# Building capacity for adaptation pathways in eastern Indonesian islands: Synthesis and lessons learned

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Editorial

# Building capacity for adaptation pathways in eastern Indonesian islands: Synthesis and lessons learned

## 1. Introduction

Mainstreaming climate change into decision-making to achieve 'climate compatible development' (CCD) for communities in the developing world is a significant and pressing challenge (Metz and Kok, 2008; Mitchell and Maxwell, 2010). Development investments and actions must be identified which achieve co-benefits for poverty alleviation and climate adaptation, plus greenhouse gas (GHG) mitigation (Fig. 1), thus contributing to the United Nations' (2015) Sustainable Development Goals. This process is complicated by the uncertainties in climate change projections and impacts (Ranger and Garbett-Shiels, 2012) and the necessity for cooperation between public and private actors across multiple sectors (Conway and Mustelin, 2014). In addition, other drivers such as population growth, increasing economic volatility and modernisation interact with climate change to generate non-linear and unexpected outcomes and shocks for livelihoods, requiring a complex systems approach to development planning and evaluation (Ramalingam, 2013).

By taking a systems approach to future uncertainty, the recent construct of adaptation pathways provides a potentially useful decision-making framework (Wise et al., 2014). It combines several core principles. First, climate change impacts and responses cannot be considered in isolation, but are components of dynamic, multi-scale social-ecological systems. Second, adaptation involves multiple stakeholders with competing values, goals and knowledge which must be recognised and negotiated. Third, responses to change must be coordinated across spatial scales, jurisdictional levels and sectors. Fourth, planning processes should design and implement incremental adaptation strategies to address proximate causes or symptoms of vulnerability, plus transformative strategies to tackle systemic causes, which in developing countries are often the institutional and political roots of disadvantage (Lemos et al., 2007; Pelling, 2011; Rodima-Taylor et al., 2012; Barrett and Constas, 2014). Fifth, to avoid mal-adaptation, strategies should be 'no regrets' (i.e. yielding benefits under any future conditions of change: Hallegatte, 2009), and decisions to implement them should be sequenced over time.

Because extreme climate change may only emerge later this century (Stafford Smith et al., 2011), there is an 'adaptation window' of approximately 30 years in which to proactively prepare vulnerable communities and other stakeholders to face potentially drastic change (Butler et al., 2014a) by 'leap-frogging' the Sustainable Development Goals (Butler et al., 2014b). However, this is constrained by unprecedented rates of social and economic change in many developing countries (Armitage and Johnson, 2006; Curry et al., 2012), which increasing climate change and variability will quickly exacerbate. In addition, there is weak capacity across all societal and administrative levels (Cundill and Fabricius, 2010), information to support decision-making is often lacking (Ensor, 2011), and planning is largely 'top-down' and dominated by powerful government and expert stakeholders' agendas, marginalising communities' interests (Sherman and Ford, 2013). Rapid change also continually re-shapes the political and institutional environment, undermining trust and cooperation between stakeholders (Wollenberg et al., 2007). Consequently the Climate and Development Knowledge Network (CDKN, 2014) stressed the need in lower income countries for processes that can create the enabling conditions to implement CCD, including building an evidence base, and enhancing institutional and stakeholder capacity to understand and act upon it.

Although the adaptation pathways construct may be applicable to meeting this challenge in the developing world (Butler et al., 2014b), there are no empirical examples of how to implement the approach to achieve CCD in situations where stakeholder capacity is low, poverty is entrenched and change is rapid. In this Special Issue we present the design, outputs and outcomes of a four year project which attempted to catalyse an adaptation pathways process in a relatively under-developed region of Indonesia, Nusa Tenggara Barat (NTB) Province (Fig. 2). As well as being typical of the socio-political contexts of many countries in the tropical Asia-Pacific region, NTB is representative of its geographical and ecological characteristics,

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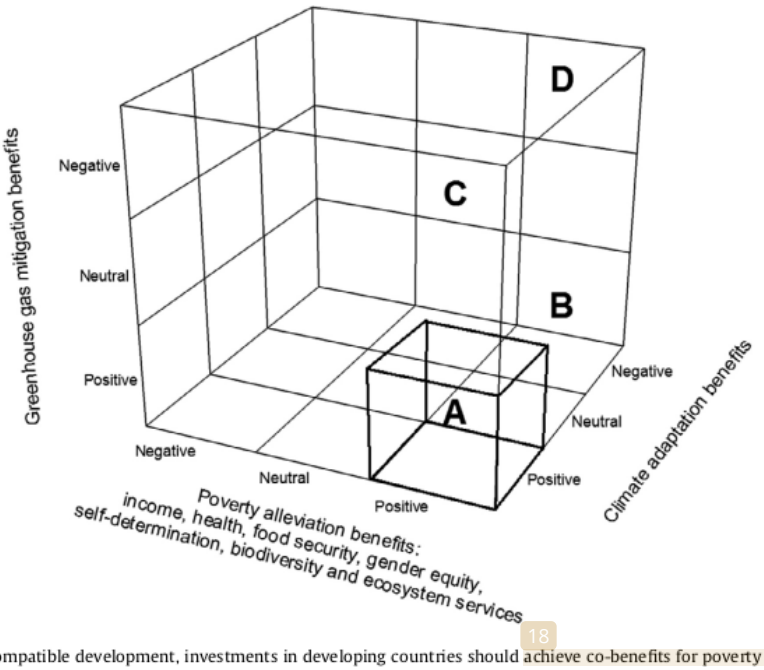


**Fig. 1.** To attain climate compatible development, investments in developing countries should achieve co-benefits for poverty alleviation, adaptation and greenhouse gas mitigation, and therefore contribute to the Sustainable Development Goals (A). Those that are mal-adaptive (B), increase greenhouse gas emissions (C), or both (D) must be recognised and modified (from Butler et al., 2014b).

consisting of archipelagic islands (Lombok and Sumbawa) remote from political and urban centres where rural livelihoods predominate. Hence the lessons learned are applicable more broadly. This editorial synthesises the Special Issue's papers, and distils the key lessons learned for consideration by other policy, aid and research initiatives attempting to initiate CCD in the Asia-Pacific region.

## 2. Adaptation and development in Indonesia and NTB

Indonesia is a culturally diverse archipelago that is prone to natural disasters (e.g. volcano eruptions, tsunamis and droughts) and highly exposed to climate change and sea level rise (Ministry of Environment, 2009). Climate change is exacerbating pressure on many natural resources that are already over-exploited due to population and economic growth (World Bank, 2009). Mitigation (i.e. the effort to reduce GHG emissions) has been the focus of combating the impacts of climate change since 1990, when a National Committee on Climate Change was formed. In 2009, then President Yudhoyono announced that Indonesia would reduce greenhouse gas emissions by 26% below 'Business as Usual' levels by 2020, primarily by reducing Indonesia's high deforestation rates and forest fires (Ministry of Environment, 2009).

Adaptation to climate change has drawn relatively little policy attention. However, following the Intergovernmental Panel on Climate Change's recognition that adaptation measures were necessary to reduce the vulnerability of those most exposed to climate risks. National Adaptation Plans of Action (NAPAs) were established to link climate adaptation planning to national development processes, and to identify priority activities requiring funding (Hardee and Mutunga, 2010). Indonesia's NAPA, RAN-PI, was developed in 2007, and outlined a strategic approach to development that decreases the current rate of environmental destruction and increases resilience to climate variability and change (Ministry of Environment, 2010a).

The complexity of Indonesia's governmental and institutional arrangements increased following the 'Reformasi' triggered by the Asian Economic Crisis of 1997, and the resulting fall of the 1966–1998 'New Order' Regime. The centralised planning system is still employed, but democratic powers to elect officials, design institutional arrangements and raise taxes have been decentralised to provinces and districts (Antlov, 2003). Consequently, the number of provinces and districts has increased and coordination between departments and sectors has suffered. Linkages between national and regional adaptation planning have been undermined, and local initiatives have emerged instead. In 2010 the NTB provincial government pioneered the first attempt in Indonesia to formally mainstream adaptation into provincial development planning by establishing a Climate Change Task Force (CCTF). This was informed by a Lombok Vulnerability Assessment, carried out by the Ministry of Environment, NTB Government, World Wide Fund for Nature and the German International Cooperation Agency. The analysis adopted a risk-based approach to identify the sensitivity and exposure of different sectors on the island (Ministry of Environment, 2010b), but to date its recommendations have not been integrated into provincial development plans.

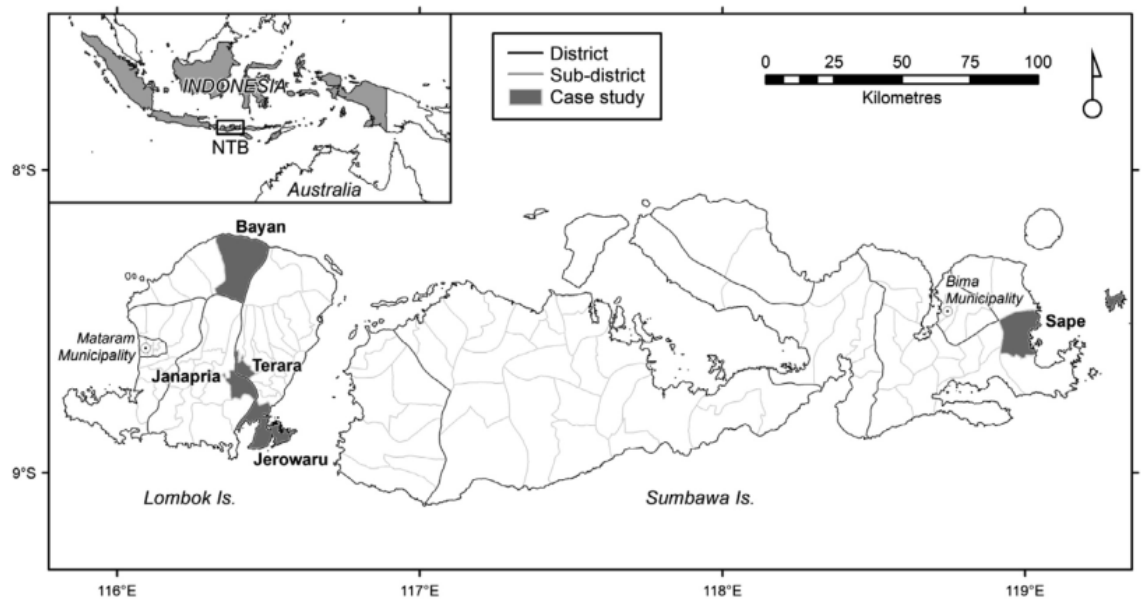


**Fig. 2.** Nusa Tenggara Barat Province, Indonesia, showing the locations of the five rural sub-district case studies.

At a community level several donors and non-government organisations (NGOs) have established projects to enable households to adapt to climate change. For example, in 2010 the Australian Government's aid agency (AusAID) funded Climate Field Schools in Lombok, building farmers' capacity to apply climate forecasts (BMKG, 2010). In 2012 the USAID-funded Indonesian Marine and Climate Support Project began vulnerability assessments and adaptation planning for selected villages in Lombok (USAID, 2010), and the United Nations World Food Program established a Climate Change and Food Security Program in NTB (WFP, 2012). However, these projects are largely uncoordinated and disconnected from the CCTF and national planning processes.

Consequently in NTB, as in other regions of Indonesia, there is an urgent need to integrate government and NGO activities to avoid duplication of resources (Djalante and Thomalla, 2012), to focus on community and household-scale adaptation (Bohensky et al., 2013), and to mainstream efforts to reduce GHG emissions. Yet the potential for mal-adaptive and GHG-intensive development remains high due to the combination of low stakeholder capacity, poor coordination between the varied government, donor and NGO development programs, and stakeholders' lack of awareness of potential future impacts of climate change and other drivers (Butler et al., 2014b). These factors, along with the rapid rates of social and economic change mean the window to re-orientate development towards CCD through the practice of adaptation pathways is quickly closing.

## 3. Synthesis of the special issue

The genesis of the project on which this Special Issue reports was the anticipation that the CCTF and the institutional flux caused by decentralisation presented an opportunity to establish an alternative approach to development planning in NTB. Consequently, in 2010–2014 AusAID funded a project with the goal to 'integrate adaptation pathways practice into development planning to build stakeholders' adaptive capacity, and reduce the vulnerability of rural communities to adverse future change'. This was to be achieved by focussing on the annual cycle of integrated top-down and bottom-up development planning ('musrenbang') in five rural sub-district case studies (Fig. 2).

Through consultations at the village, sub-district and district government levels, musrenbang formulates community development plans linked to provincial and national plans, and therefore provides an ideal mechanism for coordinating and achieving CCD at the local level. However, musrenbang processes are currently far removed from adaptation pathways practice. Information on which to base future-orientated decisions is often inadequate and unavailable to participants. Although communities are represented at all consultation stages, the process is captured by political elites and government officials; women and poorer households are marginalised by the lack of procedural justice, and non-government stakeholders are seldom included (Purba, 2011; Aswad et al., 2012). There is also confusion amongst participants about their roles (Aswad et al., 2012), exacerbated by the regular subdivision of districts and sub-districts (Hunter, 2004).

In the first paper, Butler et al. (2016a) describe the project's design as a governance experiment, whereby actors in a system are engaged to purposefully induce change in that system (Loorbach, 2010). The project applied principles of adaptive

co-management, a novel form of adaptive governance which has been proposed as potentially useful in priming and implementing adaptation because it can generate collective action amongst diverse stakeholders by enabling individual and social learning, cross-scale networks and empowerment of marginalised stakeholders (Plummer, 2013; Baird et al., 2014). This was to be achieved by linking multiple actors across geographical scales and jurisdictional levels via four activities, facilitated by a cross-cultural research team (the 'Tim Kolaboratif') and a Steering Committee (Fig. 3). The activities were: (1) the development of adaptation pathways tools by the Tim Kolaboratif; (2) scenario planning workshops carried out at the provincial and sub-district level, followed by integration workshops which produced sub-district CCD plans; (3) trials of no regrets adaptation strategies in case study sub-districts developed by the planning workshops, and (4) engagement with musrenbang in each case study to incorporate the CCD plans. In addition, monitoring and evaluation were conducted by a sub-team of the Tim Kolaboratif to promote adaptive management within the project's governance.

The project's Theory of Change (ToC) assumed that the three evolutionary stages of adaptive co-management would occur. In Phase 1, which encompassed project activities, stakeholders were primed to act as 'policy entrepreneurs' and change agents. A key expectation was that the planning workshops would induce double-loop (i.e. re-visiting of assumptions about cause and effect) and triple-loop learning (i.e. re-assessing underlying values and beliefs, potentially resulting in changes to institutional norms; Pahl-Wostl, 2009; Reed et al., 2010), thus identifying systemic drivers of community vulnerability and designing transformational strategies to tackle them. In Phase 2, the change agents generated by Phase 1 would create or exploit policy 'windows of opportunity' for adaptation pathways practice to be adopted in the case study musrenbang, and throughout NTB. In Phase 3 adaptation pathways processes would be implemented, resulting in CCD strategies and innovations being applied within communities. Through each phase it was assumed that the numbers of stakeholders engaged would grow, cumulatively building adaptive capacity, defined here as "the potential for actors within a system to respond to changes, and to create changes in that system" (Chapin et al., 2006, p. 16641). In addition, an ex-post participatory evaluation method was designed to test the ToC's assumptions and measure the governance experiment's outcomes.

The evaluation showed that the governance experiment was unsuccessful: although some of the trialled adaptation strategies were implemented by musrenbang in case studies, most prioritised strategies that constituted the sub-district CCD plans were not. Adaptation pathways practices and tools were not adopted in the case studies, or elsewhere, because windows of opportunity did not materialise within the project time-frame. There was also limited evidence of double- and triple-loop learning. Despite this, the evaluation clearly illustrated that stakeholders had been successfully primed to

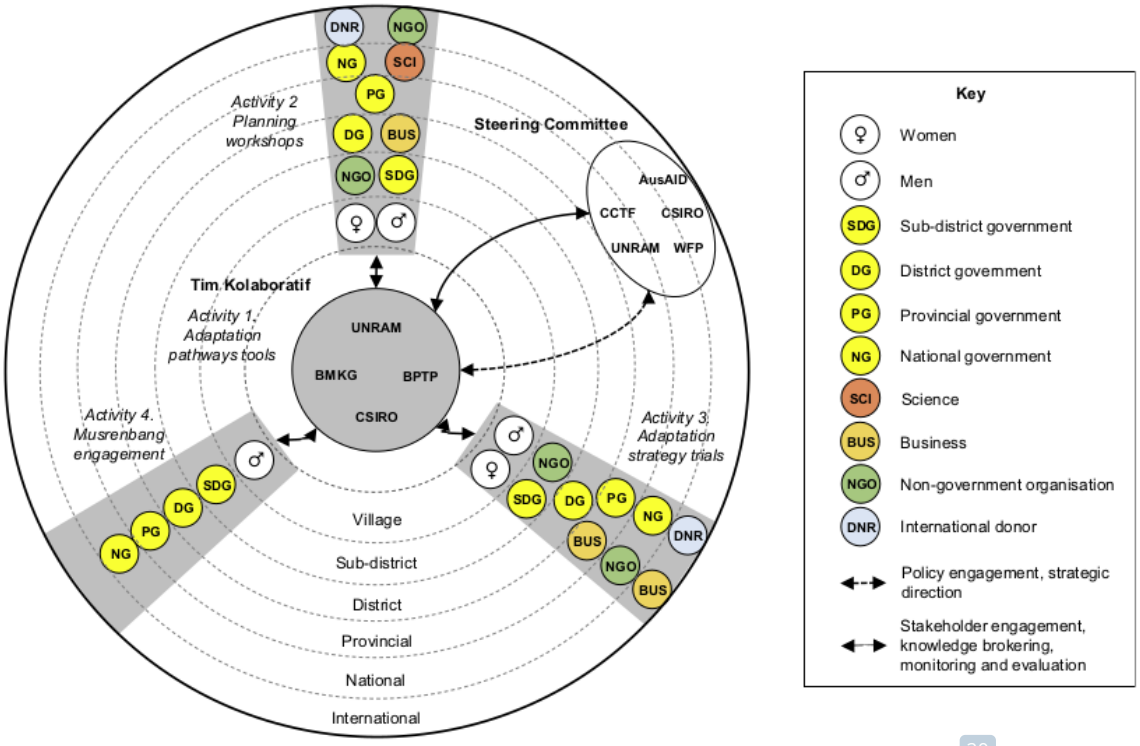


**Fig. 3.** The project's design and four activities, relative to stakeholder groups and their jurisdictional levels. Acronyms are CSIRO (Commonwealth Scientific and Industrial Research Organisation), UNRAM (University of Mataram), BPTP (Agricultural Technology Assessment Agency), BMKG (Agency for Meteorology Climatology and Geophysics), NTB Climate Change Task Force (CCTF) and the World Food Program (WFP). See Butler et al. (2016a).

transform musrenbang if future opportunities arose: leadership, trust, enhanced knowledge, community empowerment and cross-scale networks had all clearly emerged. Also, early impacts were evident at the community level as a result of the adaptation strategy trials. Much of this success was attributable to the Tim Kolaboratif's emergence as effective brokers, facilitators and change agents.

In the second paper, Bohensky et al. (2016) analyse the perspectives of 124 planning workshop participants from different jurisdictional levels regarding climate change and development. Bohensky et al. applied Brown's (2008) concept of 'knowledge cultures' to characterise groups who use different languages to describe climate change, choose different avenues of action, and are directed towards different outcomes. They found distinct knowledge cultures amongst the project participants which were distinguished across several variables: levels of social organisation, gender and geographical location (i.e. between sub-district case studies). Most participants believed that climate change was occurring, but those working at higher organisational levels attributed climate change to human factors, while those at lower levels thought it was a natural phenomenon. Participants from higher levels tended to think of 'the future' in longer time frames than those from local levels. Place-based knowledge cultures were evident for other development challenges, and highlighted the myriad of immediate issues beyond climate change which concern stakeholders. Bohensky et al. also suggest that the acceptance of anthropogenic climate change and the need for an institutional response were more often associated with government actors working at higher levels, and may therefore be associated with cultural and political elitism.

The following four papers describe data and tools applied in the participatory planning process. McGregor et al. (2016) present an original modelling approach, the Conformal-Cubic Atmospheric Model (CCAM), which downscales global climate models under 'Business as Usual' global GHG emissions scenarios to derive climate change projections at a 14 km resolution for NTB. Present-day CCAM outputs were validated against contemporary data, and correlated well. Importantly, the results also demonstrate the steep climatic gradients which occur across island geographies such as NTB, and the spatial variations in future rainfall and temperature changes that are likely to emerge as a result.

Kirono et al. (2016) analyse historical and future rainfall in NTB and potential implications for the agriculture and water sectors. Using 50 years of historical data they show that there is cyclical variability and a long term decline in rainfall. Dry season rainfall is correlated with the El Nino Southern Oscillation, while wet season rainfall is less so. Applying the CCAM data from McGregor et al. (2016) they project that existing rainfall patterns will continue, as will the trend in declining annual rainfall. Crop water demand estimates suggest that the first growing period for rice, the staple food crop, in November–March will be impacted by reduced rainfall, as will higher value crops in the second growing period (March–June). These projections corroborate those of the Lombok Vulnerability Assessment, but give crop-specific detail and include Sumbawa in the analysis. The authors also emphasise the importance of presenting potential rainfall variability and risks in a form accessible to all stakeholders, and illustrate the graphics used to illustrate these projections in the planning workshops.

To apply the downscaled climate projections and also population growth projections (see Fachry et al., 2011) to estimate potential future impacts on rural communities, Rochester et al. (2016) developed a typology of NTB's 105 rural sub-districts based on the ecosystem goods and services (EGS) underpinning livelihoods. A cluster analysis generated seven types, which again demonstrated the heterogeneity and diversity of livelihood systems across the islands. This paper also presents an approach to integrating different data and knowledge types which is required when accurate statistics are lacking, as is often the case in developing regions.

Skewes et al. (2016) then introduce a participatory tool, the Asset Drivers Wellbeing Interaction Matrix, which applied the climate and population projection data to assess their relative impacts on EGS and human well-being under the 'Business as Usual' scenario amongst the sub-district types, and within sub-districts. The tool enables the semi-quantitative valuation of EGS by workshop participants in terms of income, food security, health and culture, and then presents these results graphically beside potential future impacts. The authors illustrate how the tool can incorporate various sources of expert and local knowledge in real time, and acts as a 'boundary object' to generate learning and reflection within planning processes. They also present the simple graphics used to illustrate EGS' relative values and the sources of future impacts which can inform adaptation strategies. Importantly, the results illustrate how in some areas population growth will have greater impacts than climate change. Also, due to steep climate gradients and livelihood heterogeneity, assessments carried out at coarser scales of resolution (e.g. sub-district types) may obscure important local variations in EGS' contribution to well-being, and the relative impact of different drivers.

Butler et al. (2016b) then demonstrate the scenario planning approach used in the planning workshops, which incorporated the data and tools presented by the previous four papers. The approach was designed to exemplify adaptation pathways practice, and to stimulate double- and triple-loop learning to address systemic causes of vulnerability with transformative strategies. Rather than applying decision-sequencing, which was considered potentially confusing, normative back-casting was used to identify no regrets strategies that would be compatible with potential future development scenarios. However, the resulting 'tapestry' of strategies were predominately incremental (81%), and built communities' adaptive capacity by meeting conventional development needs (e.g. intensification of existing production systems, education, health). Only a minority were transformative and addressed the root causes of vulnerability (e.g. corruption, poor community representation in development planning, population growth, gender inequality), suggesting that limited double- and triple-loop learning had occurred. While the vast majority of strategies were no regrets, some were potentially mal-adaptive, particularly those in coastal areas exposed to sea level rise, and those related to infrastructure. It was also evident that higher level stakeholders identified more transformative strategies, while local level stakeholders focussed more exclusively on

incremental strategies due to their greater familiarity with immediate community needs, and the finer (i.e. sub-district) scale of analysis applied in their workshops.

Wise et al. (2016) present the final stage of the planning process, which reviewed and integrated the 'no regrets' strategies from the prior scenario planning workshops to create a CCD plan for each case study. Integrated strategies were prioritised using a multi-criteria analysis against nine criteria for CCD (income, food security, social cohesion, health, ecosystem services benefits, disaster risk reduction, biodiversity benefits, gender equality and GHG mitigation). The highest-ranked strategies delivered considerable co-benefits for human development and ecosystem services, and hence enhanced adaptive capacity, but GHG mitigation co-benefits were minimal. The strategies were then re-assessed for their potential risk of mal-adaptation by testing the reversibility and feasibility of actions required to achieve them.

The results reflected those from the prior scenario planning workshops: priority strategies varied greatly between the case study sub-districts according to local vulnerability contexts and the potential future local impact of drivers, but the majority (82–85%) were incremental and related to standard development needs. Only a small minority were transformative, indicating that even in a second learning cycle little double- or triple-loop learning had occurred. The most potentially mal-adaptive strategies were infrastructural investments, because they were irreversible and highly feasible, but paradoxically are a pre-requisite to the delivery of 'soft' adaptation benefits (e.g. road access to provide health services). Current development programs were also 'screened' for their degree of CCD by comparing them with priority strategies. The results showed that some strategies were being delivered by development programs, while others were not. However, in general development programs tackled fewer systemic drivers, were poorly coordinated and had a higher risk of mal-adaptation.

Finally, Liu et al. (2016) present an integrated benefit cost analysis of two incremental adaptation strategies developed by the planning process: maize-castor inter-cropping and the 'bondre' seaweed growing system, which were both innovations designed to promote resilience to climate variability. The evaluation framework is based on three models: a household benefit cost model, a diffusion model, and a regional benefit cost model. The analyses were based on expert opinion and locally-derived information, and hence could be applied in data-poor situations typical of developing countries. The results demonstrated moderate (for intercropping) to highly positive (for seaweed) benefit cost ratios, and in both cases returns could double participating households' annual income. However, the approach is unable to account for less tangible social and ecosystem service benefits, potentially leading to the underestimation of adaptation and GHG mitigation benefits, respectively. Hence the authors recommend that such detailed econometric modelling at the household level should be complemented by qualitative approaches that can evaluate intangible process outcomes at multiple levels of a system.

## 4. Lessons learned

The experiences of this four year project provide useful lessons that could assist the design and implementation of future policy, aid and research initiatives attempting to build capacity for adaptation pathways and CCD in the Asia-Pacific region. We distil 10 lessons into two themes: the design of interventions aiming to integrate adaptation pathways into community development planning, and implications of our results for achieving CCD in eastern Indonesian islands and similar geographies. Many of these lessons are derived from the participatory evaluation of the project's outcomes relative to the ToC (see Butler et al., 2016a).

### *4.1. Design of adaptation pathways interventions*

#### *4.1.1. Lesson 1. To effect institutional change, governance experiments should understand and engage with appropriate political actors*

One explanation for the lack of success in establishing adaptation pathways practice into case studies' musrenbang was the project's inadequate engagement with key, but ephemeral political actors. Although a Steering Committee was established to achieve this by including directors of the government agencies responsible for the CCTF (Fig. 3), these individuals were moved to other government positions following provincial elections, curtailing their political agency. Such 'churn' is known to undermine individuals' embeddedness in organisations and their ability to influence decision-making (Lefsrud and Meyer, 2012). It also became apparent that due to ongoing decentralisation, the power and influence relating to development decision-making lay increasingly among district politicians. These individuals were not directly involved in project activities or governance, and as a consequence the Tim Kolaboratif and other change agents were unable to precipitate policy windows of opportunity at the district level.

#### *4.1.2. Lesson 2. Transformation of planning processes requires long time frames and sustained support for change agents*

Although the project was funded for four years, this was insufficient time to generate transformation of musrenbang in the five case studies or beyond. This was partly due to the time required for the pre-requisite capacity building activities, beginning with the establishment of the Tim Kolaboratif as a trans-disciplinary fulcrum for the project, and its development of adaptation pathways tools and processes (1 year), followed by the planning workshops (2 years) and parallel adaptation strategy trials (18 months). Once completed, these activities left only sufficient time for the Tim Kolaboratif to engage with one musrenbang cycle. While the evaluation clearly demonstrated that stakeholders had been successfully primed to instigate change, sustained, long-term resourcing is necessary to enable change agents to take future opportunities when they emerge. Similar observations have been made by Cundill and Fabricius (2010) in South Africa.

*4.1.3. Lesson 3. Rapid change and institutional flux are an obstacle to achieving adaptive co-management*

Paradoxically, rather than creating an opportunity for mainstreaming adaptation pathways and CCD into development decision-making, ongoing decentralisation was an obstacle because it generated uncertainty and undermined trust amongst stakeholders (see Butler et al., 2016a). Consequently, the governance experiment's intention to generate adaptive co-management as a vehicle for the adoption of adaptation pathways into musrenbang largely failed because government officials wished to maintain control of the process during such uncertainty. Wollenberg et al. (2007) found similar effects of political upheaval on attempts to instigate collaborative governance elsewhere in Indonesia. Instead, adaptive co-management emerged most effectively through the adaptation strategy trials at a local level, and such 'livelihood innovation niches' could act as bridgeheads for collaborative governance to expand into formal planning processes when conditions allow (Butler et al., 2016a). However, as discussed in Lesson 2, sustained resourcing of these bridgeheads is critical.

*4.1.4. Lesson 4. Stakeholders have distinct knowledge cultures, and their influence on power dynamics and planning outputs must be understood by researchers*

The existence of different knowledge cultures amongst administrative levels suggests that our governance experiment's approach and methods of integrating stakeholders' world views and perspectives were justified. The scenario planning workshops deliberately engaged higher level and local level stakeholders separately (see Butler et al., 2016b) prior to integrating their outputs in a second round of workshops (see Wise et al., 2016). However, although this approach intended to mitigate potential power asymmetries amongst knowledge cultures, and workshop activities were also designed to minimise intra-participant power dynamics and empower community-level and female participants (see Butler et al., 2015), we were unable to track how the knowledge cultures influenced the identification of proximate and systemic causes of vulnerability, and resultant incremental or transformative strategies. Future governance experiments should also account for knowledge cultures, and attempt to better understand and manage their influence on participatory planning processes and their outputs and outcomes.

*4.1.5. Lesson 5. Participatory processes must place an emphasis on double- and triple-loop learning to identify systemic drivers of vulnerability and transformative strategies*

Various tools and activities were designed within the participatory planning workshops to encourage double- and triple-loop learning, and therefore to identify and tackle systemic drivers of community vulnerability (Butler et al., 2016a; Wise et al., 2016). However, the strategies which emerged from the scenario planning workshops were predominately incremental. Following the subsequent integration workshops, the resulting priority strategies were also predominately incremental. This indicates that either the workshops' design or activities did not adequately trigger double- or triple-loop learning, or that extended learning processes are necessary to induce this deeper level of analysis amongst stakeholders with relatively low capacity. As discussed in Lesson 4, power dynamics amongst stakeholders and their knowledge cultures may also have been influential.

*4.1.6. Lesson 6. Quantitative and qualitative evaluation methods are necessary to measure tangible and intangible outcomes and impacts of governance experiments*

Our study developed two approaches to ex-post evaluation. The first (Butler et al., 2016a) was a participatory and qualitative approach which interviewed stakeholders who had been involved in planning workshops to test the project's ToC. The second (Liu et al., 2016) combined benefit cost, diffusion and regional benefit modelling to assess household and wider economic impacts of incremental adaptation strategies. These were complementary: the participatory evaluation allowed stakeholders from across the system to evaluate the change process, while the econometric approach measured the current and potential future benefits of the trialled adaptation strategies at the household and regional level. The participatory approach also created a learning feedback loop, potentially re-kindling the adaptive co-management process. If undertaken at regular intervals after the project's completion, or timed to follow crises or shocks, this approach may galvanise change agents to exploit windows of opportunity. As emphasised by Brooks et al. (2011) and Bours et al. (2013), such qualitative approaches are essential to measure not only the tangible outcomes of adaptation processes, but also the intangible outcomes which are preconditions for achieving future adaptation and CCD impacts.

*4.1.7. Lesson 7. In data-poor contexts, planning tools must be designed to integrate different forms of data and knowledge*

While the climate change and human population projections applied in our process were derived from modelling good quality data, similar information necessary for other aspects of planning were patchy, unreliable or unavailable. These issues are characteristic of less developed regions and countries. Three papers demonstrated how stakeholders' knowledge and local expertise can be drawn upon to fill data gaps: Rochester et al.'s typology of sub-districts invited experts to semi-quantitatively rank the importance of EGS to local livelihoods; Skewes et al. (2016) used a similar approach to value EGS amongst planning workshop participants, and Liu et al. (2016) applied expert's local knowledge to assess diffusion rates and other variables for their benefit cost modelling. While not evaluated specifically, a key aspect of such knowledge gathering exercises is the empowerment and learning benefits that they create for local experts and stakeholders, augmenting these core components of adaptive co-management.

### 4.2. Implications for achieving CCD

#### 4.2.1. Lesson 8. Due to steep climate and livelihood gradients across island geographies, CCD planning must be undertaken at a fine scale, limiting the feasibility of out-scaling

A characteristic of NTB is the steep climate gradients across its islands, which results in considerable local variations in climate projections and impacts. Combined with variable population densities and growth rates, potential impacts on priority EGS and well-being differ considerably between sub-districts (see Skewes et al., 2016). Consequently, priority strategies contrasted between case studies as a function of perceived drivers, their future impacts on the local EGS base, communities' adaptive capacity and local knowledge cultures. This suggests that in island geographies, CCD planning must be focussed at the level of the sub-district or below, which has implications for the resources and time required to undertake effective planning. Furthermore, it is probably not feasible to scale-out many of the incremental strategies targeting local production systems. While a typology of resource use such as that developed by Rochester et al. (2016) may assist, Skewes et al. (2016) showed that there is considerable variation amongst EGS and impacts even within sub-district types. However, transformative strategies (e.g. community empowerment in development planning) may be more generalizable across multiple administrative units, as are the adaptation pathways skills, processes and tools developed by this project, which are themselves potentially transformative.

#### 4.2.2. Lesson 9. Potentially mal-adaptive infrastructural investments are a pre-requisite to delivering CCD

A paradox highlighted by Wise et al. (2016) is that infrastructural investments carry the greatest risk of being mal-adaptive. Yet infrastructure such as roads, ports and irrigation are pre-requisites for the delivery of more CCD-compatible strategies. This suggests that in less developed regions, and particularly in coastal areas exposed to sea level rise, infrastructure-related decisions should carefully consider future climate uncertainties if 'soft' strategies are to be reliably delivered in the future.

#### 4.2.3. Lesson 10. Some existing development interventions may already be delivering CCD

The comparison of priority strategies with current development programs in case study sub-districts by Wise et al. (2016) showed that some were being delivered, albeit inadvertently. However, some strategies were not, and transformative strategies were even less prevalent than those developed by the planning processes. Many of the development programs were ineffective, and workshop participants were unaware of them, confirming a general lack of coordination and engagement across sectors and with communities.

## 5. Conclusions

Taken together, these 10 lessons suggest that while some current development programs have the potential to deliver CCD, planning processes such as ours are urgently required to review current interventions, screen potentially mal-adaptive infrastructural investments, enhance coordination and collaboration between multiple stakeholders, and generate learning which can address systemic drivers of community vulnerability through transformative strategies. Our experiences have highlighted strengths of our approach, but also areas where improvements are necessary, particularly in terms of political engagement and culturally-relevant participatory methods which can generate double- and triple-loop learning.

Most importantly, our synthesis demonstrates that in order to build capacity for adaptation pathways in the current context of rapid change and institutional flux typical of the Asia-Pacific region, effective governance experiments must be consistently and adequately resourced over at least a five year time period. This chimes with Woolcock et al. (2011, p. 84), who state that "policy horizons of five years and even of 10 years are, frankly, painfully and unrealistically short to anyone acquainted with economic history". Shorter projects such as ours can prime stakeholders through adaptive co-management, but windows of opportunity to mainstream adaptation pathways and CCD into development planning may only emerge over longer timeframes. Crucially, these opportunities will not be taken unless change agents and local bridgeheads for adaptive co-management are consistently supported and resourced. The pertinent question then is, what form does this extended process take, and how is support provided? Alternatively, should governance experiments only be attempted to coincide with policy windows or other shocks to the system? If so, how can these opportunities be recognised and capitalised upon?

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