a large segment of the population and contribute up to 15% of Indonesia’s GDP. Indonesia’s reefs are home to 90% of the fish stock and account for 60% of the protein intake of the average Indonesian, and recent data show significant reef degradation. It is estimated that over 70% of all coral reefs in Indonesia may already suffer damage and over 700 native wildlife species face extinction. Maintaining healthy coral reef systems are therefore vital to the country” (World Bank Group, 2011, p. 8).**

In Indonesia, not only is climate adaptation along coasts necessary to protect communities from potential disasters, but biodiversity protection and enhancement are fundamental for the economy and society. For this reason, NBS can be seen a valuable approach to climate adaptation across the country.

## Climate governance and policies

Democratic governance has been present in Indonesia for decades, with the country holding democratic elections since 1955 and presidential elections since 2004 (Dunne, 2019). Indonesian government operates at different levels, from high-level central government to local city and district government bodies, however the majority of policies are implemented by central government (IIED, 2014). A lack of institutional and financial capacity, disconnection between different levels of government and across government sectors, a lack of financial and technical support for local governments, and a lack of transdisciplinary collaboration have been highlighted as critical issues limiting climate change adaptation in Indonesia (IIED, 2014).

Indonesia has been criticized as being one of the largest emitters of greenhouse gas emissions as a result of deforestation, peatland fires, and fossil fuel burning for energy production (Dunne, 2019). Although the country has committed to 29-41% reduction in carbon emissions by 2030, it has been argued that current trends could cause the country's carbon emissions to actually double by that the target year (Dunne, 2019). Moreover, central government tends to be reactive in decision-making when it comes to climate mitigation and adaptation efforts. For example, in 2015 a nationwide moratorium was established preventing the drainage of peatlands for palm oil production after massive peatland fires caused widespread devastation (Dunne, 2019). After this occurred, the Peatlands Restoration Agency was required to restore 2 million hectares of tropical peatlands by 2020, which ended up reducing deforestation at the time by 60% (Dunne, 2019). These reactive efforts have not prevented further degradation of the natural environment, as massive deforestation continues to be reported in the media and the new capital project threatens the future of the flora and fauna in the region (Barclay, 2019; Costa, 2019; Van de Vuurst & Escobar, 2020).

Numerous action plans have been established by the Indonesian central government to address climate change and lay out plans for mitigation and adaptation. The *National Action Plan Addressing Climate Change* highlights mangrove, coral reef, and forest restoration projects that have taken place in northern Java alongside hard infrastructure implementation to reduce coastal erosion, empower local communities, increase vegetative coverage, and sequester carbon (Republic of Indonesia, 2007). Capacity building is also mentioned to raise awareness of climate change impacts amongst farmers (Republic of Indonesia, 2007). The document states that long term goals include fully integrating climate adaptation into national development plans to promote economic, social, and environmental resilience (Republic of Indonesia, 2007). The document states that "development that only focuses on economic targets without consideration of natural resource sustainability will increase Indonesian vulnerability to climate change" (Republic of Indonesia, 2007, p. 29). Overall, environmental restoration, capacity, awareness, and knowledge building are critical components of the plan (Republic of Indonesia, 2007).

Another key action plan implemented in 2012 is the *National Action Plan for Climate Change Adaptation (RAN-API)*, which has numerous objectives including economic, livelihood, infrastructure, and ecosystem service enhancement, as well as food security, energy security, and housing accessibility (Republic of Indonesia, 2007). Action items to meet these objectives related to NBS include ecosystem rehabilitation, integration of climate adaptation into development plans, promotion of research on sustainable development and resilient infrastructure, capacity development, and monitoring and evaluation of adaptation initiatives (Republic of Indonesia, 2012).

Integration of climate adaptation into development plans remains limited. For instance, the *National Long Term Development Plan for 2005-2025* focuses on national development and becoming internationally competitive and does not recognize climate adaptation as an integral part of development plans. Although the document highlights the need to protect the natural environment, it is primarily concerned with the benefits that biodiversity provides to the economy and national development (President of the Republic of Indonesia, 2007). Notably, current development plans do not highlight the need for climate adaptation (President of the Republic of Indonesia, 2007). This reflects the lack of integration of climate adaptation initiatives into development plans and lack of coordination between government sectors frequently noted by researchers (Albert et al., 2020; Dodman & Satterthwaite, 2009; Nesshöver et al., 2017; Wihlborg et al., 2019).

## Building with Nature (BwN) Indonesia

| | |
|---|---|
| **Project title**<br><br>Building with Nature Indonesia (BwN) | **Context**<br>• Demak District (near Timbul Sloko village), Northern Java, Indonesia<br>• 1.16 million in Demak District of Indonesia<br>• ~3,500 people live in the Timbul Sloko village area<br>• Aquaculture is prominent in the region |
| **Issues being addressed**<br>• Flooding which is negatively impacting livelihoods<br>• Mangrove degradation<br>• Coastal erosion<br>• Aquaculture productivity loss | **Strategies used**<br>• Mangrove restoration<br>• Sustainable aquaculture practice implementation<br>• Capacity development<br>• Knowledge gathering |
| **Project partners (from EcoShape)**<br>• **Government agencies** (MMAF, MPWH)<br>• **NGOs** (Wetlands International, Blue Forest)<br>• **Knowledge institutes** (Deltares, Wageningen Marine research institute, UNESCO-IHE, UNDIP)<br>• **Consultancy and engineering firms and contractors** (Witteveen+Bos, Boskalis, Van Oord) | **Project timeline**<br><br>2015 - 2020 |

***Figure 13.*** *Summary of BwN Project Indonesia. Data sources: R. H. Bosma et al., 2021; Wilms et al., 2020.*

Building with Nature (BwN) Indonesia was initiated by EcoShape in the Demak District of Northern Java, Indonesia, in 2015 (**Figure 14**; Wilms et al., 2020). BwN is defined as “a design approach that harnesses the forces of nature to benefit environment, economy and society, while developing water-related infrastructure” (Wilms et al., 2020, p. 9). The BwN approach integrates both hard engineering and nature-based design principles into climate adaptation projects, including restoration and creation of new ecosystems (Wilms et al., 2020). In the case of Indonesia, NBS were identified as vital to address issues facing the region, including coastal erosion, mangrove degradation, and aquaculture productivity loss (Bosma et al., 2021; Wilms et al., 2020). The key objectives of the project included (1) restoring mangroves as a coastal protection system using permeable structures, (2) restoring aquaculture ponds and promote sustainable practices, and (3) training locals for long term maintenance and management of mangroves and aquaculture facilities (Wilms et al., 2020).


***Figure 14.*** *Building with Nature Indonesia pilot projects in Demak. Source: Google Maps, 2021.*

The project is organized through a public private partnership between government agencies, NGOs, research institutes, and consultancy and engineering firms (Wetlands Int'l, 2013). While the Netherlands regularly uses the BwN approach to manage coasts and rivers on full-scale projects, the case study of the Demak District is considered a large-scale pilot project for the region (Wilms et al., 2020). The future vision for the project is expansion across Asia with the goal of implementing 15 large-scale pilot projects across Indonesia, the Philippines, Malaysia, China, and India (Wetlands Int'l, 2020a; Wilms et al., 2020).

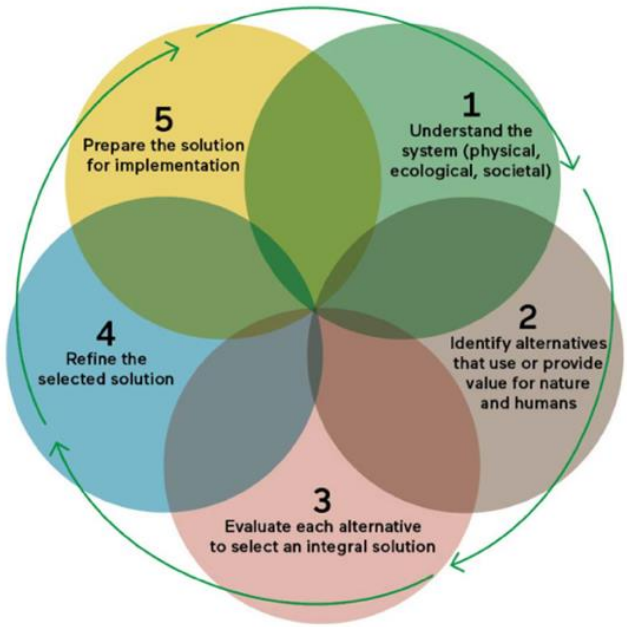


***Figure 15.*** *Steps to generating BwN solutions. Source: Wilms et al., 2020, p. 27.*

Five phases are integrated into the BwN approach, from context definition to implementation, however long term monitoring and maintenance is an additional step discussed in the project evaluation (**Figure 15**; Wilms et al., 2020). The main barrier to implementation of BwN noted by organizers is the lack of knowledge and understanding of the approach compared to conventional CCA options (Wilms et al., 2020). Requirements of the BwN approach closely relate to the guiding principles of NBS previously highlighted and include:

- The need for context-specific design and a solid understanding of the local context,
- transdisciplinary and cross-sectoral collaboration,
- participatory approaches that directly involve local communities in the project,
- capacity development across the local government and community,
- improvement of institutional and regulatory frameworks to integrate BwN into local governance and policies, and
- long term maintenance, monitoring, and knowledge sharing (Bosma et al., 2021; Wetlands Int'l, 2020b; Wilms et al., 2020).

The project faced several challenges limiting widespread benefits. First, during monitoring, program organizers identified massive land subsidence as a result of uncontrolled groundwater extraction, industrial, and infrastructure development in the region (Building with Nature in Indonesia, 2019a). It was found that major institutional framework changes are required to solve this issue and BwN interventions would only delay the consequences and reduce the impact of related hazards (Wilms et al., 2020). This shows that land and economic development continues to be prioritized over socioeconomic and ecological improvements.

Second, monsoon floods washed away permeable structures in 2016, which led to new approaches to make the natural infrastructure more resilient (Building with Nature in Indonesia, 2016). Over time, it has been found that the permeable structures typically have a short lifespan due to damage during rain storms, and while some permeable structures have been lost, the 3.5 kilometres of structures have been added in Demak and 14 kilometres have been added elsewhere as of 2019 (Building with Nature in Indonesia, 2019a).

According to project organizers, there have been several positive outcomes in regard to local capacity development and long term maintenance of mangrove and aquaculture facilities (Building with Nature in Indonesia, 2019b). For instance, at least 100 hectares of mangroves along the coast have been established as protected areas and work is in progress to integrate NBS into broader institutional and regulatory frameworks (Building with Nature in Indonesia, 2018; Wetlands Int'l, 2014). Shrimp farm productivity has also substantially increased due to the promotion of sustainable aquaculture practices through Coastal Field Schools[3] (Building with Nature in Indonesia, 2018).

[3] BwN focuses on *Low External Input Sustainable Aquaculture* (LEISA), which project organizers describe as an approach to "…manage a pond in such a way that (1) they, and their children in the future, can earn a fair income, (2) natural resources remain in a condition that allows present and future generations to benefit, and (3) others are not negatively impacted by their farming" (Bosma et al., 2021, p. 13). Training for LEISA is provided to locals through Coastal Fishing Schools.

Additionally, support for locals to expand into alternative livelihoods has been provided to community members who gave up portions of their ponds for mangrove restoration purposes (Building with Nature in Indonesia, 2018). Ownership of the permeable structures has been transferred to local communities and funding for maintenance of mangroves has been secured in the short term (Building with Nature in Indonesia, 2019a). Finally, community members have been able to maintain mangrove and aquaculture infrastructure without expert help due to the success of Coastal Fishing Schools and other training strategies (Building with Nature in Indonesia, 2019b). Despite highlighted challenges, the project has been successful at improving livelihoods and restoring mangroves in Demak.

## Evaluation of BwN Indonesia

### *Context relevance*

Contextually relevant interventions were prioritized in the BwN project. During initial stages, the socioeconomic, political, and ecological context was evaluated and informed decision-making in regards to choosing appropriate interventions (Wilms et al., 2020). For instance, locally-sourced material was selected for permeable structures that trap sediment and allow mangroves to naturally replenish over time (Wilms et al., 2020). Choosing locally-sourced material was seen as important to facilitate long term maintenance, including regular repair and installation of permeable structures (Wilms et al., 2020). There are also ongoing efforts to adapt implemented interventions based on changing conditions in the region identified through ongoing monitoring (Wilms et al., 2020).

### *Evidence base*

Analysis of satellite imagery, interviews, and discussions with locals are being conducted on an ongoing basis to monitor project outcomes and changing socioeconomic and ecological conditions (Wilms et al., 2020). Although the organizers claim to have conducted a cost benefit analysis to determine the most appropriate solutions for the local context, it is worth noting that the project organizers were biased towards mangrove restoration and details on the cost benefit analysis are not available online. The organizers highlighted that hard engineered solutions are less effective and more costly and unsustainable options, however mangroves were seen as beneficial due to numerous co-benefits provided to people and nature (Wilms et al., 2020). While this may be true, it is unclear whether alternative solutions would have been equally beneficial, such as hybrid interventions incorporating gray infrastructure and NBS.

### *Integration into wider context*

Integration of the project into broader institutional and regulatory frameworks was only considered during final stages of the project as organizers eventually worked on integrating mangrove protection and CCA into regional development plans (Wilms et al., 2020). Project organizers are also seeking to expand BwN across Asia in the years ahead, which would help integrate the project regionally and nationally over the long term and raise awareness of mangrove restoration for CCA and sustainable aquaculture practices (Wetlands Int'l, 2020a; Wilms et al., 2020).

### *Social equity considerations*

Social equity was highlighted at different points of the project. Community members, experts, and government officials were directly involved in planning and implementation of interventions (Wilms et al., 2020). As previously noted, Coastal Field Schools were also established in local communities to train local fish farmers on sustainable aquaculture practices, who would continue to share this knowledge with other fish farmers in the region over the long term (Building with Nature in Indonesia, 2016; Wilms et al., 2020). Moreover, financial and technical support was offered to locals as incentives to participate in mangrove restoration work (Wilms et al., 2020). Finally, the organizers have been actively working on building mutual trust between community members and local government by increasing compliance with local regulations on the one hand, and securing funding from local governments for long term maintenance on the other hand (Wilms et al., 2020).

### *Collaborative decision-making*

Collaborative decision-making is advertised as a foundation of the project due to the EcoShape consortium involving local community members, government officials, NGOs, consultancy and engineering firms, and research institutes into the project (Wilms et al., 2020). However, details regarding collaborative decision-making at different stages of the project have not been made publicly available and this information is not provided in published technical documents outlining project phases. It is unclear whether diverse stakeholders were directly involved in the project and the level of collaboration that occurred (Wetlands Int'l, 2013; Wilms et al., 2020).

### *Summary*

The guiding principles highlighted by Albert et al. (2020) have been successfully integrated into the BwN project in Indonesia to varying degrees. Determining the local context and appropriate solutions was a priority and evidence was gathered from diverse sources, including interviews and discussions with local community members. At the same time, it is unclear whether alternative solutions to mangrove restoration were seriously considered. Integration of the project into broader institutional and regulatory frameworks appears to have been prioritized during final stages of the project, particularly through ongoing work to expand BwN across Asia. While equity and local capacity development have been prioritized, the extent to which collaborative decision-making occurred through the EcoShape consortium remains unclear. Overall, despite a lack of precise details on methods used at each stage of the project, the guiding principles have been incorporated to varying degrees into BwN efforts in Indonesia.

# Chapter 7: Discussion and Conclusion

*Table 1. Summary of case study findings.*

| CASE STUDY:<br><br>NBS PRINCIPLES: | BwN Indonesia | AFCPA Cambodia |
|---|---|---|
| Place-specificity | **HIGH PRIORITY**<br>- Local socioeconomic, political, ecological context integrated into all stages of project | **HIGH PRIORITY**<br>- Local socioeconomic and ecological context integrated into all stages of project |
| Evidence base | **MEDIUM PRIORITY**<br>- Expert and local knowledge incorporated into planning, design, implementation, and monitoring<br>- Potential bias towards mangrove restoration interventions | **HIGH PRIORITY**<br>- Expert and local knowledge incorporated into planning, design, implementation, and monitoring |
| Integration | **HIGH PRIORITY**<br>- Integration of approach into policy and institutional frameworks only prioritized at final stage of project<br>- Plans for BwN project expansion across Asia in the future | **HIGH PRIORITY**<br>- Integration of approach into policy and institutional frameworks, integration of farmers into domestic, regional, and global markets, and monitoring of impacts at the landscape scale prioritized at different project stages |
| Equity | **HIGH PRIORITY**<br>- Concerns and preferences of local community members integrated into project<br>- Capacity development, education, and awareness-building key components of project<br>- Ownership solutions transferred to locals for long term maintenance<br>- Financial and technical support provided | **HIGH PRIORITY**<br>- Concerns and preferences of local community members integrated into project<br>- Capacity development, education, and awareness-building key components of project<br>- Ownership transferred to locals for long term maintenance<br>- Financial and technical support provided |
| Transdisciplinarity | **MEDIUM PRIORITY**<br>- Highlighted as important due to EcoShape consortium of partners, however lack of details on collaborative decision-making throughout project | **HIGH PRIORITY**<br>- Collaborative decision-making was prioritized throughout the project |

The presented case studies have demonstrated barriers and opportunities for implementation of NBS to reduce flood risk and improve community well-being. The guiding principles of NBS presented by Albert et al. (2020) have been integrated into both the BwN Indonesia and AFCPA Cambodia projects to varying degrees. Notably, the AFCPA project in Cambodia did a better job at prioritizing each guiding principle at different stages of the project compared to BwN Indonesia. Detailed information on lessons learned was also more readily available for the AFCPA Cambodia project. The case studies and literature review presented in this report highlight the benefits of NBS to improve ecological and socioeconomic well-being while also providing valuable insight into guiding principles for future NBS projects. Additionally, the following lessons can be learned from the AFCPA Cambodia and BwN Indonesia projects.

First, participatory approaches should be integrated into the project at different stages and local concerns and preferences should be incorporated into decision-making. Actively responding to community concerns by integrating local knowledge into the project can help empower local community members (Adaptation Fund, 2014a, 2014b). As highlighted in the literature review, it is important that social equity in all its forms is embedded into NBS projects for long term success.

Second, the socioeconomic and ecological context needs to be well-understood and included in the planning, design, and implementation of NBS interventions. Notably, integration of the project into the wider context (e.g., landscape and regional scale, provincial and national regulatory and institutional frameworks) is necessary to maximize opportunities for upscaling and identify potential barriers for future projects. In the case of BwN Indonesia, land subsidence was only identified later as a critical challenge to CCA (Wetlands Int'l, 2021; Wilms et al., 2020). This could have potentially been identified earlier in the project if more research had been conducted at the regional scale.

Third, local government agents should be involved in the project early on and organizers should stay in communication with these agents throughout the project to ensure long term support despite government staff changes during the years of the project (Adaptation Fund, 2014a, 2014b). Local, regional, and national governments should work on integrating climate change mitigation and adaptation needs into development plans and other relevant policies in the short-term. Researchers have highlighted this as a critical component to successful implementation of NBS (Dodman & Satterthwaite, 2009; Wihlborg et al., 2019; Zwierzchowska et al., 2019).

Finally, all levels of government must shift their priorities towards social and ecological well-being rather than economic growth and urban densification as it currently stands. Researchers have highlighted this as a key issue to address if NBS implementation and climate adaptation is going to be successful over the long term (Chan et al., 2018; Daniere & Garschagen, 2019; Drosou et al., 2019). Broader institutional, political, and regulatory shifts are necessary to reduce the impacts of climate change and enhance resilience of vulnerable communities. Governments have the power to be proactive and implement these changes in the years ahead.

This report seeks to identify barriers, opportunities, and guiding principles for successful implementation of NBS to reduce flood risk and improve the lives of local communities. Several barriers to implementation have been highlighted, including path dependency towards hard engineered solutions, the focus on one-size-fits-all solutions rather than context-specific solutions, a lack of knowledge and awareness of NBS, a lack of collaborative decision-making, a lack of interest and prioritization of NBS and CCA, inappropriate spatial planning, a lack of resources and local adaptive capacity, and social equity concerns related to NBS.

Opportunities for implementation that address these barriers have also been highlighted, including but not limited to the need for policy reform, technical and financial support for locals, inclusive and collaborative decision-making, and integration of the socioeconomic and ecological context into planning, design, and implementation. These opportunities have been translated into guiding principles by Albert et al. (2020) and the case studies presented in this report showcase the importance of these guiding principles throughout all project phases. Specifically, (1) taking the local context into account, (2) developing a solid evidence base as the foundation of any project, (3) integrating the project into the wider physical, political, and institutional context, (3) prioritizing inclusive decision-making approaches, and (4) emphasizing transdisciplinary collaboration are seen as critical pieces of the NBS implementation puzzle (Albert et al., 2020).

Although presented case studies focus on the Southeast Asian context, this report is useful for all project organizers, planners, and key decision-makers seeking to implement NBS internationally. The barriers, opportunities, and guiding principles highlighted emphasize the need to carefully consider how we design, plan, and implement CCA projects. Overall, findings in this report are relevant to urban, peri-urban, and rural governments and communities seeking to reduce flood risk through natural interventions in a proactive, evidence-based, context-specific, inclusive, collaborative, and integrative way.

There are several limitations to this report worth highlighting. First, information on case studies is gathered through readily available online secondary sources. In the case of BwN Indonesia, the lack of readily available information pertaining to specific steps of the project means that findings may not reflect actual steps taken and alignment with guiding principles used for the assessment. The use of secondary sources was partially due to time availability and partially due to COVID-19 pandemic travel restrictions limiting the potential for fieldwork. Next, material available in languages native to Indonesia or Cambodia have not been referenced, therefore only English translated documents (often provided by international organizations) have been included in the report. In some instances, the lack of readily available English documents may limit findings from the case studies.

Future research into NBS should incorporate first-hand evidence through fieldwork, seek out information from the organizations involved in the project, and be conducted in collaboration with local language speakers to translate documents. A recommendation to project organizers is to ensure that details on implementation techniques for NBS projects are available online and clearly communicated in order to facilitate knowledge sharing and case study research.

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