(Re)conceptualising maladaptation in policy and practice: towards an evaluative framework

Working paper

PRISE
Pathways to resilience in semi-arid economies

Research for climate–resilient futures

(Re)conceptualising maladaptation in policy and practice: towards an evaluative framework

June 2015

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This report has been produced as part of a series of preliminary papers to guide the long-term research agenda of the Pathways to Resilience in Semi-arid Economies (PRISE) project. PRISE is a five-year, multi-country research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change.

Front cover image:

Urban China.

Acknowledgements

The authors are indebted to Minte Bezabih, Florence Crick, Guy Jobbins, Richard Klein, Hayley Leck and Thomas Tanner for valuable feedback and critical reviews. We are also grateful to Rajeshree Sisodia and Roo Griffiths for editing and support.

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Abstract

Maladaptation has received notable policy attention in recent years, but has yet to be fully explored in both conceptual and practical terms. As a consequence, the term suffers from a lack of consensus regarding its definition and application.

We outline five areas of conceptual clarity needed in understanding and evaluating maladaptation:

1. Deliberate non-action should, if contributing to increased climate risks and negative outcomes for people and communities, be considered maladaptation.
2. Strategies that do not have a primary focus on climate change should also constitute maladaptation.
3. It is only with time that the success or failure of an intervention will become evident; maladaptation can occur long after a project cycle has completed. One of the principal challenges in evaluation is therefore knowing when to classify a strategy as maladaptive or not. In addition, any assessment of maladaptation has to take into account the discounted value of an intervention's impacts both now and in the future.
4. Ecosystems, livelihoods and economies are not static. Under climate change, climate risks and vulnerabilities to particular climate variables are also likely to shift. Assessments of maladaptation therefore need to recognise the complexities associated with shifting baselines and establishing counterfactuals.
5. Distributional aspects of adaptation need to be recognised in any evaluation of maladaptation. Not only is climate change is likely to affect segments of the population differently, in terms of both direct impacts and influences on wider drivers of development, but the act of implementing (or choosing not to implement) an adaptation strategy can fail to uniformly reduce climate risks across all social groups.

Building on this conceptualisation of maladaptation, we present the groundwork for a framework that can lend itself to qualitative and quantitative assessment of adaptation strategies and clarify the differences between four distinct types of adaptation outcomes – ranging from optimal adaptation to maladaptation. In our framework, maladaptation is categorised by determining the impact strategies have on climate risk and wellbeing. The framework also assesses the implications for each category through a distributional and temporal lens.

Crucially, we also highlight the framework's applicability in assessing strategies that do not explicitly seek to address climate change or are not labelled as adaptation (and hence cannot be considered as maladaptation in the traditional sense of the term). This is particularly relevant when recognising the large potential for development activities to impact (positively or negatively) on people's climate risk, now and into the future. For this reason, we discuss the concept of 'maladaptation-like' outcomes, for which the framework can also be applied.

We then use the framework to highlight a number of different 'symptoms' that can act as early warnings for maladaptive outcomes, hoping to guide policymakers in achieving early diagnosis. In doing so, our aim is to make this onerous concept more tractable and applicable for planners and practitioners so as to make it possible to diagnose strategies that are likely to lead to maladaptation. It is our hope that this work will stimulate debate and galvanise interest in advancing efforts to understand and, critically, to avoid maladaptation in the face of increasing climate risks in the coming decades.

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1. Introduction

Climate change adaptation has received considerable policy attention in recent years, from donors, governments and communities alike. Much of this owes to growing recognition that, despite efforts to promote mitigation, people and communities will inevitably contend with the risks of a changing climate, both now and/or in the future (Guivarch and Hallegate, 2013). Ensuring adaptation actions are robust and effective in reducing climate risks is therefore key. Yet we know little about what constitutes successful adaptation (Ford et al., 2013). Indeed, it is only relatively recently that the academic and policy communities have paid attention to the prospect of adaptation actions leading to increased climate risk and ultimately 'maladaptation' (Barnett and O'Neill, 2010; Brown, 2011; McCarthy et al., 2001; Moser and Eckstrom, 2010). Reflective of this, maladaptation is poorly understood; few attempts have been made to clarify what it looks like in practice (Magnan, 2014). Maladaptation therefore deserves a closer look.

Given the considerable sums of international and domestic climate finance currently committed to promoting adaptation, particularly in developing countries, there is a need for continued emphasis in understanding the drivers and characteristics of maladaptation (Klinsky et al., 2012). While a number of definitions and frameworks for the assessment of maladaptation have been proposed (Barnett and O'Neill, 2010; Magnan, 2014; Noble et al., 2014), large conceptual differences still exist. In addition, much of the existing literature is narrowly focused on specific sectors or contexts and fails to support decision-makers in identifying the root causes of maladaptation in the investments and planning decisions they manage.

This paper aims to address a number of these conceptual shortfalls in order to provide a framework for identifying maladaptation that is of relevance to policymakers and practitioners. It starts by examining current framings of the term and proposes a reconceptualisation of the concept. It goes on to present a conceptual framework for evaluating adaptation strategies against four elements: climate risk; wellbeing; time; and distribution. The aim of the framework is not to provide precise indicators and weightings to allow for the quantification of maladaptation (although, in time, this may prove feasible). Rather, the framework is meant to raise awareness by clarifying the main constituents of maladaptation, and to help identify strategies likely to lead to maladaptive outcomes early. Alongside this, we identify a number of different 'symptoms' of maladaptation and discuss methods for diagnosing it. We hope the framework and identification of different symptoms can lend themselves to the development of further decision support tools to make it possible to self-diagnose and evaluate maladaptation in policy and practice.

2. Contextualising maladaptation

Interest in the concept of maladaptation has grown considerably, but it has yet to be fully explored in both conceptual and practical terms (Magnan, 2014). As a consequence, maladaptation suffers from lack of consensus around its definition and application in policy and programming.

Perhaps the best starting point in conceptualising maladaptation is to consider how it relates to adaptation in general. Adaptation commonly refers to *'the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities'* (Agard et al., 2014: 1758). The need to support adaptation has arisen from recognition that, while human and natural systems are able to cope with adverse circumstances and conditions, climate change and other changing drivers of development will require systems to adapt in order to maintain this capacity (Noble et al., 2014). A key component of adaptation is therefore managing and helping reduce the risks climate change poses for people and communities. Maladaptation, on the other hand, broadly concerns itself with strategies that have gone wrong, have been implemented badly or have been poorly thought-through. This may ultimately cause greater suffering of intended beneficiaries or others not specifically targeted, either now or in the future (ibid.).

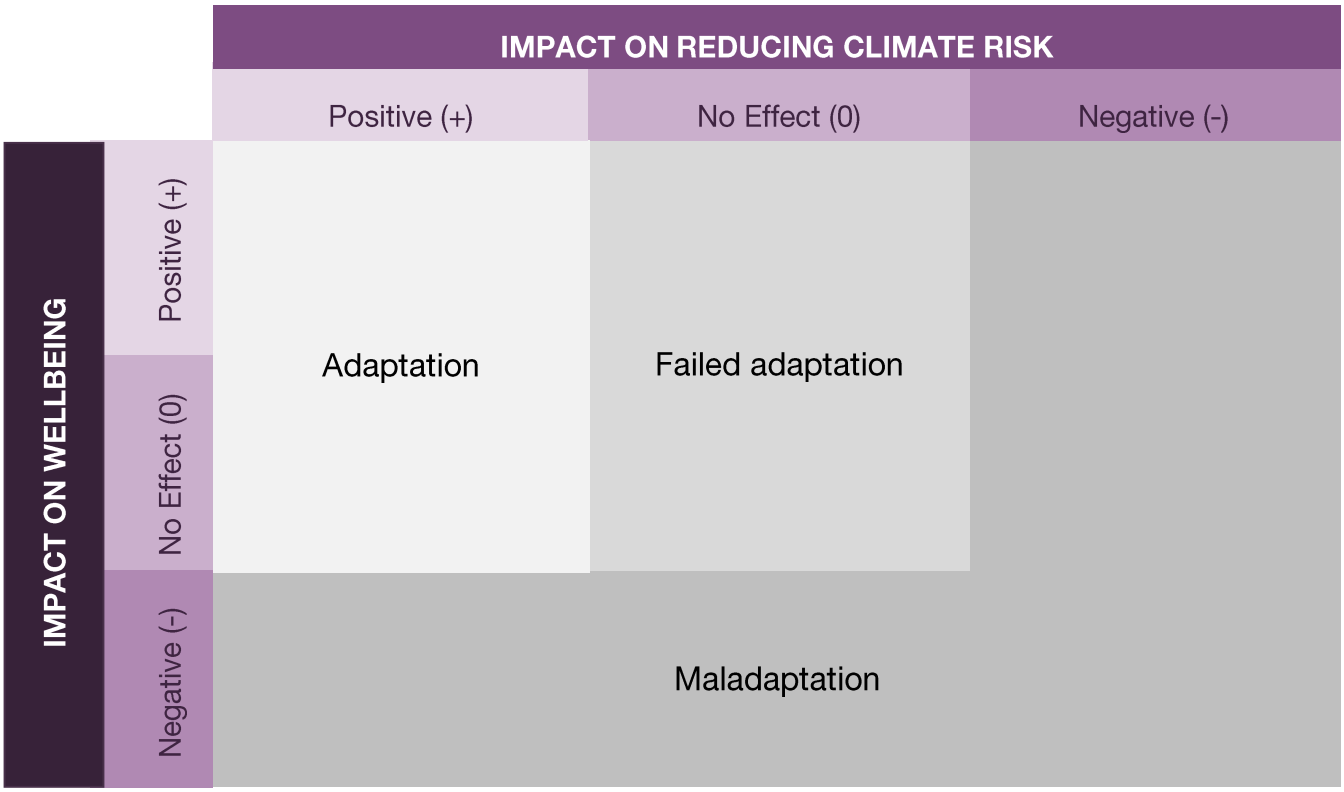
Maladaptation is a relatively recent term – at least within the climate and development literature. While a handful of early references to maladaptation are evident (Burton, 1996, 1997; Smit, 1993), it was not until the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) that maladaptation received more widespread attention among academics and practitioners alike. The TAR defined maladaptation as *'an adaptation that does not succeed in reducing vulnerability but increases it instead'* (McCarthy et al., 2001: 990 in Magnan, 2014). Since then, the term has expanded considerably in scope; in many ways, this explains some of the difficulties in differing definitions and interpretations. Perhaps the most commonly used definition is that of Barnett and O'Neill (2010), which describes maladaptation as *'action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups'* (p.211). Others have conceptualised maladaptive outcomes more broadly as actions that run counter to sustainable development (Brown, 2011; Eriksen and Brown, 2011).

Maladaptation receives considerable attention in the IPCC's more recent Fifth Assessment Report (AR5), where maladaptive actions are defined as those that *'may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future'* (Agard et al., 2014: 1769). Here, the addition of welfare is important, as it recognises that, while the primary aim of adaptation strategies is to reduce climate risk, these strategies can also have a significant impact on wider economic, social, cultural and psychological factors – many of which will have little to do with climate change or climate risk. An adaptation strategy that has resulted in large negative contributions towards the welfare (or wellbeing, as we refer to later in Section 4.2) of different social groups can therefore be considered maladaptation. This may be the case even if there are significant positive contributions to reducing climate risk. Inevitably, this argument creates some degree of subjectivity, particularly in identifying the threshold beyond which a strategy is deemed to have brought about a significant negative contribution. Furthermore, there will always be relative winners and losers. It is nonetheless important to recognise the implications of adaptation for wellbeing (however hard to measure), something that has received little attention within the adaptation literature to date.

With this in mind, Figure 1 presents a simple way of conceptualising the relationships between adaptation (where a strategy has a positive contribution to reducing climate risk and no negative effect on wellbeing); failed adaptation (where a strategy has little to no effect on climate risk); [1] and maladaptation (where a strategy impacts negatively on climate risk and/or wellbeing). The framework can be applied at any spatial space, whether assessing adaptation outcomes at the household, community or system level; inevitably, distinct indicators relevant to each would have to be chosen. The conceptualisation and definitions of each of the outcomes, including details of spatial and temporal aspects, are further developed in a more nuanced and complex iteration of the framework outlined in Sections 4 and 5 (see Table 2).

[1] Note that we classify a strategy with no effect on climate risk but a positive effect on wellbeing as failed adaptation. See Section 5 for further details and justification.

Figure 1: A simple conceptualisation of the relationships between adaptation, failed adaptation and maladaptation



It is important to recognise that maladaptation can arise from adaptation strategies prioritising short-term outcomes over the risks associated with longer-term threats (Noble et al., 2014). This temporal element acknowledges that maladaptation *'is a process that results in increased vulnerability to climate variability and change, directly or indirectly, and/or significantly undermines capacities or opportunities for present and future adaptation'* (Magnan, 2014: 3). Thus, any interpretation of the framework in Figure 1 has to consider and weigh up the balance of an adaptation strategy's impact on both climate risk and wellbeing now and in the future (see Section 3.3).

While there is general agreement that maladaptation involves action to adapt to change that ultimately increases vulnerabilities or reduces adaptive capacity (Adger et al., 2005; de Franca Doria et al., 2009), there is disagreement over what causes such action (IPCC, 2014). Some have described maladaptation as occurring as a result of inaccurate predictions and unexpected impacts leading to errors in assessing risk (Tompkins et al., 2005); others see it as action based on misunderstandings of the dynamics and complexity of systems, leading to poor decisions (Pittock, 2011; Satterthwaite et al., 2009) or short-term decisions (World Bank, 2010). For instance, where system dynamics and complexity are not well understood, or spatial and temporal implications of adaptation are poorly considered, decisions may be made that lead to unintended maladaptive outcomes (Pittock, 2011; Satterthwaite et al., 2009). In some cases, perceptions of climate change may also cause a shift away from adaptive action to inaction or maladaptive behaviour as beliefs about the magnitude of climate change increase (Niemeyer et al., 2005). Reactive responses to climate shocks and stresses, often hastily planned and focused on the short term, are also considered to be at greater risk of promoting maladaptation (World Bank, 2010).

3. Clarifying maladaptation

One of the reasons why maladaptation is such a powerful term is that it encourages practitioners and policymakers to recognise the decisions they take now to address climate change can backfire and inadvertently make people more vulnerable in the longer term. However, a lack of consensus and clarity on how to characterise maladaptation currently prevents decision-makers from being able to apply the concept in practice. In reviewing the available literature, we note commonly used framings of maladaptation are both inconsistent with each other and confusing. This hints at the need for further elaboration, even a reconceptualisation, of the concept. Five areas in particular stand out as needing greater elucidation, described below.

Coping with climate change in Dhaka, Bangladesh.

3.1 Inaction as maladaptation

Our first point of clarification is that a deliberate non-action should, if contributing to increased climate risks and negative outcomes for people and communities, be considered maladaptation. This differs somewhat from the most commonly used definition of maladaptation by Barnett and O'Neill (2010), referring to *'action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups'* (p.211, emphasis added). Many others adopt similar interpretations, referring either to 'changes' (McCarthy et al., 2001: 990), 'adjustments' (Parry et al., 2007: 720) or 'actions' (Agard et al., 2014: 1769). Each of these definitions implies change or deviation has occurred. It is for this reason that we instead refer to adaptation 'strategies' in this paper, recognising that inactions, or lack of deviation from current trajectories, may constitute viable strategies in response to a changing climate. [2]

Considering inaction as maladaptation may at first appear counterintuitive, as adaptation is typically considered an active adjustment to limit expected climate impacts. However, from a practitioner's perspective, it makes little sense to exclude deliberate inaction, as choosing to do nothing or not changing course can be considered successful responses to future climate change. For example, conscious delayed action, under a 'wait and see' approach, may be considered a valid strategy for protecting significant and irreversible investments under high levels of uncertainty, particularly for investments; in others, it can be considered maladaptation if delayed action increases the cost of inevitable retrofitting or leads to locking in future development trajectories – see Section 6 (Agrawala et al., 2011; Ranger et al., 2010). Indeed, in some contexts, it may very well be the case that all other available adaptation strategies are considered less successful, less feasible and more costly than to remain on current development trajectories and deal with the consequences at a later point.

This issue of if (and how) development trajectories should change in response to long-term climate change plays out in national policies across many developing countries, where immediate development needs and an inability to cope with current climate variability have led many to prioritise efforts to address the 'adaptation deficit' (Burton, 2005; Moser and Ekstrom, 2010). In many cases, efforts to address the adaptation deficit can be considered inaction, as it may be that no policy adjustment takes place. Countries (or communities) can make a conscious decision that continuing support to addressing the underlying causes of vulnerability – often through non-climate-specific interventions – is the most effective option in light of immediate development needs, even when taking the implications of long-term climate risks into account. Indeed, addressing the adaptation deficit is likely to concomitantly support the enhancement of the adaptive capacity of people and communities to future climate change. This may be the case even if there is no deviation from current practice or planning (and hence no adaptation action in the traditional sense).

We argue that situations like these, where a conscious decision that weighs up the various implications of future climate and costs/benefits of different adaptation strategies has been made and results in a decision to support inaction, should constitute a viable adaptation strategy (and should therefore be eligible to qualify as maladaptive). This is also the case for strategies that are not aimed primarily at addressing climate impacts. Many projects that support economic or social development may have considered climate change and seen it only as a secondary, tertiary or even negligible priority. The latter is an example of inaction as a conscious strategy – one that the vast majority of development-related activities are likely to have chosen, particularly those addressing short-term development needs (Jones et al., 2015).

3.2 Interventions that do not have a primary focus on climate change can also constitute maladaptation

A wide range of strategies can help reduce a person or community's climate risk. Social protection schemes, women's empowerment programmes and direct cash transfers are each examples of interventions that can have a large impact on people's ability to cope with and adapt to changing climate stressors. Yet these strategies are unlikely to have considered climate change or climate change adaptation as a primary aim of the intervention. Rather, they may deem climate change a secondary, tertiary or even negligible priority (the latter being an example of inaction as a conscious strategy).

The growing attention donors, non-governmental organisations (NGOs) and governments are paying to 'resilience-building' also illustrates this issue well. The resilience narrative has encouraged many development and humanitarian actors to move away from

[2] Intriguingly, while the main body of the IPCC's AR5 appears supportive of this stance, stating that 'in a general sense maladaptation refers to actions, or inaction that may lead to increased risk of adverse climate-related outcome (See Glossary)' (Noble et al, 2014: 857, emphasis added), the glossary makes no such distinction, solely identifying actions as contributing to maladaptation (Agard et al., 2014).

addressing individual stressors towards a recognition of the interaction between the various overlapping stressors that affect people's livelihoods (Fan et al., 2014). Resilience-building programmes often cast climate change (and climate change adaptation) together with wider pressures such as food security, political instability and economic shocks – often through processes of 'mainstreaming' climate change adaptation. Despite climate change not being a primary objective, we argue these kinds of interventions should still be thought of as adaptation strategies. Thus, they can ultimately result in maladaptation, should such strategies lead to adverse outcomes.

The challenge of dealing with interventions that do not have a primary focus on climate change also reveals a significant weakness in the practical application of any maladaptation framework. While it is evident that maladaptation can arise only from adaptation strategies per se, the distinction between adaptation and development is often blurred, making it difficult to identify what is and is not classified as adaptation. More importantly, a focus on maladaptation to overlooks the impacts non-climate-related interventions are likely to have on people's climate risk (OECD, 2009). For example, a long-lived hydropower investment that fails to consider changing future patterns of precipitation in its design and implementation could lead to increased future levels of climate risk owing to reduced capacity from increased sediment loads, lower water availability or higher probabilities of dam failure as result of climate change (Lambruso, 2014). However, no adaptation has occurred in this case, and the intervention cannot therefore be considered maladaptive.

Coolmunda Dam Spillway

Given the large potential for wider development activities and strategies – many of which may not have considered the impacts of climate change – to impact on levels of climate risk, we see considerable use in also applying the framework to 'maladaptation-like' outcomes. Here we are interested in strategies that do not stem from deliberate adaptation, but which, just like maladaptation, result in increased vulnerability to climate change now and in the future. Here, the very same properties apply: strategies can be screened with the same criteria and characteristics to assess whether there has been a negative impact on levels of climate risk or wellbeing in much the same way. While acknowledging the distinction between maladaptation and maladaptation-like activities is of great practical relevance, it does increase the remit of the framework's applicability quite substantially. When seeking to explore the impacts of maladaptation-like strategies, it may be best to prioritise the framework's application in contexts with clear potential implications for climate risk – such as policies to promote economic transformation, national development strategies or large infrastructure investments.

3.3 Discounting the future

A fundamental component of maladaptation is time: it is only with time that the success or failure of interventions will become evident. In this regard, the principal challenge is when to say something qualifies as 'adaptation' or 'maladaptation'. Our current understanding of the term 'maladaptation' recognises that actions taken to reduce climate risk and vulnerability now may ultimately end up increasing either in the longer term. This trait is well illustrated in the context of groundwater abstraction in arid and semi-arid regions across North Africa and South Asia. For example, in many areas of Indian and Pakistan, groundwater is considered a common pool resource and a public good. Both countries instigated electricity subsidies to enable farmers to pump groundwater at a price below the marginal cost of supply (85% of the cost of supply in the Indian case) and reducing their input costs (Badiani et al., 2011; GoB, 2011). Khair et al. (2014), however, point out the potentially maladaptive nature of actions in this context, as a lack of strong institutions governing access and abstraction of water pumped from finite aquifers can, over time, lead to over-abstraction and groundwater depletion, in essence a process of subsidising maladaptation. Further such instances of maladaptation in South Asia point to reactive coping strategies, where 'tubewell capitalists' respond to falling water tables by digging deeper and higher-capacity wells (Dubash, 2002; King and Salem, 2012; Mustafa and Qazi, 2007).

While the temporal elements of maladaptation have been well documented and analysed in the literature, few have considered the practicalities of how to evaluate maladaptation over time. Should the introduction of an irrigation system in central Mali that has resulted in a significant and prolonged reduction in farmers' vulnerability to changing rainfall patterns over a 20-year period, with a relatively small increase in risk towards the very end of its lifecycle (perhaps owing to groundwater depletion), be classified as maladaptation? Inversely, should the creation of a large reservoir that adds considerable financial costs and debt burden to a poorly resourced local government in Ethiopia for 20 years during its construction, only to result in moderate reduction in the risks posed by climate variability after its completion, be labelled successful adaptation? These examples demonstrate the difficulties of working through maladaptation in practice. Indeed, some may classify them as maladaptive and others not. In many ways, evaluation of maladaptation can never be truly objective; there will always be subjective judgement calls associated with the boundaries that determine whether adaptation strategies fall within the categories outlined in Figure 1 (and later Table 2).

The examples above also highlight an issue that the literature on maladaptation has not addressed: discounting of future costs and benefits. The realisation that strategies taken today will have long-term implications for climate risk and vulnerability presents a number of challenges to the assessment of maladaptation. One cannot simply assume the benefits accrued from an adaptation strategy with immediate benefits will be valued equally to benefits accrued in the distant future. Many adaptation strategies are likely to bring distant benefits, recognising that the changing risk profiles associated directly with climate change are likely to be gradual rather than a sudden step-change. At the same time, there can be situations where the imperative to adapt is greater, such as when impacts may be irreversible, where action may be more difficult in the future or when addressing long-term decisions (Smith, 1997; Smith and Lenhart, 1996). Nonetheless, any effort to assess whether a strategy is maladaptive must therefore take into account the discounted future costs and benefits accrued (Preston et al., 2013). In certain cases, strategies that have helped alleviate climate risks and promote wider wellbeing over the course of a particular investment, but result in mild longer-term dis-benefits (such as locking a community into a specific livelihood practice), may ultimately be considered the most effective available strategy. This point is particularly pertinent in developing countries, given the immediacy of many development challenges and

their susceptibility to existing climate variability (and hence higher discount rates compared with other regions). We therefore argue that any assessment of maladaptation has to take into account the discounted value of an intervention's impacts both now and in the future.

3.4 Shifting baselines and counterfactuals

Another issue assessments of maladaptation have to contend with is the fact that ecosystems, livelihoods and economies are not static. Moreover, under climate change, climate risks and vulnerabilities to particular climate variables are likely to shift. Exploring the potential impacts of an intervention to reduce mortality to heat extremes in Burkina Faso, a 'stable' mortality rate after the intervention's implementation may imply the country's ability to cope with heat extremes is not improving. This is assuming the nature and frequency of such extremes remains constant (and therefore the intervention is not being effective). A longer-term increase in deaths may even seem to imply the intervention is maladaptive. However, if heat extremes are more severe and/or frequent, a stable (or even slightly increased) rate of mortality might indicate 'successful' adaptation measures that helped prevent a much larger increase in mortality in the face of rapidly worsening extremes (Brooks et al., 2011). Unpicking these shifting baselines is not easy. However, factoring them into any assessment of the effectiveness of adaptation strategies is key to preventing false labelling – whether optimal, sub-optimal or maladaptive.

A second confounding factor is also apparent: how effective are alternative strategies? It is possible to find cases where there is no viable adaptation strategy that results in a reduction in climate risk and vulnerability or heavy costs to society. In the situation where all options are likely to increase risk, current conceptualisations are likely to consider any strategy (including inaction) as maladaptive (see also temporal dimensions discussed in Section 4). Rather, we argue that an adaptation strategy should be considered partially (or even entirely) successful if it is the best available and reasonable strategy within the context that it is being applied, even if this results in a slight increase in risk (i.e. it is the least-worst option). In many ways, this is similar to the issue of counterfactuals in impact evaluation, which tries to establish and factor in the question: what would have happened otherwise?

Establishing the counterfactual in relation to adaptation is one of the hardest elements of assessing maladaptation. This is because of many factors, including the uncertainty of future climate impacts; the long-term nature of climate change and many adaptation strategies; and the many interactions between climate change and wider development drivers. Again, some element of subjectivity is inevitable. There are, however, ways of trying to account for this in impact evaluation.

One option is to rely on qualitative scenarios, developed through participatory exercises with local communities to ground comparisons firmly in local knowledge. Other, more quantitative, options include the use of randomised control trials (RCTs), comparing similar communities that have implemented a particular strategy with those that have not. RCTs may have their limitations in the context of adaptation/maladaptation assessment owing to difficulties in identifying suitable control groups (the impact of climate change are likely to be context-dependent, even at high spatial scales), resource and data limitations and ethical objections (Brooks et al., 2014).

Related to the issue of shifting baselines is the question of how to account for the changing influence of livelihood characteristics on drivers of adaptive capacity (and therefore indicators of adaptation effectiveness or maladaptation). Recognising indicators and proxies for successful adaptation may shift is a consideration few have accounted for in practical terms. Indeed, while each of these conceptual issues provides challenges to evaluating the effectiveness of adaptation strategies, finding appropriate ways of accounting and compromises for them will be crucial to any framework assessment of maladaptation (whether qualitative or quantitative). It also brings up the notion that factors presently thought to contribute most to successful adaptation – or rather, optimal adaptation, as we define later in Section 5 – may not be considered the same by different social groups or at different times (Barnett and O'Neill, 2010).

3.5 Distributional aspects of adaptation

Another area largely neglected in current discussions of maladaptation is distribution and equity. Distributional aspects of adaptation are important for two reasons. First, climate change is likely to affect segments of the population differently, in terms of both direct impacts and influences on wider drivers of development. Second, the act of implementing (or choosing not to implement) an adaptation strategy can fail to uniformly reduce climate risks across all social groups (Huntjens et al., 2012). In fact, strategies with the highest risk of maladaptation are those where the benefits are mainly received by one group, while others elsewhere face increased vulnerability as a result of the strategy's implementation (Barnett and O'Neill, 2010).

It is not only in relation to climate risk that adaptation strategies can influence inequity. Implementation of adaptation strategies can act to unequally distribute wider social and economic costs and benefits among different social group (Eriksen and Brown, 2011; Lemos et al., 2007). They can also serve to reinforce unequal power relationships, gender roles and subjugation of marginalised groups (Brody et al., 2008; Jones and Boyd, 2011; Onta and Ressureccion, 2011). Above all, it is important to acknowledge that adaptation will invariably result in winners and losers (Kates, 2000). We therefore argue that maladaptation should take into account the influence adaptation strategies can have on the distribution of wellbeing – whether in relation to reduced economic income, susceptibility to non-climate-related risk or simply a negative impact on qualities that people place a high value on (such as cultural landmarks, traditional ways of living or factors important to their heritage).

Flooding Sudan

Oriny, a flood-affected village in Upper Nile State, Sudan.

4. Characteristics of maladaptation

While the term 'maladaptation' has many contested definitions, it has few conceptual frameworks to guide researchers, policymakers and practitioners in identifying maladaptive outcomes. Here, we provide a characterisation of maladaptation that incorporates, seeks to build on and further develops current conceptualisations of maladaptation in practice. We address aspects of the five points of clarity listed in Section 3 and seek to lay the conceptual underpinnings for a user-focused evaluative framework for maladaptation. We also note the framework does not address all of the challenges posed by conceptualising maladaptation, and many questions around implementation still exist. Future ground-truthing, modification and further elaboration will be crucial to testing the framework's validity and utility.

In trying to ensure the framework is policy- and practitioner-orientated, we describe four different dimensions of maladaptation that we consider its constituent parts and propose that any framework recognise and incorporate four distinct elements: climate risk; wellbeing; time; and distribution. Below, we detail and justify our understandings of these four elements, before explaining how they interact as part of a simple overarching assessment framework (in Section 4.5).

4.1 Climate risk

The first element of our maladaptation framework relates to the propensity of an adaptation strategy to increase levels of climate risk. At its simplest, a strategy may be considered maladaptive if it contributes negatively to climate-related outcomes or reduces the ability of people and communities to deal with and respond to climate change. This is typically the characteristic most associated with maladaptive strategies. For our purposes, we adapt the definition Field (2012) uses to consider climate risk the likelihood over a specified time period of severe alterations in the normal functioning of a community or a society owing to hazardous physical events as a result of climate change interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects (p.5).

Climate risk is commonly broken down into three main components: climate hazards; exposure; and vulnerability (Oppenheimer et al., 2014). In the context of maladaptation, it is important to consider how strategies impact on all three individually. For example, any assessment of a strategy's influence on climate risk would have to consider its impact on the frequency and severity of climate hazards facing people and communities (climate hazard); the exposure of people and their assets to climate hazards (exposure); and the capacity of people to deal with and respond to shocks and stresses, their ability to adapt to change and their susceptibility to climate-related impacts (vulnerability). Assessments of maladaptation therefore require a number of different indicators to be taken into account.

Each component of climate risk may not necessarily be weighted equally, nor are factors that contribute to each likely to look the same everywhere. Vulnerability, for example, is highly context-specific: the factors that make a coastal fisher vulnerable to climate change in Lamu, Kenya, are unlikely to be the same as those for a pastoralist in Karamoja, Uganda. Understanding the context and scale within which the framework is applied is therefore key to allowing users to understand how each component affects people's climate risk in any given area. The latter point is particularly important in weighing up instances where a strategy may have contributed negatively to one component of climate risk, such as increasing the number of people living in flood-affected areas, but contributed positively to another, such as enhancing people's capacity to deal with flood risk and prevent economic losses. Recognising the points raised in the previous section, assessments of climate risk must also take shifting risk profiles into account, as well as consider the impact of strategies relative to other reasonable available options. It is here where some of the methods outlined in Section 3.4 may be of use. It is for this reason that we refer to 'positive' and 'negative' contributions to climate risk, as effective adaptation strategies may result in no absolute gains (or even slight declines in overall levels of climate risk), as highlighted by the Burkina Faso heat extremes example earlier.

4.2 Risk of diminished wellbeing

The second element of maladaptation evaluation relates to the recognition that an adaptation strategy can not only influence levels of climate risk but also lead to adverse impacts on the wellbeing of people and communities. This is a consistent with the IPCC's definition of maladaptive actions, which includes reference to 'diminished welfare, now or in the future' (Agard et al., 2014: 1769). Here, however, we propose that any interpretation of maladaptation go beyond welfare to include the largely intangible elements that make up a good quality of life, such as psychological wellbeing, cultural identity and sense of place, as well as strong and sustainable livelihoods, basic needs and health. For this reason, we refer to wellbeing and not welfare. Under this framing, an adaptation or strategy can be maladaptive when there are negative contributions – unintended or otherwise – on people's wellbeing. We argue that considering climate risk alongside diminished wellbeing in diagnosing maladaptation best captures the negative ancillary effects an adaptation strategy can have on wider development objectives, if not properly thought-through from the outset. Indeed, assessment of wellbeing has taken off as an academic discipline in recent years (Tay et al., 2015). Drawing on insights from this burgeoning field, any assessment of the impact of adaptation strategies on wellbeing should aim to capture both objective and subjective measures and seek a more holistic understanding of the processes that underlie a person or community's wellbeing (Kahneman et al., 1999).

There will inevitably be a degree of overlap between wellbeing and climate risk (particularly in relation to the vulnerability component). However, we acknowledge that many economic, social and environmental aspects that make up a person's wellbeing will not play a significant role in reducing their vulnerability to climate change. Depending on the context, this may relate to wider livelihood opportunities and economic prospects, happiness and mental health or simply aspects that people derive value from in their day-to-day lives, such as cultural identity, heritage or sense of place (Fresque-Baxter and Armitage, 2012). Many of these wider factors – whether related to wealth, comfort, material or emotional necessities – are just as important to consider in assessing the impacts, and effectiveness, of an adaptation strategy.

4.3 Time

The third element relates to time. How a strategy is likely to impact on both climate risk and wellbeing both now and in the future can determine whether a strategy is maladaptive or not (see Section 3.3). In this sense, maladaptation occurs when short-term costs (or gains) outweigh longer-term costs (or gains) during the period of time of interest. Crucially, any weighting of near- and long-term costs/gains needs to factor in the issues of discounting: rarely will they be equal. Also important to note is that maladaptation can occur long after a project cycle has completed (particularly in the case of long-lived infrastructural investments). Knowing when to designate this final outcome is difficult, and thus it is often better (and more practically useful) to identify processes likely to lead to maladaptation rather than maladaptive outcomes.

4.4 Distribution

The last element of our maladaptation framework relates to the distributional elements of adaptation. Climate risk is often differentially distributed across a system and over time. But it is not only the impacts of climate change that will have distributional elements; so will interventions taken to respond to climate change. Adaptation strategies can, if poorly implemented, affect the distribution of levels of climate risk across a community or society; indeed, winners and losers are somewhat inevitable (Boutrup Møller and Nielsen, 2013). With this in mind, the central aim of an adaptation strategy may not simply be to collectively reduce risks across the entire system but to ensure risks are more equitably distributed across different social groups (or, at the very least, ensure that those most in need are not negatively affected). Indeed, this is the aim of many gender and climate change programmes, such as 'gender mainstreaming' projects, that seek a rebalance of climate risk and the empowerment of women and girls (Djoudi and Brockhaus, 2011).

If a strategy has a large negative impact on the distribution of risk across a system, or if there is a significantly uneven distribution of impacts on economic and social wellbeing, this strategy should be considered maladaptive. An uneven distribution of risk occurs when the costs (or gains) are far larger for one social group than for others. It may even be the case that some people benefit from an adaptation strategy while others face an increase in climate risk and diminished wellbeing as a result.

As with all other elements of maladaptation, distribution of risk depends on time: negative impacts on distribution can happen at any point and need to be weighed up over the period of evaluation. This final element of maladaptation has received scant attention within the climate literature to date.

4.5 Bringing the four elements together

Simply identifying how each element contributes to maladaptation is not sufficient in helping guide decision-makers in

avoiding maladaptive strategies. Nor can it serve as the basis for an evaluative framework without us knowing how each interacts with the others. Below, we present a framework that starts to bring together the five points of clarification described in Section 3 and the four elements outlined in Section 4 in a way that allows decision-makers to evaluate where specific adaptation strategies are likely to contribute to one or more aspects of maladaptation. Important to note is that this framework does not (and cannot) address all the challenges raised in this paper. Rather, it seeks to build on and advance current understandings and best practice approaches to assessing maladaptation. It is hoped that the framework will serve as the basis for further elaboration and validations – such as through the development of qualitative and quantitative indicators.

The framework starts by isolating the two first elements identified in Sections 4.1 and 4.2 as overarching 'characteristics' of maladaptation: climate risk and risk of diminished wellbeing. These are further subdivided into two 'sub-categories' that relate to the distribution of risk: recognising that impacts can have an effect on collective risk; and their potential to further exacerbate inequalities in the distribution of risk across different social groups. Given that the last remaining element, time, cuts across both the categories and sub-categories, we embed temporal aspects into each (see Table 1). In this sense, an evaluation of any aspect of maladaptation cannot be considered a snapshot in time. Rather, maladaptation should be evaluated against the impacts a strategy has both now and/or in the future. Below, we describe each sub-category in greater depth and highlight examples.

Table 1: Towards an evaluative framework for assessing maladaptation

CATEGORY	IMPACT ON CLIMATE RISK		IMPACT ON WELLBEING	
SUB-CATEGORY	Collective climate risk over time	Distribution of climate risk over time	Collective well-being over time	Distribution of well-being over time
How Strategies May Contribute To Maladaptation	An adaptation strategy is maladaptive when it impacts negatively on collective climate risk across a system (relative to other available strategies) now and/or in the future	An adaptation strategy is maladaptive when it exacerbates inequitable distribution of climate risk across a system (relative to other strategies) now and/or in the future	An adaptation strategy is maladaptive when it impacts negatively on collective wellbeing across a system (relative to other strategies) now and/or in the future	An adaptation strategy is maladaptive when it exacerbates inequitable distribution of wellbeing across a system (relative to other strategies) now and/or in the future
Example	In arid and semi-arid areas of Kenya, adaptation strategies designed to promote economic growth have, over time, undermined traditional support structures and the adaptive capacity of many pastoralists (Carabine 2014))	Construction of Wonthaggi desalinisation plant in Australia impacted disproportionally on poorer households in the form of higher water costs and do not have the same opportunities to reduce water use due to low levels of income and lack of land tenure (Lee, 2007 in Barnett and O'Neill 2010)	In Northern Burkina Faso, many former pastoralists have been encouraged to diversify livelihoods as a result of persistent drought. Besides the material losses, many of these former herdsmen feel they have lost their cultural identity as a result of adapting their livelihood practices (Traore & Owiyo, 2013; Warner et al. 2013)	In the Humla region of Nepal, adaptation strategies involving the planting of drought-resistant crops have reinforced gendered roles of agricultural work and led to increased pressure for girls to be removed from schooling. Despite this, the strategies have had a positive impact in collectively reducing climate risk at the household and community levels (Onta & Resurreccion 2011)

When considering the application of the framework and interplay between the different characteristics and sub-characteristics of maladaptation, it is important to remember these should not necessarily be weighted equally and are highly dependent on context. Decision-makers may prioritise climate risk over maintaining wellbeing; others may be less willing to sacrifice quality of life or other social, cultural or economic aspects of their livelihoods that are of value. Equally, a decision-maker may decide reductions in collective risk are of great value, despite having little-to-no impact on improving inequitable distributions of climate risk across a society. These will inevitably require judgement calls, and mean any evaluative framework should be weighted appropriately.

The aim of this framework is not to provide precise indicators and weightings to allow for maladaptation to be qualified (although, in time, this may prove feasible). Rather, the framework is meant to raise awareness by clarifying the main constituents of maladaptation and to help identify strategies likely to lead to maladaptive outcomes early.

Section 6 of this paper attempts to address some of the issues to consider in applying the framework. It is also possible to further refine the framework to suit the various needs of different decision-makers at all levels of governance – whether in the form of criteria for the design and implementation of future adaptation programmes, identification of specific indicators for maladaptation to be identified and tracked or ideas for incorporating elements of maladaptation into existing monitoring and evaluation (M&E) systems.

5. Defining adaptation outcomes

The premise underlying maladaptation is that adaptation strategies can lead to several different outcomes, not all of which are desirable. With the foundations of an evaluative framework now in place, it is possible to reflect on how maladaptation is distinguished from other types of adaptation outcomes. Building on the simple conceptualisation presented in Figure 1, and using the characteristics of maladaptation listed above, we propose four distinct types of adaptation outcomes: optimal adaptation; suboptimal adaptation; failed adaptation; and maladaptation. As with many aspects of maladaptation, the distinctions are subjective and largely dependent on a person's definition and interpretation of the different labels associated with each outcome. However, it is hoped the following will help support policymakers, practitioners and researchers think through different outcomes in practical terms. Another advantage is that the distinctions presented below lend themselves to both qualitative and quantitative evaluation.

Optimal adaptation occurs when a strategy successfully minimises the risks of maladaptation described above. Essentially, this means a strategy should make large positive contributions to a reduction in climate risk without diminishing wellbeing. In recognition of shifting baselines and counterfactuals (described in Section 3.4), positive contributions should be considered with respect to both the changing nature of future risk and the cost and implications of other available adaptation strategies. We therefore categorise an optimal adaptation strategy as one that has significant positive effects across both sub-categories of climate risk and no negative contribution towards wellbeing (see Table 2).

Table 2: A typology of adaptation outcomes

		IMPACT ON REDUCING CLIMATE RISK		IMPACT ON WELLBEING	
		Collective climate risk over time	Distribution of climate risk over time	Collective well-being over time	Distribution of well-being over time
ADAPTATION OUTCOMES	Optimal adaptation	Significant positive effect across both sub-categories of climate risk		No negative effect on wellbeing	
	Suboptimal adaptation	Limited positive effect on at least one sub-category of climate risk		No negative effect on wellbeing	
	Failed adaptation	No effect on any sub-category of climate risk [3]		No negative effect on wellbeing	
	Maladaptation	Negative effect on at least one sub-category of climate risk or wellbeing			

[3] In a scenario where there is no effect on dimensions of climate risk but positive effects on at least one dimension of wellbeing, we would consider this to be failed adaptation.

Adaptation can be described as suboptimal adaptation when a strategy does not maximise opportunities to reduce collective climate risk or does little to encourage more equitable redistribution of climate risk among a population. In the typology described in Table 2, we propose that suboptimal adaptation occurs when there is a positive effect on at least one sub-category of climate risk, and no negative effect on wellbeing.

Failed adaptation occurs when a strategy has a negligible impact (neither positive nor negative) on reducing climate risk both now and/or in the future. With this in mind, strategies that do not have a discernable influence on climate risk but have a positive impact on wellbeing can also be considered as failed. Such interventions may even be considered optimal or suboptimal development strategies.

By this argument, maladaptation occurs when a strategy has large negative contributions to the climate risk or wellbeing of social groups now and/or in the future. This can be in relation to either collective or distributional aspects of both categories. For example, if an adaptation strategy has been effective at reducing levels of climate risk, but has resulted in a significant increase in economic income inequality, then it can be considered maladaptation.

Knowing how different types of adaptation strategies are classified allows for a more nuanced understanding of the relationships between each. For the purposes of this paper, which focuses specifically on maladaptation, the most important point of clarity is knowing what types of activities and process are most likely to lead to maladaptive outcomes (i.e. negative contributions to at least one sub-category of climate risk or wellbeing). This should help decision-makers identify and diagnose maladaptive symptoms before they are likely to result in negative outcomes. Below we describe some of these activities in detail.

6. Diagnosing maladaptation

A number of different factors can trigger maladaptive outcomes. Here, it is important to distinguish between factors likely to lead to maladaptation in the future and maladaptation as an end-state. From a decision-maker's perspective it is the former that is of far greater relevance. The option of waiting until a strategy has terminated in order to evaluate whether it has resulted in a maladaptive outcome is not only unhelpful in guiding its implementation but also difficult, as maladaptation may arise long after a strategy has terminated (reflected in the time dimension). With this in mind, we recognise that, just because a strategy is likely to lead to maladaptation, this does not mean a maladaptive outcome is guaranteed. We therefore refer to 'symptoms' of maladaptation, recognising that each has the potential to contribute to a maladaptive outcome.

The next logical step in developing an evaluative framework for assessing maladaptation is therefore to identify likely symptoms of maladaptation. This can then help decision-makers and evaluators to gauge whether their investments and strategies are likely to result in maladaptive outcomes. In Table 3, we outline a number of proposed maladaptive symptoms from across a range of different sources within the climate change and development literature. These are by no means exhaustive, and many more can (and should) be identified as symptoms of maladaptation. It is also worth noting that many of the symptoms are interrelated, and are not mutually exclusive. As with all aspects of maladaptation, a time dimension runs through each. It is thus important to consider how each symptom is likely to affect the characteristics of maladaptation both now and/or in the future. Table 3 is simply an example of the type of application the framework may lend itself towards in seeking to add practical value to decision-makers.

In listing some of the key symptoms of maladaptation, it is evident that many can be grouped together. Below, we describe three separate groupings, and provide further brief details of some of the individual symptoms that fall within them.

Table 3: Symptoms of maladaptation and their impacts on the characteristics of maladaptation

	SYMPTOM OF MALADAPTATION	IMPACT ON CLIMATE RISK		IMPACT ON WELLBEING		Source
		Increased collective climate risk over time	Increase in unequal distribution of climate risk over time	Diminished collective well-being over time	Increase in unequal distribution of well-being over time	
Enabling environment for adaptation	Not able to learn: A lack of feedback and learning prevents robust decision making	x				Tschakert & Dietrich 2010
	Risk averse/prone: Not willing, or overly keen, to accept the risks associated with proposed adaptation strategies and change course	x				Barton et al 2014
	Failure to take advantage of windows of opportunity: not capitalising on opportunities presented by a changing climate	x				Ford et al 2011; McNeeley 2012
	Overly incentivizing adaptation when it is not needed: Adapting too early or adapting too quickly	x				Oberlack & Neumarker 2011
	Lack of (or too much) innovation: An enabling environment to foster innovation is not created. Strategies are either not adopted, adopted too late, or not adopted at a fast enough pace	x				Jones et al 2010
Political economy and institutions	Power and elite capture: Benefits and control over adaptation strategies are held by powerful groups - may enhance marginalisation of particular social groups		x		x	Shackleton et al 2015
	Unwilling to invest or prioritise adaptation strategies ahead of other development alternatives: Effective adaptation strategies are deemed too high to invest or not deemed a priority at the present time	x				Huq et al 2006
	Cultural and social barriers: May prevent the adoption of adaptation strategies, or limit their effectiveness amongst particular social groups	x	x		x	Adger et al 2009; Jones & Boyd 2010
	Strategies exacerbate existing structures of inequality: Not all recipients benefit equally	x	x	x	x	Boutrup Møller, & Nielsen 2013
Planning and management of adaptation strategies	Poor use of information or misunderstanding of system dynamics: Failure to recognise available information on changing profile of future risk, and the interactions between different drivers of risk and vulnerability	x		x		Wilby et al 2009
	Negative externalities: Negative impacts of adaptation strategies is not recognised or accounted for (e.g. impacts on downstream users)		x	x	x	Barnett & O'Neill 2010
	Lack of redundancy: High dependency on critical infrastructure, with few alternatives in case of failure	x				Mailhot & Duchesne 2009
	Path dependency: Locking in future development trajectories	x		x		Granberg & Glover 2011
	Not recognising interactions with wider drivers of development: Strategy that reduces climate risk but reduces the wellbeing of people and communities	x		x		Ford et al 2011
	High opportunity and/or sunk costs: Option to adopt alternative adaptation strategies is lost when one is chosen, either due to limited resourcing or 'locking in' to particular development trajectories.	x				Dobes 2012
	Strategies that contribute to greenhouse gas emissions: Potential to enhance future climate impacts	x	x	x	x	Barnett & O'Neill 2010
	Promoting incremental adaptation when transformation is needed: Not adapting at a fast enough pace	x				Rickards & Howden 2012

6.1 Enabling environments for optimal adaptation

A context where few incentives for innovation exist (perhaps because of a lack of social safety nets) may discourage people or communities from trying new ideas or implementing radically new policy options (Jones et al., 2010). In such cases, it is common for adaptation strategies to be adopted at an insufficient pace to keep up with future risk. The alternative is also possible, whereby over-incentivisation can result in adoption of strategies too quickly. Related to this is the issue of risk acceptance, whereby societies or individuals that are risk-averse may be unlikely to accept the risks associated with adopting new strategies, particularly if they involve a significant departure from current development trajectories. Likewise, those that are risk-prone may be likely to push ahead with change when no change is needed, or when the adoption of adaptation strategies arises too early for successful uptake and adoption at scale (Barton et al., 2014). Interestingly, as climate change is likely to exacerbate many future risks, it is also possible to consider those who are reluctant to adapt and change as 'risk-prone', such as those willing to 'ride it out' in the face of likely changes to future risk profiles.

To work through another example, societies and groups that fail to learn from past and current experiences and adapt their behaviour accordingly in the face of change are less likely to lead successful adaptation outcomes than those that do (Kristjanson et al., 2014; Williams et al., 2015). Again, a failure to create a suitable enabling environment does not necessarily lead to maladaptive outcomes. However, from the perspective of a policymaker or planner, knowing a particular strategy has a high risk of contributing to maladaptation, and identifying the most appropriate ways of addressing these symptoms, is key to ensuring successful outcomes (Tschakert and Dietrich, 2010).

A final enabling environment relates to windows of opportunity. Often, the ability to make large or meaningful adjustments (whether with regard to public policy or personal behaviours) is limited in time (Ford et al., 2011; McNeeley, 2012). As an example of this, the longest time frame for government decision-making in Malawi is currently in the order of 10-15 years into the future, through its Vision 2020 strategy. Although this document alludes to climate change objectives, long-term climate information is currently not used to guide projects and policies, and there is little evidence of ministries using longer-term climate information in current decision-making (Vincent et al., 2014). Since the current Vision is nearing its end, the development of a successor is underway. This presents an opportunity to embed climate information in an influential long-term development strategy. If this is missed, there is a risk of coming up against considerable institutional barriers in encouraging uptake later on.

6.2 Political economy and institutions

The political economy of institutions is complex everywhere, but not least in developing countries (Jones et al., 2014, 2015). Governance networks are often made up of multiple institutions, including government, civil society, donors and NGOs. The power dynamics inherent in these networks play out in the design and prioritisation of adaptation and development strategies, invariably representing the interests of some groups and not others (Shackleton et al., 2015).

The priorities and interests of those in power will likely determine allocation of resources and available options for adaptation. These dynamics may result in unwillingness to invest in particular adaptation options or in reducing climate risk in development strategies, the result being that opportunities for optimal adaptation are missed or at worst lead to maladaptation (Huq et al., 2006). In other cases, and especially in developing countries, the urgent need to address immediate development concerns such as health or education may override commitment to tackling climate change.

Often, scarce resources must be allocated to these priority areas before investing in climate change adaptation.

Perceptions of risk are filtered through cultural and social lenses that can act as barriers to adaptation (Adger et al., 2013; IFRC, 2014). For example, in many cultures, understandings of environmental change and risk are perceived through impacts on sense of place (Fresque-Baxter and Armitage, 2012) or through spiritual beliefs (Schipper, 2008). In turn, perceptions of risk, and how to respond to them, influence choices about adaptation (Jones et al., 2010; Nielsen and Reenberg, 2010).

Existing structures of inequality already affect adaptive capacity and can be exacerbated when different adaptation options benefit different groups. As an example, neglecting to mainstream gender into adaptation strategies can reinforce existing imbalances (Boutrup Møller and Nielsen, 2013). At the same time as differentially affecting the wellbeing of groups of society, such strategies can also lead to increased climate risk, through loss of adaptive capacity associated with employment opportunities or through increased exposure to hazards for women (Denton, 2002).

6.3 Planning and management of adaptation strategies

Adaptation strategies should be devised with full recognition of the multi-stressor contexts facing poor and vulnerable communities. Nonetheless, there are significant difficulties inherent in understanding complex social-ecological systems and in applying climate science, which make it nearly impossible to make accurate predictions about impacts (Jones et al., 2015). Rather, strategies have to be developed within an envelope of uncertainty, which is often difficult to define in the present, let alone in the future.

For these reasons, it may be that the negative externalities associated with a strategy, for example those leading to increased risk of diminished wellbeing or increased climate risk, are not recognised or adequately accounted for (Barnett and O'Neill, 2010).

Redundancy is the idea that, if a system remains diverse in its structure and function, it is less likely to be affected by shocks and stresses. For example, a drylands community may derive livelihoods from a diverse base of natural resources and employment activities, ensuring capacity to cope if a drought or flood event affects one of these. If an adaptation or development strategy encourages reliance on a single, high-income, livelihood strategy, climate risk may be increased for that community over the long term as redundancy is lost from the system (Mailhot and Duchesne, 2009).

In this way, strategies may similarly lock in future development trajectories, or create path dependency. For example, hard engineering solutions to reducing climate risk, for example sea walls, versus ecosystem-based approaches, for example mangrove restoration, might have this effect (Carabine et al., 2015). Alternatively, development of long-lived infrastructure that does not adequately consider future climate change and variability can lock in development trajectories associated with urban development or transportation networks (Jones et al., 2015). The opportunity costs in these examples may also be sufficiently high so as to lead to maladaptive outcomes.

In some cases, practitioners may decide to take a course of climate action that contributes to reduction of greenhouse gas emissions, without additional measures for adaptation or development. Given that further climate change is inevitable in the coming decades and the risks for developing countries, and arid and semi-arid areas in particular, are high (IPCC, 2014), such a strategy is likely to lead to increased climate risk compared with integration of adaptation, mitigation and development approaches (Mitchell and Maxwell, 2010). For example, many semi-arid communities are energy-poor, with lack of supply hindering sustainable development. Meeting demand can be achieved through low-carbon technologies that lead to reduced carbon emissions at the same time as increasing adaptive capacity at the community level. Geothermal and solar energy is already utilised extensively in Kenya for both large-scale and decentralised electricity production, but distribution of these resources can limit the extent to which these strategies are pursued (IPCC, 2014).

Often, practitioners promote incremental adaptation where transformation is needed, for example advocating changes in cropping regimes, when what is required is transformation to large-scale innovations in agricultural technologies (Rickards and Howden, 2002). Doing so can increase the level and distribution of risk for communities where the opportunity costs of failing to transform are high.

6.4 Taking the framework forward

Table 3 demonstrated the sort of tool the framework can apply itself towards. Indeed, it is applications such as these that can help identify symptoms and actions with a high likelihood of leading to maladaptive outcomes that are of most relevance to decision-makers. Waiting until a strategy has finished in order to evaluate whether it has contributed to maladaptation or not is far from ideal in guiding real-world decisions today – indeed, the time-based element of the framework means strategies may only become maladaptive long after a project has finished. Identifying other symptoms of maladaptation, and highlighting the enabling environments, political and institutional settings and management contexts where these are likely to lead to maladaptation, is an important next step. Indeed, the framework itself needs to be further validated and applied in practice. Efforts to ground-truth each of the characteristics, and provide contextual detail for each, will be key to the development of qualitative and quantitative indicators. Lastly, identifying the right types of toolkits that the framework can lend itself towards (such as those outlined in Section 4.5), based on practitioners' needs, and findings ways of communicating many of the abstract concepts and terms to non-specialists will determine the utility of the framework in practice.

7. Conclusions

In this paper, we have outlined five areas of conceptual clarity needed in understanding and evaluating maladaptation. We presented the groundwork for a conceptual framework that can lend itself to qualitative and quantitative assessment of adaptation strategies, and clarified the differences between four distinct types of adaptation outcomes – ranging from optimal adaptation to maladaptation. Most importantly, we have used the framework to highlight a number of different 'symptoms' that can act as early warnings for maladaptive outcomes, hoping to guide policymakers in achieving early diagnosis. Where possible, we have provided real and hypothetical examples of where the framework could and should be applied.

In doing so, our aim has been to make this onerous concept more tractable and applicable to planners and practitioners so as to diagnose strategies likely to lead to maladaptation. It is our hope that this paper will stimulate debate and galvanise interest in advancing efforts to understand and, critically, to avoid maladaptation in the face of increasing climate risks in the coming decades.

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This work was carried out under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA), with financial support from the UK Government's Department for International Development and the International Development Research Centre, Ottawa, Canada. The views expressed in this work are those of the creators and do not necessarily represent those of the UK Government Department for International Development, the International Development Research Centre, Canada or its Board of Governors.

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